Safety and Chemical Hygiene Plan

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1 Introduction to the Safety Plan

1.1 Emergency Equipment:

A brief overview:

- Red Emergency Telephones are located near the "T" of Hamilton Hall (each floor, except 1).
- Each laboratory in Hamilton Hall has two types of fire extinguisher, dry chemical (powder) and carbon dioxide.
- Normally, chemical operations are performed in the fume hoods present in each laboratory.
- The 9th floor of Hamilton Hall has "High Hazard" facilities. Extremely dangerous laboratory
- operations should be performed in one of these rooms.
- Eyewash hoses are available at the entrance to most laboratories.
- Eyewash fountains are present in most laboratories.
- Safety showers are present at the entrance to most laboratories.
- Respirators may be used if the individual has undergone specific health examination for personal safety.
- A radiation monitor is available from the Safety Chair. Radioactive materials may only be used after special training (see below), and in approved sites.
- More specific information on usages and maintenance is given in the following paragraphs.

1.2 Chemicals Present in Hamilton Hall

Over 8000 different chemicals are present in Hamilton Hall. Each laboratory must have a list of the chemicals present in the lab, and the approximate quantity present. The list must be updated yearly. A master list of chemicals present in computer database format is present in Room 403

2 Specific Information Regarding Hamilton Hall

2.1 Alarms in Hamilton Hall

2.1.1 Fire: Voice notification, plus sound, plus blue flashing light

Close the laboratory doors behind you. Use the nearest stairs. The elevator will not work. If you are already on the elevator, it will descend to the first floor, and doors will open. The elevator will not work further. Move away from the building. It is quite likely that the building sprinkler system will be actuated in the fire area. This may cause flooding in lower floors. However, do not be concerned about equipment or experiments in progress. Exit the building on first sound of the building alarm. It may take only a short time for the fire or heavy smoke to engulf escape routes. If this happens, try other exit routes. The precise evacuation route chosen depends upon where the fire is. If your

first choice is blocked by fire or heavy smoke, try an alternate route. Other things being equal, the evacuation routes shown in Appendix E are recommended.

- Experiments in progress: Turn off the power to solvent stills, heating mantles, etc., only if you can do so without delaying your departure more than a few seconds. After evacuating the building, if you realize that an unattended laboratory operation may pose a safety problem, inform the officer guarding the door or a member of the safety committee.
- DO NOT try to reenter the building until the “all clear” signal is given.
- After exiting Hamilton Hall, research groups will assemble in the Sheldon parking lot. If persons known to have been in the building are not present, and believed to be still in the building, emergency officials must be notified (e.g. the University police, located near the entrance to Hamilton Hall).

2.1.2 Tornado: Voice notification plus flashing light.

STAY INSIDE the building. Go to the BASEMENT or to the NORTH hallway of 2 or 3. The elevators WILL work, and may be used. STAY AWAY FROM WINDOWS, insofar as possible. The tornado will shatter windows and create flying glass shards that are very dangerous. Also, avoid the large lecture rooms, even though they have no windows. Often, the City of Lincoln tornado alarm will sound before the campus tornado alarm. If you hear the city alarm, obey it -- seek shelter immediately.

2.1.3 Dangerous Chemical Spill: “Continuous Buzzer” will sound.

Exit the building as rapidly as possible.

2.2 Emergency Notification:

The following incidents may happen to you or others in your vicinity:

- FIRE or Explosion (and accompanying fire)
- Large-scale Chemical Spill involving potential danger to others
- Injury Accident
- Medical Emergency, e.g. a heart attack
- Flood
- Intruder in the building

2.2.1 Your Response:

Put out **small fires** or clean up **small spills *yourself***. The following guidelines pertain:

A small fire is one where

- No immediate danger exists to personnel.
- The fire may be extinguished before spreading beyond your control.
- The blaze probably can be extinguished with the contents of a single fire extinguisher.

A small spill of a chemical is one NOT involving significant danger to yourself or others. The following are considered **MAJOR spills** (not small spills):

- *Any* spill of flammable, toxic, or corrosive liquids in **unventilated spaces** such as an elevator or stair well.
- *Any* spill or release of a material which could produce death or serious injury upon short exposure (e.g. phosgene, tetrodotoxin)
- More than approximately one gallon or four liters of any flammable or corrosive liquid.

For a MAJOR FIRE or MAJOR SPILL:

- Close the doors to the lab in order to contain blaze or chemical fumes. These doors are "Class A " fire doors, which will withstand a major conflagration for ca. one hour.
- For a spill, "secure the area" so others do not track through the chemical spill.
- Use chairs or whatever is available to block access to the spill area.
- Actuate the red building alarm located near the “T” of Hamilton Hall. In the case of an explosion or fire, do this from a safe location (another floor, or another building, etc.)
- For all emergencies, also use the red emergency telephone, also located near the “T” of Hamilton Hall. Do this from a safe location, say, another floor. STAY ON THE LINE. It may seem as if the time for the operator to answer is inordinately long, but it is not, so WAIT! The operators are highly trained, and will lead you through the emergency notification process. Cell phone users may call the University switchboard at (402) 472-7211.
- Be prepared to tell operator the nature of emergency (explosion?, fire?, spill?, injury?, apparent heart attack?), where it is and how many injured? For “double emergencies”, (say injured persons as well as fire), so inform the operator.
- You may use ***any telephone*** for emergency notification; simply dial “O” or “911” *or “9-911".*
- After emergency notification, exit the building yourself. For dangerous spill, stay near the lab door in order to be able to inform emergency personnel of details.
- Emergency personnel will need to know the ***identity*** of the chemical in question.

For injury accident or medical emergency

- Dial 911
- ***Check for other hazards.*** There may be an electrocution hazard, or hazard due to a noxiouschemical release.
- Yell! Get others involved!
- Send another person to locate the Chemsitry Lab manager. Send another person down to the doorway of Hamilton Hall to guide emergency personnel to right location in Hamilton Hall.
- A list of persons trained in CPR or First Aid is available in the front office.
- Render what assistance you can, once you determine that there is no danger to yourself.
- Generally, if blood or bodily fluids are in evidence - STAY AWAY; let trained

personnel handle the emergency.

- Stay with victim. Watch for signs of shock. Remember, no help can come until you call for help (911).
- CPR: Always check an unconscious victim for pulse and respiration. Be prepared to administer CPR *if you are certified*. A list of CPR-qualified persons in Hamilton Hall is kept in the front office. CPR training is available through Campus Recreation. Training is provided several times a year.

Burns/Fire

- If the victim is still on fire, extinguish the flames rapidly by any means available that involves no danger to the victim. The safety shower (lab doorways) is recommended.
- YELL for HELP. Have someone stay with victim while another uses the RED emergency phone or dial 911.
- Stay with victim until emergency responders arrive.
- Do not try to apply emoluments to burns of victim, unless a commercial first aid kit is available and *you are trained in first aid*.

For a **minor chemical spill**, clean it up yourself, if you are familiar with the spilled material and are sure that there is no danger to yourself. Wear protective gloves. If in doubt what to do, consult the Safety Chair or another member of the committee.

- All labs must have appropriate absorbent materials or commercial spill **kits available**. “Kitty litter” is cheap and readily available.
- Build a “dam” of absorbent material (say “kitty litter” or vermiculite) around the “spill”, so that the spilled chemical does not “run” under cabinets or inaccessible spots.
- Add additional absorbent to soak up the bulk of the spilled chemical.
- Using a “foxtail” brush, rake the absorbent into dust pan, and empty the dust pan into a zip-loc bag. Each lab should have this equipment ready at a moment’s notice. Other cleanup materials (paper or rags) should also be added to the zip-loc bag.
- The “cleanup materials” must be disposed via EH&S (2-4925), after use.
- Store the “cleanup” materials in the zip-loc bag temporarily in the hood (appropriately labeled), until EH&S can come over to pick them up.

Mercury spill:

- 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.
- Contact EH&S (2-4925). They will come over and use a huge HEPA vacuum cleaner to pick up the mercury.
- Broken mercury-containing apparatus should be placed in a zip-loc bag for pickup by EH&S.
- Labs should substitute electronic devices for apparati using mercury,
- to reduce the danger of mercury contamination of work areas. In
- particular, mercury thermometers should be replaced by alcohol

- thermometers or thermistor based temperature units.
- When 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 suitable plastic container capable of capturing
- escaping mercury in the event of breakage.

If you spill a chemical on yourself or others: The watchword is GET IT OFF IMMEDIATELY. If the spill does not involve water reactive chemicals such as active metals (sodium, potassium) or metal hydrides, flush the affected area with macro amounts of water. For a “whole-body” spill, do not hesitate to use the safety shower located at the entrance to each laboratory.

- If active metals, such as potassium or sodium, are involved, usually these can be shaken off the surface of the body, or simply remove affected clothing.
- If metal hydrides are involved, these can be brushed off the skin, or merely remove the affected clothing

For a **FLOOD**, TURN OFF THE WATER. To arrange for clean up, call the Building Manager. If the emergency occurs after hours, dial the operator “O” or “911”.

- **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.
- A simple and useful technique is to secure tubing with a three-finger clamp so that it does not “leap out” of the drain and cause a flood.
- Chemical supply firms sell small “tubing clamps” that can be used to secure rubber tubing to chemical apparatus. This prevents the tubing from slipping off the apparatus when unattended, e.g. over night.
- Simple “water flow” monitors should also be used to ensure that the flow of water is not too large, leading to the difficulties directly above.

2.3 Intruders to Hamilton Hall

The department has suffered considerable losses due to theft, and there is always a danger of physical harm from unauthorized personnel present after normal hours. If you notice a suspicious person in the hallways of Hamilton Hall, do not hesitate to call the Campus Police. In the hallways, all you have to do is lift the red emergency telephone. You do not have to say anything. The police will come to investigate. Other telephones can also be used, if you prefer (dial 2-2222 (“dial 2 for blue”)); be prepared to tell the operator why you called.

2.4 Accident reporting

Any accident that requires medical treatment and any explosion, fire or uncontained spill must be reported to the Safety Chair, who will maintain a record of such incidents.

3 Personal Protective Equipment (PPE)

3.1 Eye Protection:

You must, by law, wear approved **safety glasses** or **goggles** at all times you are in the lab. A State of Nebraska legal statute requires this action. Areas with student desks, or where safety glasses would be unnecessary, can be exempted by vote of the safety committee, upon an application by the director of the laboratory (form: appendix 1). If a section of a laboratory, rather than the whole laboratory, is to be exempted, the exempted area must be marked off with floor tape.

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

The use of high power **lasers** requires special didymium eye goggle protection. Consult the professor in charge of the laser installation. Appropriate goggles should be at hand at the entrance to each laser facility. The laser facility should be equipped with signs on the lab doorway notifying persons seeking to enter the facility that a high power laser is (or is not) in immediate use. Goggles should be donned before you enter the facility.

Reflection from an unprotected surface is a serious problem. Thus, most laser facilities have walls painted with flat black paint. Hanging strips of dark cloth are also used to further reduce the danger of reflections.

The operation of **photochemical reactors** requires the use of specialized didymium UV protective goggles. Like lasers, high power UV reactors give light that is extremely unpleasant and dangerous to the eyes after only a brief exposure. The reactor should be shielded so that the intense light does not emanate. Doorways should be posted with notices, if the reactor is in use. Thus, goggles must always be in place, BEFORE you enter the facility.

If you suffer a splash of chemical in your eye, use the **yellow eye wash fountains** immediately. The eye wash fountain installation should not be blocked by equipment. If you get a chemical in your eye, run a little water through the fountain to clear the line, before you pass water over your eyes. It is especially important to hold open your eyelids so that the stream of water is able to rinse the chemical from the eye surface. The natural human reaction is to squint the eyes because of pain associated with the chemical and also the additional pain due to the cold water. However, it does no good to pass the stream of water over eyes squinted shut. So hold open the eyelids and pass the water over the eyeball(s intermittently, allowing time to recuperate between eyeball rinses. Experts indicate that a 15 minute rinsing is required, painful though this may be. If the pain is intolerable, use intermittent rinses.

An **eyewash hose** is located at the doorway to some of the older labs. This device is easily located, even though you may be temporarily blinded by the chemical in your eye. Some water should be passed through the hose before

the stream is passed over your eye. Do not worry about water on the floor.

Eye wash fountains and eyewash hoses must be flushed once per week so that sediment does not build up in the line. Monday mornings are recommended.

For Students: In the event students get something in their eye, *always* take them to the Health Center after you finish rinsing the eyes. Somebody should accompany them.

For Faculty or Staff: In the event faculty or staff get something in their eye, they should be taken to a walk-in clinic or Emergency room. The Chemistry Lab. Manager is ready to assist the injured with transportation to this care site. An alternative site is the emergency room of hospitals. The closest available hospital is Bryan West, 2300 S 16th St, Lincoln.

3.2 Fire Extinguishers

Fire safety experts rate fire extinguishers in one of four classes according to the type of fire these extinguishers most effectively can combat:

- **Class A:** for use on ordinary combustibles (e.g. wood or paper);
- **Class B**: for use on flammable liquids;
- **Class C**: for use on electrical fires; the stream of vapor or liquid from the extinguisher must not conduct electricity;
- **Class D**: for use on flammable metals and presumably on metal hydrides, although this is not stated.

In some cases, the designations, **A. B, C or A-B**, are indicated on the extinguisher. Often, but not always, "emblems", embossed on the extinguisher also indicate the types of fire on which the extinguisher may be used. If the extinguisher is NOT to be used for electrical fires, the "emblem" with the electrical plug is crossed out by a thick red line.

In other cases, extinguishers in Hamilton Hall have ***NO*** A, B, C, etc. ratings displayed.

In Hamilton Hall, extinguishers usually are multi-class, say A-C. Personnel should know the two common types of fire extinguishers in use in Hamilton Hall (A-C, and D), and when each is to be used.

3.2.1 Operation:

For either type:

- Lift extinguisher from the wall holder.
- TWIST THE KEY to break the retaining cord.
- 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 to last about 15-20 seconds.
- After the fire is extinguished, do not replace the extinguisher on its mount. Call Facilities Management to ask for replacement of a depleted

extinguisher. They should be called even if the extinguisher is only partially depleted.

3.2.2 Types of Extinguisher:

Carbon Dioxide (CO_2) ***extinguishers***: These are useful on most of the usual types of fires, including electrical fires. Do not use a CO_2 extinguisher on a fire involving a burning active metal (Li, Na, K, Cs), organometallic, or a metal hydride ($LiAlH_4$).

Dry Chemical (POWDER) ***extinguishers***: These work well on any fire and are the extinguisher of choice for burning metals or metal hydrides. However, they make an incredible mess. If there is time for a choice of extinguisher, use a CO_2 and NOT a powder extinguisher near electronic equipment of any kind (instruments, computers). The powder is somewhat corrosive and very damaging to instruments. In addition, the powder is very fine and it is irritating to human beings.

Do not use dry powder extinguishers on another person, however bad the fire.

3.3 Protective Gloves:

Hand protection is necessary when using certain corrosive or allergenic chemicals, or in removing glassware from an oven. Working with cryogenic materials requires special gloves to avoid frostbite and tissue damage. Leather gloves are recommended if there is explosion danger.

A variety of protective gloves are available through most major scientific suppliers. Latex gloves are **not recommended** due to allergy problems of a cumulative nature. Also, they are permeable (not impervious) to organic chemicals of certain types. Appendix A contains information on glove compatibility with various organic solvents, or corrosive chemicals.

x No one type of glove is resistant to all chemicals. “Silver Shield” brand gloves are perhaps the best compromise. “Vinyl” or “nitrile” gloves are made available to undergraduate students in laboratory courses. TA’s should make sure students do not use gloves that become torn. Nitrile gloves are "single-use" PPE. They must be discarded, when removed from the hands, and NOT reused. In the course of chemical research, gloves should be changed frequently, if the research involves contaminants, as is the usual case.

Whichever type of glove is used, they must be removed before the researcher leaves the research lab. Gloves must be removed before common use items, such as telephones, are used.

Researchers should **wash hands** upon removing gloves.

3.4 Safety Showers

Safety Showers are present in the doorways to most laboratories of Hamilton Hall. These showers may be used if you are **on fire** or if you have suffered a

spill of large quantities of a dangerous or corrosive chemical on yourself.

The older installations have large brass rings near the doorway to the labs in question,. Simply pull the ring to initiate the shower of water.

In the renovated floors of Hamilton Hall, large levers, recessed in the wall, can be used to actuate the safety shower. Simply depressing the lever will dump about 50 gallons of water on yourself.

Do not be concerned about the lack of floor drains. Your concern should be to extinguish the blaze or to get the chemical off of you as rapidly as possible.

Notify the Bulding Manager or Facilities Management for clean up. If a noxious chemical was involved, the clean up materials should be eliminated through EH&S.

3.5 Respirators

According to current safety rules, respirators may only be used by persons who have had appropriate health testing and fit testing of the respirator. Contact EH&S for more information (2-4925).

3.6 Attire in the Laboratory: Lab Coats and Aprons

- Lab coats must be worn by personnel engaged in research using chemicals. The use of lab aprons is also encouraged. Two types of lab coats are approved for use in Hamilton Hall. Lab coats made of fire-retardant-treated cotton are acceptable for most uses; however, when using pyrophoric compounds, special aramide coats must be worn. Wearing of polyester or other highly flammable material in the laboratory is discouraged.
- Open-toed shoes are forbidden in laboratories, i.e. *NO* sandals or thongs.
- Dangling jewelry and billowy sleeves are not appropriate for laboratory.
- Long hair should be secured if there is likelihood that the hair might encounter chemicals. TA's in undergraduate laboratories should be careful to enforce this rule.

3.7 Hoods; Explosion Shields

- Experienced chemists do most of their work in a fume hood.
- **If danger of an explosion exists; close the doors of the hood or the hood sash.** This will contain the explosion. ***The hood doors/sash are not totally explosion resistant.***
- In extreme cases of explosion danger, researchers should use an "explosion shield" **in addition** to closure of the hood doors.
- In extreme cases, investigate the use of the "High Hazard Lab" on the 9th floor.
- Not sure? Get advice from older more experienced grad students, or from your research director.
- "Prudent Practices" (an ACS publication) should be consulted (Chem Library, reference section).

4 Safety Situations requiring your attention and response.

4.1 Gas Leaks:

If there is a STRONG odor of natural gas, ***yell to alert others*** of the danger.

- Extinguish any flames, if this would not delay your departure.
- Leave the area yourself.
- Be sure to close fire doors.

Certain sulfur compounds produce the same odor as natural gas. In fact the gas company uses these very same compounds to give natural gas its distinctive odor. 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.

If you determine that the odor is due to a natural gas leak and not due to a chemical used in research, actuate the red building alarm and dial 2-2222 from another floor or another building. d. If you detect a WEAK natural gas odor and also determine that other researchers are NOT using “thiols”, contact the building manager or safety chair. He/she will arrange for an inspection by EH&S or the gas company. Be sure all fire doors are closed.

Another very common source of complaints about natural gas odors is the “dry drain” phenomenon. Odors from sewer lines resemble natural gas. There may be unused floor drains in your lab that go “dry”. Be sure all drains have water or glycerol present. Glycerol does not evaporate, unlike water, and it is not environmentally damaging.

4.2 Use and Handling of High Pressure Cylinders of Gas.

- Cylinders MUST ALWAYS be secured to the lab bench with a heavy strap or metal chain. The strap should be on the upper half of the cylinder.
- Cylinders must *NEVER BE MOVED* unless capped. This includes movement inside a single laboratory.
- A cylinder cart must always be used when cylinders are moved. This movements across the laboratory. Cylinders are never carried by hand or "rolled" or "kicked".
- Cylinders must always carry a reducing valve appropriate to the gas in use
- Hydrofluoric acid cylinders should not be kept for protracted periods. The reaction of HF with the metal interior of the cylinder results in the buildup of very high pressures (>2000 psi) of hydrogen.

4.2.1 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 1.1, *et seq*.).

4.3 Broken Glassware; Disposal

Broken glassware should be placed in a commercial “Broken Glass Disposal” box, lined with a plastic insert. Used needles should also be added to this container. When full, the plastic sack should be removed, placed in the heavy cardboard box and the box taped shut (so that nothing can escape). The box should be labeled “broken glass” and placed outside the lab door for the custodial crew.

4.4 Power outages

In the event of a power outage lasting more than 10 minutes, do the following

- Ascertain that any electric equipment that might cause damage when power is restored (e.g. hot plates) is switched off.
- If possible to do so in a timely manner, shut down all running processes and reactions. If not possible, ensure they can be left unattended for an extended period.
- Close all hood sashes to minimum aperture.
- Shut and lock all doors.
- Leave the building by the stairs.
- Wait at least 10 minutes after power is restored to reenter.
- In the event hood fans fail, inform facilities and leave the laboratory.

5 Transporting chemicals within the building

5.1 Transporting from the stockroom or between labs

Secondary containment must be practiced. Chemicals in glass jugs must be transported in some safe container. 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. Four gallon jugs of acids or solvents are best transported inside a ten gallon plastic container with carrying handle. These are available at the stockroom. For larger quantities of chemicals, the use of laboratory carts is encouraged (instead of trying to carry multiple containers).

For example, a five gallon metal container of solvent should be transported by means of a cart.

The stockroom personnel are instructed not to give you chemicals unless you have an appropriate container to transport the chemical.

You must exercise exceptional care that chemicals do not drop and containers break while using the elevators.

Chemicals in heavy, non-breakable plastic containers or secure metal containers may be excused from the above “secondary containment” requirement.

Chemicals ordered and received from chemical supply firms such as Aldrich

Chemical Co. *still in their original shipping container* may be transported as received.

6 Chemical Handling and Storage

6.1 Flammable Materials

- “Flammable liquids" are defined as liquids with ***flash points*** less than 100°**F** (about 35°C).This includes most common organic solvents. Flash points of solvents can be found in “The Handbook of Chemistry and Physics”.
- **No more than four liters** of a flammable solvent can be stored "in the open" in an individual lab, as opposed to storage in a safety cabinet.
- Larger quantities can be stored in *metal* flammable safety cabinets. It is good practice to keep all solvents not in immediate use in a safety cabinet.
- Flammable liquids are not to be stored underneath hoods or sinks unless in safety cans.
- Flammable safety cabinets should remain plugged. If you have previously vented metal cabinets, please reinsert the metal plug.

6.2 Flammable Materials Refrigerators

Flammable materials requiring refrigeration should be stored in a "flammable materials" refrigerator or freezer. These models contain a sealed interior devoid of spark sources (thermostat or light).

“Altered” home refrigerators (thermostat placed outside), although in use on other campuses, are not acceptable at UNL.

6.3 Incompatible Materials Storage:

The following types of chemicals should be stored separate from one another. When space is limited, items on the same shelf can be segregated through use of plastic troughs.

Hazard ratings are available in *chemical supply catalogs,.*

(1). OXIDIZERS: Among others: chromium (VI) compounds, perchlorates, chlorates, bromine, nitrate salts, concentrated solutions of H2O2, permanganates, organic peroxides. In particular, oxidizers should be segregated from reducing agents. Oxidizers must also be separated from organic compounds.

(2). WATER REACTIVE MATERIALS (often REDUCING AGENTS): The most common type is metal hydrides; also boranes and active metals such as sodium and potassium.

The sprinkler system necessitates that these materials be specially covered.

(3). INORGANIC ACIDS: These should be segregated from bases, and materials which generate toxic or flammable gases upon acidification (cyanides, azides).

(4). ORGANIC ACIDS: A common organic acid is formic acid, a strong reducing agent. This acid must be segregated from inorganic acids such as nitric or perchloric (strong oxidants).

(5). BASES: These include sodium hydroxide, carbonates, and concentrated ammonia.

(6). TOXIC MATERIALS: Items listed as "extremely toxic", "cancer suspect agent", "mutagens", or "reproductive hazard" should be segregated from other chemicals.

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

6.4 Peroxide-Forming Compounds:

Some compounds form shock sensitive and explosive peroxides upon prolonged exposure to oxygen of air (see Appendix B; also the label of the chemical carries this information). Peroxides may accumulate and detonate upon concentration, heating or abrasion.

- Diethyl ether, tetrahydrofuran (THF), and cumene, among others, **must be dated** upon breaking the seal of the container.
- These materials must be used or disposed within 90 days of original opening of the container.
- A peroxide test (potassium iodide/acetic acid, or commercial test strip) may be used to gauge the buildup of peroxides.
- The use of an autoxidation inhibitors such as 2,6-di *tert*.butylphenols is encouraged.

6.5 Use of Radioactive Materials

- Users must take an appropriate course in the handling of radioactive materials.
- Labs in which radioactives are used must be certified by EH&S. Contact the UN-L Radiation Safety Office (2-4925) to initiate the approval process.
- Special waste handling methods apply. Do not move radioactive materials to other non-approved laboratories.
- See section 6.7 concerning hazard notification.

6.6 HAZARD NOTIFICATION: Doorway Placards

Each lab door must have *current* telephone number(s) of persons to be contacted in case of an emergency (typically, the faculty member as well as the graduate students, postdoctoral fellows, or technicians who work in the lab). Door placards are prepared by EHS and must be attached upon receipt to the appropriate entrances.

6.7 Special Hazard Warnings:

- By law, the entrance to labs in which **biohazards** or **radioactive materials** are in use, must carry special warnings involving the use of internationally

recognized symbols.
- **Laser** laboratories also require special warnings on doorways.
- By custom, warning should be posted if **high energy UV lamps** are in use.

6.8 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.

6.9 Chemical Security:

Chemical security safe operating procedures are posted on the Environmental Health and Safety website. The most pertinent recommendations for Hamilton Hall are:

- Laboratories should be kept locked when not in use
- Strangers should be asked to identify themselves and, if they do not belong in those areas, asked to leave. Any suspicious persons or activities should be reported to university police
- 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 in a separate Standard Operating Procedure on the EHS website. This lists specific notification procedure for the purchase and storage of specific chemicals of possible terrorist use.

6.10 Chemical Labeling

a. Each laboratory doorway must carry a list of **abbreviations** for chemicals used in the laboratory (e.g. "TFA" for "trifuoroacetic acid").

It is of paramount importance that all flasks or containers of chemicals be labeled as to components, even distilled water or soap.

Unless the abbreviation is posted, each container or flask in the laboratory **must have present the full, written chemical name(s)** of chemical(s) present.

Chemical structures are **not to be used** in labeling flasks.

6.11 "Open" Chemicals

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

Thus, flasks, beakers and other containers **must be capped** even if you leave the lab for a few minutes. This is to reduce air pollution from this source, and it is a firm requirement by the EPA.

In particular, no container that could be construed as "waste" may be left open

to the air. “Eco funnels” may be used, however, on containers of chemicals to be disposed in the near future.

6.12 NMR Samples

Researchers should be aware that NMR solvents are not necessarily inert. D_2O and deuteromethanol are obviously reactive, but so are dimethylsulfoxide and acetonitrile. Improperly stored chloroform can be very acidic. It is your responsibility when making up an NMR sample with a potentially reactive substance 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 bring it to 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.

An exception would be where your are intentionally doing kinetic measurements in the NMR spectrometer. In that case you should have discussed the experiment with the director of the NMR center in advance.

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

If you are running an NMR spectrum of a material that is highly toxic, alert the staff of the NMR facility of that fact.

You should be aware of the toxicity and general reactivity of ANY compound you are working with.

7 Disposal of Chemicals:

7.1 Disposal

ALL chemicals must be disposed via EH&S.

- “Disposal tags” are available in the 5th floor mail room, or by contacting EH&S (2-4925). An example of a typical filled out disposal tag is included as Appendix D.
- The top copy of the disposal tag must be torn off and sent to EH&S. They will come to pick up the chemical for disposal.
- The remaining copies of the disposal tag should be attached to the chemical in question by the attached string.
- All components of the chemical(s) to be disposed must total 100%.
- Full written chemical names must be used, not chemical structures or abbreviations.
- 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.

- It is permissible to dispose a few chemicals via the drain. Generally, these are neutral compounds (ph 5 – 9) that are biodegradable, e.g. ethanol, diluted with water.
- EH&S maintains a sewer disposal list on its Standard Operating Procedure page. This list should be consulted before disposal of any chemical via the drain.
- If in doubt, let EH&S decide. The chemical should be treated as a “hazardous material”, a disposal tag filled out and submitted to EH&S.

EH&S may recycle chemicals in good shape. See the EH&S website.

It is necessary to be especially careful with heavy metals and solutions of their salts. This is especially important for laboratory TA’s. Always dispose via EH&S.

7.2 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 has a Green Chemistry Institute which promotes *The Twelve Principles of Green Chemistry*
- It may be possible to use no solvent at all or recoverable inorganic salts as “solvents”.
- When it is necessary to use organic solvents, they should be recovered and reused after use.
- When heavy metal catalysts must be used, the possibility of using a trace of these materials with in situ regeneration of the catalyst should be investigated.

7.3 “Unknown” Chemicals

Chemicals whose identity is not known are automatically considered "Hazardous Materials" by the EPA, in part since they obviously have no legitimate use.

- If unknown materials are found in your lab, try to identify them by nmr, ir and mass spectrometry. Then dispose via EH&S, or use them normally.
- If the unknown materials still cannot be identified, contact EH&S.
- The transfer of these materials to another lab not under your research director’s control is considered dumping.

Any person determined to have abandoned or dumped chemicals elsewhere will be subjected to disciplinary action by the department and/or the university administration.

7.4 Empty Containers

Empty solvent containers should be allowed to air out until no odor is present.

- These containers may then be placed in the hallway with caps removed for custodial disposal.
- Containers with a residual odor or which once contained higher-boiling materials not anticipated to evaporate should be rinsed with acetone and then with soapy water prior to evaporation and disposal.
- Empty containers which contained "P-listed" chemicals (Acutely Hazardous Chemicals; see the EPA website) should not be rinsed but directly tagged for collection by EH&S.

7.5 Reference materials

- The MSDS sheets. These will arrive with a purchased chemical, and MSDS sheets may also be easily located on the internet
- Sax, “Dangerous Properties of Industrial Materials”, 5th ed, Van Nostrand Reinhold, 1975. Consult the Chemistry Lab Manager.
- “Prudent Practices In The Laboratory: Handling And Disposal Of Chemicals”, National Academy Press, 1995. Consult the Chemistry Lab Manager.
- An extremely useful handbook is made available free from NIOSH: “NIOSH: Pocket Guide to Chemical Hazards”, US Dept. of Health and Human Services. Google the title; then download or order from their website.
- Armour, Browne, and Weir, “Hazardous Chemicals: Information and Disposal Guide”, third edition, University of Alberta, 1987. (Available in rm 517).

8 Special Hazards

8.1 Magnetic fields

Superconducting NMR spectrometers, found on the 8th, 5th, 4th floors, and the basement generate strong magnetic fields capable of erasing credit cards, ruining watches and stopping pacemakers. Entries to high magnetic field areas must bear appropriate warnings. A hazard occurs if these machines should “quench”. Quantities of helium will be released to the atmosphere. The upper part of the room will be filled with a cloud of cold helium gas. This presents an asphyxiation hazard; leave the area and do not re-enter until cleared.

8.2 Vacuum Pumps, Lines and Dessicators

Belt guards are required on all vacuum pumps. If vacuum pumps are being used for solvent removal or might otherwise be venting toxic substances, they should outlet into a fume hood. Safety goggles *must* be worn around evacuated glassware such as vacuum lines and dessicators, 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.

8.3 Cryogenic Operations:

- Vacuum traps must be immediately vented once the coolant is removed in order to avoid a rapid increase in pressure which can result in an explosion or spill.
- Vacuum traps immersed in liquid nitrogen condense significant quantities of liquid oxygen (LOX). Users must be alert to the possibility this may react with organic compounds, creating a fire/explosion hazard. A safety shield should be placed in front of traps suspected of containing both condensed LOX and flammable organic materials
- Liquid nitrogen dewars should be dumped at the end of each work day.
- Liquid nitrogen 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.
- Rooms used for the long term storage of large quantities of cryogenic materials (liquid nitrogen or helium) must be equipped with an oxygen monitor.

9 Safety Training

9.1 Environmental Health and Safety

Currently, two training modules produced by EHS are required of all faculty and staff, and all students and researchers who work in Hamilton Hall.

- Core - Injury and Illness Prevention Plan (IIPP)
-

Any faculty staff or students who do research or teaching with potentially hazardous chemicals are also required to complete:

- ***Chemical Safety*** training module. (Four units)

Units 1 -4: http://ehs.unl.edu/training/online

In addition, students, faculty and researchers working these specific hazards should complete these additional requirements

- Biosafety Basics
- Biosafety in the BSL-2 Laboratory
- Bloodborne Pathogens (including HIV/HBV/HCV)
- General Electrical Safety Awareness
- NIH Guidelines for Research Involving Recombinant DNA Molecules
- Radiation Safety Annual Refresher Training

These requirements are frequently updated; personnel new to Hamilton Hall should consult the EHS website.

9.2 Safe Operating Procedures

Students, faculty and researchers working with these specific hazards need to read the relevant Safe Operating Procedure and consult the Safety Chair to be checked out.

- Cryogenic Material (7/11)
- Hydrofluoric Acid (7/09)
- Nanoparticle Safety (6/11)
- Pyrophoric Chemicals (11/09)
- Use and Storage of Peroxide-Forming Chemicals (1/09)
- Metallic Mercury Spill Procedures (8/09)
- Acrylamide (7/09)
- Centrifuge Safety (7/09)
- Compressed Gas Cylinders in Laboratories (11/11)
- Electrophoresis Safety (5/08)
- Exposure Control for Chemical Reproductive Hazards (7/09)

9.3 Chemistry Department training

Group training briefings are usually conducted around three times a year, and are required of all new staff faculty, students and other researchers in Hamilton Hall. Attendance will be taken. 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.

9.4 Records

Personnel taking EHS training are required to print out a record of completion of the training and provide it to the Department of Chemistry, typically the Building Manager. The Department will maintain record of training for all current faculty, staff and students.The Safety chair will provide to the department a record of attendance of safety briefings and of check-outs.

9.5 Medical Monitoring:

Medical monitoring, as described in the "Guidelines for the Safe Use of Hazardous Materials" is required whenever the department chair 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. An allied document of the Department, the Chemical Hygiene Plan, as well as the campus Chemical Hygiene Plan, carries additional information. Employees who suffer a chance exposure to hazardous materials, chemical or biological, may request health monitoring.

10 Administrative Controls & Responsibilities

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;
- Maintaining required documentation.
- Arranging medical monitoring for faculty or 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, and the general chemistry lab coordinator are standing members. At least four additional faculty members will be appointed by the department chair to terms of one to three years. Two co-chairs, Safety and Hazardous Materials, will be designated. Committee responsibilities include:

- Implementing the departmental safety plan.
- Instituting and coordinating safety and hazardous materials training programs for faculty, staff, and research students
- Monitoring compliance with guidelines for safe lab practices and for the safe use of hazardous materials.
- Identifying, investigating, and reporting (to the executive committee) any failure to comply with standard safety practices.
- Coordinating fire drills with UN-L facilities and the Lincoln Fire Department.
- Investigation [and reporting] of accidents;

10.3 Faculty and Facilities Managers

Faculty and Facilities Managers are responsible for:

- Instituting plans for a safe work place in research, teaching and service labs.
- Conducting any specialized safety training needed for a specific laboratory or facility.
- Ensuring the proper storage, handling and disposal of hazardous materials, the use of safe lab practices, and the use of appropriate protective equipment.
- Maintaining an inventory of chemicals used in the laboratory or facility
- Reporting any accidents to the safety committee.

10.4 Staff and Students

Staff and Students (including graduate students) are responsible for:

- Implementing the campus and the departmental safety plans.

- Attending relevant departmental and university training sessions related to safety and the safe use of hazardous materials, and keeping themselves aware of the particular hazards they may encounter in their work.
- Reporting unsafe activities/conditions, accidents, or injuries to the supervisor or safety chair.

Application for laboratory exemption from mandatory eye-protection requirement.
Department of Chemistry UNL.

____ Lab to be exempted ____ Name of person responsible for laboratory.

Are caustic or explosive materials (including organic solvents, strong acids or bases, peroxides and/or ethers) ever used in this laboratory, other than in closed containers? ___ Yes ___ No

If 'yes', please detail how exposure of students and/or instructors will be prevented.

Are hot liquids or solids ever used in this laboratory ___ Yes ___ No

If 'yes', please detail how exposure of students and/or instructors will be prevented.

Are ultraviolet light sources, lasers of power more than 5 mW, or other sources of intense light or ionizing radiation ever used in this laboratory? ___ Yes ___ No

If 'yes', please detail how exposure of students and/or instructors will be prevented.

Please detail any other hazards present in the laboratory that might lead to eye or facial injury, including breaking glass, flying shards or pieces of metal or other solid material, compressed gases or vacuum, flammable substances, etc.

If part of the laboratory is to be exempted, please attach a rough sketch of the area. The exempted area must be clearly marked on the floor with tape.

Appendix B: Partial List of Chemical Subject to Dangerous Peroxide Formation

Rapid Formation of Explosive Peroxides on Exposure to Air

Diisopropyl Ether	Divinyl Acetylene	Potassium metal
Potassium Amide	Sodium Amide	1,1-dichloroethylene

Compounds Capable of Peroxide Formation upon Exposure to Air

Acetals	Cumene
Cyclohexene	Cyclopentene
Decalin	Dicyclopentadiene
Diethyl Ether (ether, ethyl ether)	Diglyme (diethylene glycol dimethyl ether)
1,4-Dioxane	Glyme (ethylene glycol dimethyl ether)
Ethylene glycol monomethyl ether (Cellosolve)	Furan
Methyl acetylene (propyne)	Methylcyclopentane
Tetrahydrofuran (THF)	Tetralin
Vinyl Ethers	

Appendix C: NFPA Rating for Flammability

The following list is NOT comprehensive.

Rating 4: Will rapidly or completely vaporize under ambient conditions

Acetylene	Butadiene	Butyllithium (pyrophoric)
Carbon disulfide	Carbon monoxide	Diborane (explosive)
Et_2AlCl	Diethyl ether	Dimethyl sulfide
Ethylene	Ethylene Oxide	HCN
H_2	Isoprene	Methyl formate
3-Methyl-1-butene	Methylamine (anhydrous)	Ethylamine (anhydrous)
Natural Gas	Pentene	Pentane
Propylene	Dichlorosilane	Trichlorosilane

Rating 3: Liquids and solids ignitable under almost all ambient conditions

Acetone	Acetonitrile	Acetyl Chloride
Benzene	Butanol	Cyclohexane
Diisopropylamine	Ethyl acetate	Gasoline
Heptane	Hexane	Methanol
Methyl Methacrylate	Nitromethane	Potassium
Pyridine	THF	Toluene
Triethylamine	Xylenes	

Rating 2: Can ignite upon moderate heating

Butyric acid	Cresol	Dichlorobenzene
Lithium Metal	Nitrobenzene	Octanol
Phenol	Propionic acid	