University Of Minnesota

Department of Earth Sciences, LacCore and CSDCO, Laboratory Safety Plan

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Formal safety education for advanced students and laboratory workers should be made as relevant to their work activities as possible. Training that is conducted simply to satisfy regulatory requirements tends to subordinate the relevant safety issues to details associated with compliance. Such bureaucratic safety management has actually worked against fostering safety attitudes in many well-experienced laboratory workers and has undermined the credibility of warnings about bona fide hazards by emphasizing pro forma violation of rules. -Prudent Practices

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Chapter 1 – Introduction

1. Purpose

In 1990, the Occupational Safety and Health Administration (OSHA) released a regulation entitled, Occupational Exposures to Hazardous Chemicals in the Laboratory (29 CFR 1910.1450), commonly referred to as the "Laboratory Safety Standard".

This Laboratory Safety Plan (LSP) is intended to meet the requirements of the federal Laboratory Safety Standard. It describes policies, procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards in laboratories. All laboratory workers must be made aware of this plan. New employees must review the plan and receive safety training before beginning work in the laboratory. The plan must be available to all laboratory workers at all times.

This LSP also addresses the concerns of the federal Toxic Substance Control Act (TSCA). TSCA requires that prudent laboratory practices be developed and documented for research involving new chemicals that have not had their health and environmental hazards fully characterized. Laboratories engaged in research must consider the applicability of TSCA on their operation. TSCA, administered by the U.S. Environmental Protection Agency (EPA) under the New Chemicals Program, is intended to ensure that the human health and environmental effects of chemical substances are identified and adequately addressed prior to commercial use or transport of those substances. A new chemical is a chemical substance that is produced or imported and not yet listed on the TSCA Chemical Substance Inventory. Each laboratory or research group that synthesizes or imports new chemicals must determine if and how TSCA applies to their laboratory activities – see Appendix A.

2. Scope and Application

The Laboratory Safety Standard applies where 'laboratory use' of hazardous chemicals occurs. Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

1. the handling or use of chemicals occurs on a 'laboratory scale', that is, the work involves containers which can easily and safely be manipulated by one person,
2. multiple chemical procedures or chemical substances are used, and
3. protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposures to hazardous chemicals.

At a minimum, this definition covers employees (including student employees, technicians, supervisors, lead researchers and physicians) who use chemicals in teaching, research and clinical laboratories at the University of Minnesota. Certain non-traditional laboratory settings may be included under this standard at the option of individual departments within the University. Also, it is the policy of the University that laboratory students, while not legally covered under this standard, will be given training commensurate with the level of hazard associated with their laboratory work.

This standard does not apply to laboratories whose function is to produce commercial quantities of material. Also, where the use of hazardous chemicals provides no potential for employee exposure, such as in procedures using chemically impregnated test media and commercially prepared test kits, this standard will not apply. The researchers listed in the following table are covered by this Laboratory Safety Plan.

Principal Investigator	Building	Room #	Primary Research Hazards	E- mail	Phone #
Emi Ito	CivE	662-680	Chemical, physical, radiation	eito@umn.edu	4-7881
Emi Ito	Shepherd Labs	314, 354, 360	Chemical, physical	eito@umn.edu	4-7881

3. Coordination with Other Standards and Guidelines

The Laboratory Safety Standard addresses occupational safety issues for employees who work with hazardous chemicals in laboratories. Other federal, state and local standards that address use of hazardous chemicals and other materials are listed in Appendix B.

4. Roles and Responsibilities

Employees, supervisors, Departmental Safety Officers, department heads, deans, upper administrative staff, and DEHS staff all have roles to play. These roles are outlined below.

A. President, Vice Presidents, Provosts and Chancellors (Central Administration)

- Upper level administrators are responsible for:
- Actively promote the importance of safety in the research community;
- Ensure deans, directors and department heads provide adequate time and recognition for employees who are given laboratory safety responsibilities.
- Objectively evaluate direct reports on their safety involvement and continuous improvement efforts.

B. Deans, Associate Deans, Directors and Department Heads

- Actively promote the importance of safety in the research community;
- Support and participate in safety improvement efforts;
- Establish collegiate, departmental or institute based safety committees or other effective means to facilitate continuous safety improvement;

- Monitor the effectiveness of safety improvement efforts;
- Ensure PIs and Lab Directors provide adequate time and recognition for employees who are given laboratory safety responsibilities;
- Identify an appropriate number of technically-qualified Departmental Safety Officers (DSO) for the unit. Colleges or institutes made up of a number of large laboratory-based departments are urged to assign Departmental Safety Officers within each department or division;
- Ensure that the designated DSO and safety committees have dedicated time and resources to carry out their assigned responsibilities;
- Establish and maintain processes to ensure the DSOs are informed of new and changing faculty space assignments, including faculty leaving the University
- Objectively evaluate direct reports on their safety involvement and continuous improvement efforts.

C. Supervisors/Principal Investigators (Jessica Heck and Emi Ito, respectively)

Immediate supervisors of laboratory employees are responsible for:

- Assure potential hazards of specific projects have been identified and addressed before work is started;
- Ensure effective safe operating procedures are completed for lab activities involving high hazard materials and activities;
- Identify and provide necessary safety supplies and personal protective equipment:
- Discuss and reinforce safe work practices and PPE use, provide coaching and disciplinary action as necessary;
- Conduct continuous inspection of the research space under the supervisors control, ensure that unsafe conditions are identified and corrected;
- Ensure that all accidents, injuries, and spills are reported to DEHS;
- Investigate laboratory incidents, identify root causes, and implement appropriate solutions;
- Actively participate in safety improvement efforts;
- Provide initial and annual update training for lab workers regarding hazards in their area and associated with their work;
- Maintain documentation of initial and annual training to laboratory personnel
- Objectively evaluate direct reports on their safety involvement and continuous improvement efforts.

D. Employees

Employees who have significant responsibility for directing their own laboratory work are responsible for assuring that potential hazards of specific projects have been identified and addressed before work is started. All laboratory employees however, are responsible to:

- Complete required safety training;
- Read and understand lab standard operating procedures;
- Follow safe work practices applicable to the procedures being carried out;
- Actively identify, report, implement, and make suggestions for safety improvements;
- Assure required safety precautions are in place before work is started;
- Follow University lab dress code and wear PPE required for procedures;

- Notify DEHS of accidents, spills or conditions that may warrant further investigation and/or monitoring.

E. Departmental Safety Officer (Jessica Heck)

The DSO:

- serves as liaison and facilitates communication between employing department and DEHS;
- coordinates training to ensure researchers understand their responsibilities and the policies applicable to their research;
- schedules and participates in inspections of laboratories (in conjunction with departmental safety committees and DEHS);
- Assists in facilitating follow-up on improvement recommendations
- notifies DEHS of new or existing operations that may warrant further investigation and/or monitoring;
- Participate on or facilitates departmental safety committees.

F. Department of Environmental Health and Safety (DEHS)

- Develop centralized processes and safety management systems to assist Colleges and Departments to fulfill their safety responsibilities.
- Provide technical resources and expertise to Colleges and Departments to help facilitate continuous safety improvement.
- Conduct periodic inspections and audits to verify implementation of safety management systems and safe work practices.
- Maintain written safety performance expectations and guidance in the form of a Research Safety Manual or other written materials.
- Provide educational information and training assistance to departments and colleges relative to hazard identification and safe work practice.
- Participate on and provide guidance to safety committees or other safety improvement mechanisms.
- Identify and share best practices across departments and colleges.

G. Safety Committees

Safety Committees or other Departmental or Collegiate safety improvement mechanisms).

- Maintain a working knowledge of their work areas, are interested in safety improvement, and visible advocates for safety.
- Evaluate and improve departmental and collegiate safety cultures.
- Identify high-risk job tasks and promote the development of safe work practices.
- Identify and share best practices across the Department or College
- Identify the need for written programs and recommend implementation to department or college leadership.
- Committees have access to, and regular communications with, departmental and collegiate leadership through clearly defined reporting mechanisms.
- Promote and facilitate safety training
- Participate in periodic safety audits and inspections.
- Solicit reports of unsafe conditions and suggest corrective actions.
- Review incidents, near misses, accident investigation reports.

- Review potential serious injuries and incidents. Not for fault finding, but for fact finding to prevent a re-occurrence of the same or similar incident.
- Review injury and incident data for trends.
- Establish departmental and collegiate goals for safety improvement.

Chapter 2 – Laboratory Safety Procedures

This chapter gives general guidance for working safely in laboratories. Using this section in conjunction with other safety references will help researchers maintain a safe laboratory. This chapter also has information, which will help researchers prepare laboratory-specific Safe Operating Procedures (SOPs).

1. Chemical Procedures

A. Controlled Substances and Alcohol

In conducting research with controlled substances, University authorized employees must comply with federal and state laws and regulations regarding their uses, including registration with the Drug Enforcement Administration (DEA), storage requirements, inventory maintenance and substance disposal. A condensed guide to federal regulations as well as policies and forms pertaining to controlled substances are available on the Controlled Substances webpage.

Ethyl alcohol used for education, scientific research, or medicinal purposes can be purchased tax-free through University Stores, which holds the University of Minnesota site license for alcohol purchases with the Federal Bureau of Alcohol, Tobacco, and Firearms. Further information and links to the ordering form are available at the following link: Tax Free Alcohol Ordering Procedures.

B. Labeling Chemicals in the Laboratory

All chemicals in the laboratory are required to have a label that indicates chemical contents and hazard warnings. Chemicals purchased from a manufacturer will have labels from that manufacturer that meet the chemical labeling requirements. Chemicals that are transferred from manufacturer containers into a secondary container or chemicals that are synthesized in the lab must have appropriate labels. This requirement also applies to the apparatus of a reaction that will be left overnight or beyond a normal work shift.

Exemptions: Chemicals that will be used within one work shift. This means that they will not be unattended during the work period of their intended use.

At the University of Minnesota, there are three accepted methods of labeling non-manufacturer containers or other vessels that will be left beyond one work shift. The laboratory PI/supervisor must decide on a method of container labeling and make sure it is enforced in the lab.

Acceptable Labeling Methods:

- Label each container with the chemical contents AND their hazards.
- Label each container with an acronym or symbol (i.e. chemical formula, chemical structure etc.) AND post a key in a highly visible spot in the lab that lists the chemical name and hazard for each acronym or symbol.
- Label each container with an acronym or symbol (i.e. chemical formula, chemical structure etc.) AND keep the container in an area (i.e. a secondary containment tray or on a designated shelf) that is labeled with the hazards of the material stored there. For this option, the container MUST return to the location by the end of the work shift.

For more guidance and labeling examples, please refer to the Secondary Container Labeling guidance document located here: http://z.umn.edu/containerlabeling.

Please note that hazardous waste has additional requirements. Detailed labeling requirements for waste can be found in the Hazardous Waste Guidebook.

C. Prudent Practices in the Laboratory

Laboratory standard operating procedures found in Prudent Practices in the Laboratory: Handling and Disposal of Chemicals (National Research Council, 2011) are adopted for general use at the University of Minnesota.

D. The American Chemical Society's "Safety in Academic Chemistry Laboratories"

ACS's "Safety in Academic Chemistry Laboratories" is another useful text. This manual presents information similar to that found in Prudent Practices, but in a considerably condensed format.

E. Hazardous Waste Management

Extensive and detailed policies regarding hazardous waste management are specified in the University's guidebook "Hazardous Chemical Waste Management, 5th edition". Please refer to this text for approved waste handling procedures.

In general, waste is stored in secondary containment and segregated by compatibility in the same way as new chemicals. Waste containers must be capped when not being filled. All chemicals must be labeled with a completed yellow hazardous waste label. Completion of the yellow label must meet the same standards as primary and secondary container labeling. Date all mixtures and chemicals. Hazardous waste is stored with the stock chemicals.. Keep closed at all times, and only fill to 85-90% capacity. Empty is defined as having less than 3% of a bottles contents reaming in the bottle. Most empty bottles can be rinsed (or neutralized) and put in the trash, but this depends on the EPA code. Secondary containment required for boxed hazardous waste that is liquid. DEHS hazardous waste module on ULearn is required training prior to using hazardous waste and on an annual basis.

- Drain disposal forms annually
- Benchkote: neutralize acids and trash for most chemicals.
- Use the minimal amounts of chemical necessary.
- Se the chemical inventory or DEHS chemical registry for DDC, EPA and CAS numbers.

2. Hazardous waste and chemical container labeling

- Improve lab safety
- You, your personal safety
- Your fellow lab workers
- Emergency responders
- Improves Waste Management's Safety
- During transportation
- During storage
- During processing here at the U of MN and by contracted vendor.
- Practice good handwriting and press hard.

F. Emergency Procedures for Chemical Spills

Complete spill response procedures are described in the Hazardous Chemical Waste Management Guidebook. However, the quick reference guide is included for convenience in this Laboratory Safety Plan.

Chemical Spill Quick Reference Guide

Evacuate

- Leave the spill area; alert others in the area and direct/assist them in leaving.
- Without endangering yourself: remove any victims to fresh air, remove contaminated clothing and flush contaminated skin and eyes with water for 15 minutes. If anyone has been injured or exposed to toxic chemicals or chemical vapors, call 911 and seek medical attention immediately.

Confine

- Close doors and isolate the area. Prevent people from entering spill area.
- Determine if the spill is within your capability to clean up safely
- If yes, follow your lab's procedures for spill clean-up.
- If not, continue on with the remainder of this guide.

Report

- From a safe place, call 911 and report the spill (Twin Cities Campus 911 operators will contact on-call DEHS personnel).
- Be prepared to give your name, phone and location; location of the spill; the name and amount of material spilled; extent of injuries; safest route to the spill.
- Stay by that phone, DEHS will advise you as soon as possible.
- DEHS or the Fire Department will clean up or stabilize spills, which are considered high hazard (fire, health or reactivity hazard). In the case of a small spill and low hazard situation, DEHS will advise you on what precautions and protective equipment to use.

Secure

- Until emergency response personnel arrive: block off the areas leading to the spill, lock doors, post signs and warning tape, and alert others of the spill.
- Post staff by commonly used entrances to the area to direct people to use other routes.

3. Spill containment/cleanup

Most small spills (<0.5L for most chemicals) can be handled by lab personnel. Some small spills are highly hazardous and should follow the moderate to large spill guidelines below.

- Notify others around you
- If you would like additional guidance call the DSO or DEHS.
- Kitty litter, soda ash, etc. (kitty litter not for HF)
- Start at perimeter and work inward
- Package cleanup materials as hazardous waste.

4. Moderate to large spills

Spills of any size that pose immediate hazards or spills you do not feel comfortable handling

- Evacuate the area and alert others
    - Leave the spill area; alert others in the area and direct/assist them in leaving.
    - Without endangering yourself: remove victims to fresh air, remove contaminated clothing and flush contaminated skin and eyes with water for 15 minutes. If anyone has been injured or exposed to toxic chemicals or chemical vapors, call 911 and seek medical attention immediately.
- Confine the spill by closing doors and isolating the area
    - Close doors and isolate the area.
    - Post signs, lock doors, use warning tape. Prevent people from entering spill area. Post additional staff if necessary.
    - Do not clean up a spill that has hazardous vapors.
- Call 911 from a safe place. Provide the following information to dispatch:
    - Building, room, or location of the spill
    - Caller's name, location, and phone number

- Type of emergency
- Is there a fire or explosion, or is anyone injured?
- Name and amount of material released
- Safest route to spill

- You may be asked to:
  - Restrict traffic and personnel into area if safe to do so
  - Remain available for follow-up
  - Stay by the phone

5. Radioactive Procedures

All researchers using radioactive materials at the University of Minnesota must:

- obtain a permit for the possession and use of radioactive materials (contact the University of Minnesota Radiation Protection Division at 612-626-6002);
- complete required training modules; and
- comply with the radiation policies and procedures of the university (contained in the Radiation Protection Manual).

The Radiation Protection Manual contains information on a number of topics including license committees, the permitting process, purchasing procedures, transfer procedures, general safety, personnel dosimetry, waste management, emergency management (spill control), record keeping, and regulatory guides on occupational exposure and prenatal exposure.

Training is required for all personnel who require access to areas where radioactive materials are used or stored. This training can be completed on line at: Radiation Training.

A. Sources

Sealed 137Cs source emits gamma radiation and is located in the MSCL-S in 668 CivE

Rigaku x-ray diffractometer in PillsH

Check sources and Geiger counter located in 668 for MSCL-S and in PillsH for Rigaku.

B. Basics

No food or beverage allowed in rooms with radiation sources

No food or beverage ***trash*** allowed in rooms with radiation sources.

ALARA: As Low As Reasonably Achievable

C. Responsibilities:

- Permit Holder (Emi Ito-137 Cs / Rick Knurr-Xray): Responsible for assuring the safe, secure use and storage, and proper disposal of radioactive materials authorized under the permit. They must maintain an inventory of radioactive materials and receive approval from the Radiation Protection Division of any modifications to activities, use or storage locations.
- Users: Every employee working with radioactive materials and radiation producing devices is responsible for attending required training and following established procedures. Accidents must be reported immediately to DEHS.
- Policy: https://policy.umn.edu/operations/radiation
- Annual survey conducted by DEHS.
- Only trained, authorized staff may be given access to 668 keep doors locked when authorized staff are not present.

D. Training

- Annual training required: powerpoint presentation from DEHS. Initial training: Radiation Orientation (required for anyone who has keys to 668)
- Additional training required for those who set up the MSCL-S or use the Rigaku
- MSCL-S loading is not considered handling a radiation source, per Andy, but those under 18 may not load the MSCL-S.

E. Prenatal exposure guidelines

- Located in the RPT PowerPoint (which must be read annually).
- If you choose to declare a pregnancy (which is recommended, but not required) there is additional training.

F. Required Record Keeping

Permit holders for radioactive materials are required to keep up-to-date records for the following:

- records of receipt & use of each radioactive material stock vial
- records of disposal into each radioactive waste container
- records of radiation contamination survey results of storage/use areas
- records of quarterly reports of inventories to RPD (includes copy of survey results for each calendar quarter)
- new employee and annual refresher training records for all staff who are granted unescorted access to the permit holder's posted labs

G. Radiation dosimeter assignment and use

- State and Federal regulations require the assignment of personnel radiation dosimeters to individuals who are likely to be exposed to greater than applicable radiation dose limits. Guidance on determination of who needs a dosimeter(s) and how to obtain these is available online. Each permit holder should review this information or contact RPD to determine if personnel radiation dosimetry is required.
- Ring dosimeters: wear name label towards source.

6. Other Lab Safety Procedures

Other lab and general safety information is available on the University of Minnesota website as indicated below:

Emergency Eyewash and Safety Shower Installation

Research Occupational Health Program (ROHP)

- Respiratory Protection Program
- Hearing Conservation Program

Laboratory Close-out Procedure

7. Laboratory-Specific Standard Operating Procedures

Each PI must have written Standard Operating Procedures (SOPs) for the research protocols conducted in his or her laboratory. Like the LSP, the SOPs must be accessible to all researchers. Keeping hard copies in the lab or having them on a computer in the laboratory fulfills the accessibility requirement. SOPs developed through DEHS will be posted periodically in Appendix E.

Laboratory-specific SOPs are valuable research tools that supplement the departmental LSP. The process of writing SOPs requires an individual to think through all steps of a procedure and perform a risk assessment before beginning work. The SOP provides a written means to inform and advise researchers about hazards in their work place, allows for standardization of materials and methods, and improves the quality of the research.

SOPs should include exposure controls and safety precautions that address both routine and accidental chemical, physical or biological hazards associated with the procedure. A template for writing new SOPs is available in Appendix F and guidance for writing biologically-related SOPs is available on the Biosafety section of the DEHS website.

8. Emergency Procedures

- Campus Emergency Procedures bomb threats, medical emergencies, fire, severe weather, utility outages, warning systems/sirens, workplace violence
- Chemical Spills
- First Aid for Laboratory and Research Staff
- Radioactive Material Incidents

A. First Aid Basics

Never risk your own safety. Always check the scene for safety. Give victims only the care you are trained in. If you would like to take a first aid/CPR/AED or field first aid course please let the DSO know. When necessary, wear gloves when assisting others.

B. Incisions and lacerations

Apply pressure – elevate – don't remove large objects

C. Choking

cough – back slaps – then abdominal thrust

D. Stroke

F.A.S.T. – Face, Arms, Speech, Time

E. Frostbite

Move individual into a warm place. Remove wet and constricting clothing and items. Protect between fingers and toes with dry gauze. Warm frostbitten area in lukewarm water only if medical care will be delayed and there is no danger of refreezing. Protect and elevate.

F. Hypothermia

Provide basic life support and call 911 as needed. Get the individual into a warm place and cover with blankets. If outdoors, place blanket under the person as well. Do not rub or massage the person's skin.

G. Heat Stroke

Provide basic life support and call 911 as needed. Get the individual into a cool place and remove outer clothing. Cool the person with cold water.

H. Acid burns (and other chemical contact)

brush off any powder; cool water for >20 min. Remove contaminated clothing.

I. Heat burns

Cool water, not ice water. Don't remove burned-on clothing. Do not apply water to burns >20% of the body.

J. Emergency procedures

In the event of a life-threatening illness or injury, dial 911.

Information to give to 911:

- your name
- phone number you are using
- location and number of victims
- age/sex/condition of victims
- what happened, any special circumstances
- what is currently being done to help
- If the victim is responsive convey the following to EMS personnel:
- S.A.M.P.L.E -- Signs and symptoms, Allergies, Medications, Previous problems, Last food and drink, Events

K. Urgent, but non-life-threatening

Employees with urgent, but non-life-threatening, illnesses or injuries should go to the nearest medical clinic.

- HealthPartners Occupational and Environmental Medicine is the provider for occupational health services for University employees in the twin cities.
- Students should go to Boynton Health Services
- The HealthPartners 24 hour CareLine phone service is available anytime. Call 612-339-3663.

9. Fire

If you doubt your ability to fight a fire *EVACUATE IMMEDIATELY and Call Emergency personnel*

A. If a fire breaks out in the lab

- RACE: Rescue – Alarm – Confine – Extinguish/Evacuate
- Relocate people away from danger
- Activate alarm
- Contain fire and smoke
- Extinguish, if safe to do and-and you are familiar with a fire extinguisher

B. If someone is on fire:

- Use a fire blanket
- Stop drop and roll. Don't allow them to run.

C. If you hear a fire alarm

- When the alarm has sounded, all employees, students, and visitors must orderly evacuate the building through the nearest safe exit route.

- Employees should meet outside of the building at a predetermined relocation point. Do not leave for coffee/lunch without checking in with someone.
- Do not re-enter the building or laboratory until the Emergency Responders have notified everyone that it is safe to return!

D. UMN Fire Policy

While you are never required to attempt to extinguish a fire yourself, under University policy, any university employee may attempt to extinguish a fire using a fire extinguisher if:

- The fire is small and not spreading rapidly.
- The employee chooses to use the extinguisher voluntarily.
- The employee is trained and knowledgeable on fire extinguisher use.
- The employee can identify what is burning and has the proper class of extinguisher.
- There is no immediate danger and there is a clear escape path in the event the fire quickly grows.

10. Planning for Shutdowns

Researchers should develop written procedures to deal with events such as loss of electrical power (affecting fume hoods, coolers etc.) or other utilities (water), or temporary loss of personnel due to illnesses such as pandemic flu. Guidance on factors to consider when developing shut-down plans is included in the Lab Hibernation Checklist in Appendix G.

11. Closing out a laboratory

Any researcher leaving the University needs to properly close down his/her lab. If the principal investigator does not take proper care to clean-up the laboratory, then the department for which they worked under becomes responsible. We strongly encourage departments to develop administrative controls to prevent this from happening. A good tool to use is the laboratory closeout checklist available on the DEHS website. Otherwise, DEHS does offer laboratory clean-up services for an hourly fee.

Chapter 3 – How to Reduce Exposures to Hazardous Chemicals

Engineering controls, personal protective equipment, hygiene practices, and administrative controls each play a role in a comprehensive laboratory safety program. Implementation of specific measures must be carried out on a case-by-case basis, using the following criteria for guidance in making decisions. Assistance is available from DEHS.

1. Basics

Leave PPE in the room you are working in.

Inspect protective gloves for tears, pinholes, etc. before use. Order new PPE if old and worn out and have lab coat laundered when necessary.

Use glove guide to help you pick out the right gloves.

Know how to clean up after you are done. See specific SOPs for clean up procedures.

Keep science separate from food – do all mud preps (e.g., sieving prior to picking under binocular scope, sample grinding in mortar) at sinks and benches in lab rooms. Same with lab glassware: not in kitchen sink or dish rack. No hand-to-mouth activities in chemical or radiation rooms.

Prevent or minimize the release of toxic substances in cold rooms since these have contained recirculated atmospheres.

Restrict the use of the material to a designated area, such as a fume hood.

Verify equipment such as fume hoods are in proper working order.

Know what you are putting in equipment such as the freeze dryer and Horiba - avoid chemicals and evaluate procedures.

No food allowed in the lab.

Access to emergency equipment, showers, eyewashes, fire extinguishers and exits should never be blocked.

2. Responsibilities

Each individual is responsible for knowing the particular hazards associated with use of that chemical and responsible for proper storage, use, and disposal of all chemicals they use.

List of hazards can be found in the LacCore Chemical List, MSDS, Prudent Practices, and online.

3. Factors in chemical exposure

Factors: Toxicity (extent to which a substance is poisonous), dosage (amount of chemical exposure), and duration (amount of time exposed to chemical (acute vs. chronic)). Avoid exposure by:

- Substitute a less hazardous chemical when possible
- PPE (gloves, eye protection, lab coats)
- Work in fume hoods or glovebox
- Don't eat, drink, or chew gum in the lab
- Don't store food or beverage containers near chemicals
- Be careful when handling needles
- Don't wear gloves/lab coats outside of the lab
- Wash lab clothing separately from personal clothing

4. Engineering controls

Know locations and proper use of safety showers, eye washes, first aid kits, SDS, fire extinguishers, exits. Eyewashes are flushed weekly. Logs are posted by the eyewash. Check log before using chemicals.

Eyewashes, emergency showers, fire extinguishers – located in ShepL 314 and 360 and CivE 668 (rooms with fume hoods). Familiarize yourself with their locations.

Keep your work area clean! Use lab bench protector sheets to help keep area clean. Use them in fume hoods and any other place where chemicals are being used.

A. Fume Hoods

The laboratory fume hood is the major protective device available to laboratory workers. It is designed to capture chemicals that escape from their containers or apparatus and to remove them from the laboratory environment before they can be inhaled. Characteristics to be considered in requiring fume hood use are physical state, volatility, toxicity, flammability, eye and skin irritation, odor, and the potential for producing aerosols. A fume hood should be used if a proposed chemical procedure exhibits any one of the following characteristics:

- airborne concentrations might approach the action level (or permissible exposure limit)
- flammable vapors might approach one tenth of the lower explosion limit
- materials of unknown toxicity are used or generated
- the odor produced is annoying to laboratory occupants or adjacent units

Procedures that can generally be carried out safely outside the fume hood include those involving the following:

- water-based solutions of salts, dilute acids, bases, or other reagents
- very low volatility liquids or solids
- closed systems that do not allow significant escape to the laboratory environment

- extremely small quantities of otherwise problematic chemicals. The procedure itself must be evaluated for its potential to increase volatility or produce aerosols.

In specialized cases, fume hoods will contain exhaust treatment devices, such as water wash-down for perchloric acid use, or charcoal or HEPA filters for removal of particularly toxic or radioactive materials. Fume hoods must not be used for work with infectious agents.

- make sure the flow check tissue is in motion, work towards the middle (do not work in the closest 6")
- keep the sash low (not just for splash but to reduce airflow turbulence)
- keep it clean and minimize storage
- do not block baffles (lower back portion)
- minimize foot traffic around the hood
- do not store chemicals in the fume hood
- do not put sources of spark in hood when using flammable gasses or liquids.
- Keep sash closed when not in use.

Fume hoods: Understand which chemicals must be used in fume hoods. Refer to SDS. Always make sure the "telltale" strip of tissue is fluttering. Do not use the fume hood for storage of chemicals or equipment. You should keep the sash low and work towards the back of the hood. If procedures are left in the fume hood, you need proper chemical labeling and contact information located next to the hood.

B. Safety Shields

Safety shields, such as the sliding sash of a fume hood, are appropriate when working with highly concentrated acids, bases, oxidizers or reducing agents, all of which have the potential for causing sudden spattering or even explosive release of material. Reactions carried out at non-ambient pressures (vacuum or high pressure) also require safety shields, as do reactions that are carried out for the first time or are significantly scaled up from normal operating conditions.

C. Other Containment Devices

Other containment devices, such as glove boxes or vented gas cabinets, may be required when it is necessary to provide an inert atmosphere for the chemical procedure taking place, when capture of any chemical emission is desirable, or when the standard laboratory fume hood does not provide adequate assurance that overexposure to a hazardous chemical will not occur. The presence of biological or radioactive materials may also mandate certain special containment devices. High strength barriers coupled with remote handling devices may be necessary for safe use of extremely shock sensitive or reactive chemicals.

Highly localized exhaust ventilation, such as is usually installed over atomic absorption units, may be required for instrumentation that exhausts toxic or irritating materials to the laboratory environment.

Ventilated chemical storage cabinets or rooms should be used when the chemicals in storage may generate toxic, flammable or irritating levels of airborne contamination.

D. Secondary containers

When chemicals are transferred from the original container to a secondary container, a new label should be attached that shows the chemical content, composition and appropriate hazard warning: flammable, explosive, corrosive, toxic, etc.

- Improve lab safety
- You, your personal safety
- Your fellow lab workers
- Emergency responders
- Improves Waste Management's Safety
- During transportation

- During storage
- During processing here at the U of MN and by contracted vendor.
- Practice good handwriting and press hard.

E. Secondary containment

Chemicals are grouped based on first two digits of DDC #

- required for transporting chemicals between rooms
- required for storing liquid chemicals

  should hold 1.5 times volume of largest container

Secondary containment (e.g. dishpans, deep trays) is required for all bottles of liquid chemicals. All stored chemicals must also be segregated by compatibility – acids with acids, bases with bases, oxidizers separate from organics, etc.

Storage of chemicals in the lab should be based on DDC code. Each secondary containment should only contain chemicals that are compatible.

F. Sharps/broken glass

- Never dispose of in the trash. Do not fill sharps or broken glass boxes more than ¾ full.
- Glass: Seal the plastic bag, then seal the box.
- Sharps: seal container with supplied lid.
- Never cut towards yourself or another person. Be aware of where your hands are.
- Be sure that your tetanus vaccination is up to date.

G. Vacuum equipment:

- •secure it
- •scrubbers on exhaust
- •glassware only for vacuum operations and inspect
- •wrap glassware with reinforced tape
- •vent glassware slowly.

H. Centrifuge:

- Main hazards: mechanical failure and dispersion of aerosols.
- Always check vapor caps for wear and tear.
- Always balance buckets, tubes, and rotors.
- Make sure bucket swings freely.
- The operator should not leave a centrifuge that is ramping up.
- Stop the centrifuge if there are any unusual conditions (noise or vibration) and check load balances.
- Clean the centrifuge at the end of the day.

I. Glassware

- Always check for chips and star cracks before use.
- All broken glassware should be disposed of using a broken glass box.
- Clean up broken glass immediately.

J. Gas cylinders and regulators

- Gas cylinders need to be chained up during use and storage and capped during transport.
- Gas cylinders are particularly dangerous and must be handled according to strict protocols. Keep all cylinders chained when in place and capped when being moved. Use hand trucks to transport cylinders. Label empties. Spares and empties are stored in the ShepL 3rd-floor plumbing access room (ShepL 330). Get training before using or moving gas cylinders.
- When transporting chemicals across campus always have secondary containment. Some chemicals have extra requirements (dry ice for example). Ask if you are working with a new chemical.

K. Propane Tanks

- Store in the flammable cabinet out at the garage. Store upright on a flat surface so that the propane liquid level is below the relief valve.
- Use caution when using multiple propane devices at one time.

5. Environmental exposure

Prevent release of chemicals into the environment. Use secondary containment. Follow disposal requirements listed in the section on disposal.

6. Personal Protective Equipment (PPE)

A. Skin Protection

As skin must be protected from hazardous liquids, gases and vapors, proper basic attire is essential in the laboratory. Long hair should be pulled back and secured and loose clothing (sleeves, bulky pants or skirts) avoided to prevent accidental contact with chemicals or open flames. Shoes with closed-toed and heel covering must be worn by all individuals occupying laboratory area. Full-length pants or skirts are required to cover all skin that could be exposed during a spill.

Lab coats are routine equipment for all laboratory workers. Remember that lab coats should be worn to protect employees against both chemical and biological hazards. Working in a biosafety level 1 laboratory does not excuse an employee from wearing a lab coat. Lab coats are required when working with radioactive materials, hazardous chemicals and biologicals. The laboratory coats must be appropriately sized for the individual and be buttoned to their full length. Laboratory coat sleeves must be of a sufficient length to prevent skin exposure while wearing gloves.

Flame resistant laboratory coats are recommended when working with pyrophoric materials or large amounts (greater than four (4) liters) of flammable liquids. It is recommended that cotton (or other non-synthetic material) clothing be worn during these procedures to minimize injury in the case of a fire emergency.

It is the responsibility of the employer to purchase lab coats and provide laundry service for employees. Lab coats cannot be taken home for laundering.

Gloves made of appropriate material are required to protect the hands and arms from thermal burns, cuts, or chemical exposure that may result in absorption through the skin or reaction on the surface of the skin. Gloves are also required when working with particularly hazardous substances where possible transfer from hand to mouth must be avoided. Thus gloves are required for work involving pure or concentrated solutions of select carcinogens, reproductive toxins, substances which have a high degree of acute toxicity, strong acids and bases, and any substance on the OSHA PEL list carrying a "skin" notation.

Since no single glove material is impermeable to all chemicals, gloves should be carefully selected using guides from the manufacturers. General selection criteria are outlined in Prudent Practices in the Laboratory: Handling and Disposal of Chemicals (National Research Council, 2011), and glove selection guides are available on the DEHS website. However, glove-resistance to various chemical materials will vary with the manufacturer, model and thickness. Therefore, review a glove-resistance chart from the manufacturer you intend to buy from before purchasing gloves. When guidance on glove selection for a particular chemical is lacking, double glove using two different materials, or purchase a multilayered laminated glove such as a Silvershield or a 4H.

B. Gloves

- Gloves are selected based on breakthrough time, permeation rate, and degradation rating.
- Breakthrough time: time it takes for a chemical to pass through a protective film
- Permeation rate: amount of time a glove will provide effective permeation resistance when totally immersed in the text chemical.
- Degradation rating: breakdown of physical properties of a glove because of contact with a chemical.
- Check compatibility matrix from manufacturer
- inspect glove before use
- dispose disposable gloves, wash and inspect reusable gloves.
- certain chemicals require specific non-disposable gloves, for example, coulometry solutions, nitric acid (HNO_3), hydrofluoric acid (HF), and acetone.
- Glove/chemical compatibility guide is available here.
- Know the right glove for the job! If you are unsure, ask the DSO, read the SDS or SOP (or all three).
- Take off any rings or jewelry that may tear gloves.
- Do not touch door handles with gloves, and remove gloves before leaving the lab room in which you are working.
- Do not reuse disposable gloves – they are meant for single use.
- Thoroughly wash *reusable* gloves after use, and inspect them carefully for damage or wear before use.
- Always wash hands after handling any chemicals, labware, sediments, etc., even if you were wearing gloves.
- Keep gloves away from flames.
- Consider double gloving for extra protection when using highly hazardous materials or where there is a high potential for spills or splashes.
- Gloves should not be worn when working on computers.

C. Clothing

Similarly, no long and loose hair or clothing (sleeves, lanyards, and jewelry) that have the potential to get caught in machines. Make sure you shoes are tied so you don't trip.

- closed-toed shoes, long pants, lab coats, tie back/tuck in long hair.
- Remove PPE in public spaces, leave it in the room you are working in.
- Know the right PPE (especially glove) for the right job.
- Closed shoes and lab coats are required when working with chemicals.
- You may want to keep a spare change of clothes in the lab, just in case you have a chemical exposure and need to change clothes.
- We should have Lab coats and coveralls sizes to fit most and can order where necessary.

- As with gloves, lab coats must be removed before you leave the lab room in which you are working, and must not be worn around the building.
- Lab coats should not be put away dirty. Lab coats needing laundering need to be separated from in-use stock and sent for cleaning. See the DSO if any lab coats are in need of cleaning.
- Even if you are not working with chemicals (e.g., you are sampling or describing cores), remember that someone near you may be. Shepherd Labs 314 and 360 require close-toed shoes and long pants for entry.

D. Eye Protection

Eye protection is required for all personnel and any visitors whose eyes may be exposed to chemical or physical hazards. Side shields on safety spectacles provide some protection against flying particles, but goggles or face shields are necessary when there is a greater than average danger of eye contact with liquids. A higher than average risk exists when working with highly reactive chemicals, concentrated corrosives, or with vacuum or pressurized glassware systems. Contact lenses may be worn under safety glasses, goggles or other eye and face protection. Experts currently believe the benefits of consistent use of eye protection outweigh potential risks of contact lenses interfering with eye flushing in case of emergency.

Splash goggles are required when working with any chemicals. HF requires the addition of a face shield over splash goggles. Safety glasses are required in situations where other eye injuries could occur (operating saws, hammers/chisels, etc.).

E. Respiratory Protection

Respiratory protection is generally not necessary in the laboratory setting and must not be used as a substitute for adequate engineering controls. Circumstances which may require the use of a respirator include the following:

Working with chemicals that are highly toxic and highly volatile or gaseous

Experimental protocols that require exposure above the action level (or PEL) that cannot be reduced by engineering or administrative controls

A rare experimental situation that potentially involves Immediately Dangerous to Life and Health (IDLH) concentrations of chemicals

Prior to use of respiratory protection, researchers must contact DEHS to conduct a hazard assessment, and enroll in the University of Minnesota Respiratory Protection Program through the Office of Occupational Health and Safety.

Don't wear respirators without proper training and fit testing. All users must be trained (partial exceptions for voluntary users). All users must be medically evaluated (exemption for some voluntary users). Mandatory users must be fit tested. There is a lot to know. Ask in advance for evaluation.

Required for respiratory hazards that meet OSHA requirements. If an SDS indicates you need to wear a respirator please contact the DSO so that you can work with DEHS's Respiratory Protection Program. You may not use a respirator without review of respiratory hazards by DSO. The University also has a voluntary portion of the RPP program for hazards that do not meet OSHA requirements. When a filtering face piece is used for personal comfort, no hazards are present, you need DSO approval, but not DEHS approval. Remember, you may not use a respirator without DSO review, even if it is voluntary use.

F. Hearing protection

Currently under review with DEHS.

G. Hard hats

When CEGE is operating the crane on the loading dock everyone is required to wear a hard hat. The first time you wear a hard hat you will must let the DSO know so that proper fit and use of a hard hat can be reviewed. Some field work also requires hard hat use, field-specific training will be provided.

7. Hygiene Practices

Eating, drinking and chewing gum are all strictly prohibited in any laboratory with chemical, biological or radioactive materials. Researchers must also be careful to restrict other actions (such as applying lip balm, rubbing eyes or using iPods or cell phones) which could inadvertently cause exposure to research materials. Consuming alcohol or taking illegal drugs in a research laboratory are strictly prohibited, as such actions potentially endanger the health and safety of not only the user, but everyone in the building. Infractions will be met with serious disciplinary action.

Don't store food in cold rooms, chemical fridges, and sample freezers.

Don't block exits.

Don't work alone whenever possible.

Don't store food in cold rooms, chemical fridges, and sample freezers.

Don't block exits.

8. Procedure specific exposure guidelines

A. HF

HF is one of the most acutely toxic chemicals used in this lab. Special training will be required before use of HF. There is no concentration of HF which can be relied upon as safe! As little as 7 ml of anhydrous HF in contact with the skin untreated can bind all the free calcium in an adult. LacCore uses 48% HF as sold by supplier. There is no material that is completely resistant to HF degradation. HF is readily absorbed into skin binding to calcium and magnesium in the body to form insoluble salts that interfere with cellular metabolism causing cellular death and necrosis. Never use HF alone. Always be current on your training. Always use the appropriate PPE. If you need to assist someone with HF exposure, do not contaminate yourself. Help individual to eyewash/safety shower flush the area with large amounts of water for 5 minutes. Have the person remove all contaminated clothing while under the shower. Apply calcium gluconate antidote (you should be wearing gloves when providing first aid). The person will need immediate medical care.

B. Liquid nitrogen dispensing

- Gloves that can be shaken off easily
- Pressure release (ice buildup under caps of dewars leading to sealing → explosion)
- Asphyxiation (oxygen displacement)

Liquid nitrogen has a boiling point of -320 ˚F (-196 ˚C, 77 K) and an expansion ratio of 1 : 694 at that temperature. It is a burn, explosion, and suffocation hazard. Required PPE: goggles, closed-toed shoes, long pants, long sleeves/lab coat, cryo gloves, and face shield + goggles (when under pressure).

C. Dry ice

- No storage in cold rooms
- Handle with gloves
- Asphyxiation; be aware in vehicles
- Shipping dry ice requires biennial training by DEHS.

Dry ice off-gases carbon dioxide, which can build up in storage locations and lead to suffocation. Dry ice is not permitted in cold rooms. When storing dry ice in coolers make sure they are not sealed and use the proper gloves when handling dry ice. Avoid leaning over or sticking your head in coolers containing dry ice to avoid CO_2 poisoning. Use caution when transporting dry ice in a vehicle (keep the windows open). You must have additional training to be able to ship items on dry ice. If you are ever asked to ship something on or with dry ice please work with the DSO.

D. Power tools

- Read the manual. Get trained.

- Use gloves to protect hands from splinters when handling wood but do not (i.e., never) wear them near rotating blades and other machinery parts where the gloves can catch (OSHA, others)
- Wear hearing protection, eye protection at all times
- No long and loose hair or clothing (sleeves, lanyards, jewelry, shoe strings) that have the potential to get caught in machines or result in a tripping hazard.

Important Notes Regarding PPE

Before leaving the laboratory, remove personal protective equipment/clothing (lab coat and gloves) and wash hands thoroughly. Do **NOT** wear laboratory gloves, lab coats or scrubs in public spaces such as hallways, elevators or cafeterias.

9. Disposal

A. Hazardous chemical waste:

See section on hazardous waste.

B. Glass

Broken lab ware, microscope slides, glass pipettes, etc. must be discarded in designated blue & white cardboard boxes in each lab room.

C. Utility knife blades, other sharp metal objects:

Sharps containers are in each room.

D. Mud

Wash muddy tools and rags into the "sediment traps" (dishpans) provided in sinks.

E. Cardboard

Break down cardboard and put it by the freight elevator in CivE.

10. Safety Data Sheets

Read an SDS to understand:

- Health, physical and environmental hazards
- Proper handling and storage
- PPE needed for normal use is in section 8
- Hazard information and protective measures
- Universal GHS format
    - 1. Hazard Identification,
        - Chemical properties, health, reactivity, flammability, protective equipment
        - Danger, Caution, Warning phrases
    - Components and amount
    - First aid Measures
        - what to do based on type of exposure (skin contact, eye contact, …)

11. Globally Harmonized System

Worldwide system for hazard communication

Unify how information is conveyed and convey it in more than one way (text and pictograms)

Developed by the United Nations, adopted by the US

New labels (Product identifier, supplier identifier, chemical identity, hazard pictograms, signal words, hazard statements, precautionary information)

Safety Data Sheets (SDS) replace MSDS

A. Symbols

- Oxidizer
- Gas under pressure
- Explosive, self-reactive, organic peroxide
- Corrosive
- Flammable, self-reactive, pyrophoric, self-heating, emits flammable gas, organic peroxide
- Carcinogen, respiratory sensitizer, reproductive toxicity, target organ toxicity, mutagenicity, aspiration toxicity
- Irritant, dermal sensitizer, acute toxicity (harmful), narcotic effects, respiratory tract irritation
- Acute toxicity (severe)
- Environmental toxicity

B. Signal words

- Not interchangeable, each category has it's own determination of which word, or neither, is to be used.
- Used to emphasize the hazard and discriminate between levels of hazard. Danger, more severe. Warning, less severe.

C. Set number of hazard and precautionary statements. (H###, P###)

- "H" hazard statement
- "2" physical hazard, "3" health hazard, "4" environmental hazard
- "P" Precautionary statement
- "2" prevention, "3"response, "4" storage, "5"disposal

D. Hazard Statements

- A single harmonized hazard statement for each level of hazard within each hazard class
- Example: Flammable liquids
- Category 1: Extremely flammable liquid and vapor
- Category 2: Highly flammable liquid and vapor
- Category 3: Flammable liquid and vapor
- Category 4: Combustible liquid

12. Administrative Controls

Supervisors shall consider the hazards involved in their research, and in written research protocols, detail areas, activities, and tasks that require specific types of PPE as described above. Researchers are strongly encouraged to prioritize research so that work with hazardous chemical,

biological or physical agents occurs only during working hours (8 am – 5 pm, Monday through Friday). After-hours work (on nights and weekends) should be restricted to nonhazardous activities such as data analysis and report writing. If hazardous materials must be used at nights or on weekends, ensure that at least one other person is within sight and ear-shot to provide help in an emergency. Undergraduate workers are prohibited from working alone in the laboratory unless there is a review and formal approval by the department's DSO and/or safety committee.

Persons under 18 years of age are not allowed in university laboratories or other areas where hazardous materials are present or hazardous activities take place except under the following circumstances:

The minor:

1. is employed by the University or has been formally accepted as a volunteer worker; and has been trained in safe laboratory procedures; and has adult supervision; and has received a MN Department of Labor Child Labor Exemption, permit applications can be found at: Permit for Minors <16 years old , Permit for16/17 year olds ; and

the permit is on file with the host department; **- or -**

2. is enrolled in a University class with a laboratory component; **- or -**

3. is participating in a University-sponsored program; and has been trained in safe laboratory procedures; and

has adult supervision; and has a Lab Use Agreement Form on file with the host department.;**–or-**

4. is visiting for academic purposes; and receives written approval from the PI/Lab Director and Department Head; and has been trained in safe laboratory procedures; and has adult supervision; and has a Lab Use Agreement Form on file with the host department.

13. Lab floor plans

Lab floor plans, with exit routes, are located in each room. They are also available in Transfers/SOPs/Safety/Signs/Floor plans. It is a good exercise to view a floor plan and see if you can locate safety equipment, such as eyewashes, fire extinguishers, safety showers, chemical spill kits and soils spill kits.

14. Additional Resources

- Additional, more specific, training is required before learning any new procedure or using any equipment.
- Lab Safety Procedure – online, written by DEHS but modified for LacCore
- Hazardous Waste Guidebook – online, written by DEHS
- MSDS – online and in binders in Shepherd Labs
- SOPs – online, updates are ongoing
- Prudent Practices
- Wikipedia and other websites

Chapter 4 - Management of Chemical Fume Hoods and Other Protective Equipment

1. Fume Hoods

A. Monitoring

Fume hoods must be monitored daily by the user to ensure that air is moving into the hood. Any malfunctions must be reported immediately to Facilities Management (612-624-2900). The hood should have a continuous reading device, such as a pressure gauge, to indicate that air is moving correctly. Users of older hoods without continuous reading devices should attach a strip of tissue or yarn to the bottom of the vertical sliding sash. The user must ensure the hood and baffles are not blocked by equipment and bottles, as air

velocity through the face may be decreased. DEHS staff will measure the average face velocity of each fume hood annually with a velometer or a thermoanemometer. A record of monitoring results will be made.

B. Acceptable Operating Range

The acceptable operating range for fume hoods is 80 to 150 linear feet per minute, at the designated sash opening – usually 18 inches for a vertically-sliding sash and 30 inches for a horizontally-sliding sash. If, during the annual check, a hood is operating outside of this range, DEHS staff may request that you check to ensure the baffles are adjusted properly, and that the exhaust slots are not blocked by bottles and equipment. If a fume hood is not working properly, please contact Facilities Management at 612-624-2900 to schedule a repair.

C. Maintenance

During maintenance of fume hoods, laboratories must clean out and if necessary, decontaminate the fume hood and restrict use of chemicals to ensure the safety of maintenance personnel.

2. Eyewash and Shower

Eyewashes must be flushed weekly by the user. This will ensure that the eyewash is working, and that the water is clean, should emergency use become necessary. The user must post a log near the eyewash to document that it is being flushed every week. These logs are considered equipment maintenance records and therefore should be kept for 1 year. An eyewash record template is available in Appendix F. The user should also coordinate with Facilities Management to ensure that emergency showers and eyewashes are tested annually. Facilities Management will document their testing on separate tags.

3. Fire Extinguishers

Fire extinguishers will be checked annually by a University contractor. Please contact Facilities Management at 612-624-2900 if the fire extinguisher is out of date.

4. New Systems

When new ventilation systems, such as variable air volume exhaust, are installed in University facilities, specific policies for their use will be developed by DEHS and employees will be promptly trained on use of the new equipment.

5. Routine Inspections

Protective equipment and general laboratory conditions must be monitored periodically by the users. A laboratory self-inspection form is included in, and may be tailored for use by individual laboratories. The DSO or the Research Safety Professional may also use this form for spot-checks of the laboratories.

Chapter 5 - Employee Information and Training

1. Training Requirements

All laboratory researchers and their supervisors (Principal Investigators included) must be trained according to the requirements of the Laboratory Safety Standard. Colleges and non-academic departments that engage in the laboratory use of hazardous chemical, physical or biological agents are responsible for identifying such employees. The employees must be informed about their roles and responsibilities as outlined in this standard, as well as hazards associated with their work and how to work safely and mitigate those hazards.

DEHS provides web-based training modules on a number of training topics . At a minimum, new laboratory employees should complete the modules “Introduction to Laboratory Safety” and “Chemical Waste Management”. Employees that are working with radioactive materials must take “Radiation Safety Training”.

In addition, each laboratory supervisor is responsible for ensuring that laboratory employees are provided with training about the specific hazards present in their laboratory work area, and methods to control such hazards. Such training must be provided at the time of an employee's initial assignment to a work area and prior to assignments involving new potential exposures, and must be

documented. Refresher training must be provided at least annually. A lab-specific training document can be found in. This document highlights items that must be covered during lab-specific training. The document should be completed and kept on file as training documentation.

Volunteers and Visitors in the Laboratory

- Volunteers and visitors in University of Minnesota Laboratories must complete all of the same training requirements as regular lab employees. To access training content click here and complete the ULearn account registration form.
- If you have problems registering or logging in, please contact the ULearn Support Team at 612-626-0057 or ulearn@umn.edu.
- Volunteers and visitor's conducting research in University laboratories must complete the Volunteers and Visitor's Laboratory Use Agreement. If the volunteer is a minor, a parent or guardian must also sign the agreement.
- Because laboratories may contain hazardous chemicals, a minor who is paid to work in a research laboratory must obtain an exemption from the Minnesota Child Labor Act. An overview of this law is available on the Minnesota Department of Labor & Industry website
- Child Labor Exemption Applications for working minors should be completed by a parent, guardian or school official and filed with the Minnesota Department of Labor and Industry. Forms are available from the Department of Labor and Industry website.

2. Training Content

Employee training programs will include, at a minimum, the following subjects:

- Methods of detecting the presence of hazardous chemicals including visual observation, odor, real-time air monitoring, time-weighted air sampling, etc.
- Basic toxicological principles including toxicity, exposure, routes of entry, acute and chronic effects, dose-response relationship, LD50, Threshold Limit Values (TLVs) and Permissible Exposure Limits (PELs), exposure time, and health hazards related to classes of chemicals
- Prudent laboratory practices designed to reduce personal exposure and to control physical hazards (See Prudent Practices in the Laboratory: Handling and Disposal of Chemicals [National Research Council, 2011])
- Description of available chemical information including container labels and Material Safety Data Sheets (MSDSs)
- Emergency response information such as emergency phone numbers, fire extinguisher locations, and eyewash/shower locations
- Applicable details of the departmental Laboratory Safety Plan including both general and laboratory-specific SOPs

An introduction to the University of Minnesota Hazardous Chemical Waste Management Guidebook

3. Training Updates

Update training is required for all laboratory researchers and supervisors / principal investigators (PI's) at least annually. Departmental Safety Officers are responsible for coordinating and tracking update training. Often, DSOs may arrange for departmental-wide update-training sessions, focusing on results of laboratory audits, and highlighting issues that may need improvement. Videos from DEHS's library may be borrowed to supplement these training sessions. Individual PI's may conduct

research-group-specific safety reviews to supplement or even stand in place of departmental update sessions. Documentation (paper or electronic) of all safety training must be maintained according to the requirements outlined in Chapter 10 of this Lab Safety Plan.

4. Access to Pertinent Safety Information

- It is essential that laboratory employees have access to information on the hazards of chemicals and procedures for working safely. Supervisors must ensure that laboratory employees are informed about and have access to the following information sources:
- The contents and requirements of the OSHA Laboratory Safety Standard
- The content, location and availability of the departmental Laboratory Safety Plan (available within individual units or departments)
- The Permissible Exposure Limits (PELs), action levels and other recommended exposure limits for hazardous chemicals used in the laboratory (See OSHA Annotated Table Z-1)
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory
- Location and availability of Material Safety Data Sheets (MSDSs)
- Information on chemical waste disposal and spill response (University of Minnesota Hazardous Chemical Waste Management Guidebook)

Chapter 6 - Required Approvals

'High hazard' research is that which due to the nature of the hazard, or the quantity of the material, or the potential for exposure poses higher than usual risk to the worker. Such research may require formal review and approval by a researcher's departmental safety committee, perhaps with involvement of DEHS personnel. High hazard research could include gases or chemicals listed in Tables 1-5 of this Laboratory Safety Plan, or certain biological or physical agents. DSOs should conduct laboratory audits and consult with Principal Investigators to identify research programs which may fall into this 'high hazard' category.

PI's whose research is identified as 'high hazard' should provide copies of their SOPs to the DSO and their department's safety committee for review and approval. The committee should respond with any comments or requests for changes in a timely manner, and keep a written record of approvals within the department.

DSO approval is required for use of hydrofluoric acid, dichloromethane, **acetic anhydride,** and magnesium perchlorate.

Chapter 7 - Medical Consultation and Examination

1. Employees Working With Hazardous Substances

All employees who work with hazardous substances will have an opportunity to receive medical attention, including any follow-up visits that the examining physician determines to be necessary, under the following circumstances:

A. Signs or symptoms of exposure

Whenever an employee develops signs or symptoms associated with a hazardous substance or organism to which the employee may have been exposed in the laboratory, the employee will be provided an opportunity to receive an appropriate medical examination.

B. Exposure monitoring

Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance will be established for the affected employee as prescribed by the particular standard.

A. Silica

Proper use of other ventilation systems. Possible respirator use, see section on respirator use.

B. H_2S

LacCore does not use H_2S gas in any SOPs. However, some cores will contain H_2S. LacCore has had DEHS visit the lab during core splitting when H_2S was present. While the H_2S odor (rotten egg smell) was detectable by those working with the cores DEHS was not able to detect any H_2S with their equipment. H_2S is a colorless gas that is heavier than air and poisonous. Symptoms of exposure include respiratory irritation, coughing, headache, dizziness, fatigue, sore through, burning eyes, and loss of smell. If you are ever in doubt about the exposure limits of H_2S DEHS can be called in to check exposure levels.

C. Hearing

Testing currently pending with DEHS.

D. Radiation

See section on radiation safety.

E. Exposure incident

Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee will be provided an opportunity for a medical consultation. Such consultation will be for the purpose of determining the need for a medical examination.

F. Physical Injury

Whenever an employee is physically hurt or injured on the job, the affected employee will be provided an opportunity for a medical consultation and/or examination. Physical injuries include but are not limited to cuts, burns, punctures and sprains.

Contact the Office of Occupational Health and Safety at 612-626-5008 whenever the need for medical consultation or examination occurs, or when there is uncertainty as to whether any of the above criteria have been met.

2. Medical Examinations and Consultations

In the event of a life-threatening illness or injury, dial 911 and request an ambulance. Employees with urgent, but non-life-threatening, illnesses or injuries should go to the nearest medical clinic.

Occupational Health Clinic Information

HealthPartners Occupational and Environmental Medicine is the provider for occupational health services for University employees in the twin cities. Health Partners has 3 clinic locations around the Minneapolis and St. Paul campuses.

The HealthPartners 24 hour CareLine phone service is available any time. The CareLine is staffed with registered nurses who can counsel employees on where to seek care in the event of an exposure. Call 612-339-3663 or 800-551-0859 (TTY 952-883-5474).

All medical examinations and consultations will be performed by or under the direct supervision of a licensed physician and will be provided at no cost to the employee, without loss of pay and at a reasonable time and place.

3. Workers' Compensation Procedures and Forms

It is very important that even minor job-related injuries or illness are reported. These statistics help the Department of Environmental Health and Safety track trends that may indicate occupational hazards that need evaluation. The University of Minnesota's Policy for Reporting Workers' Compensation Related Injuries is available. This policy explains the procedures and provides the necessary reporting forms.

4. Employee Responsibilities:

A. Immediately -

Notify your Supervisor. Your Supervisor will assess the situation, assist with arranging proper medical care and begin the injury reporting process.

Promptly cooperate with your Supervisor and the Claims Administrator in the completion of all relevant documents.

5. Supervisor Responsibilities:

A. Immediately -

Assess the incident and assist the Employee in seeking appropriate medical care or necessary treatment for any work-related injury. If an injury is a potential life-threatening emergency, call 911.

Provide the Employee with the Minnesota Workers Compensation Information Sheet

list of Designated Medical Providers, and

Temporary Prescription Drug ID card.

B. Within 8 business hours -

Complete the online First Report of Injury form, or

Complete the paper First Report of Injury form and fax it to the Claims Administrator.

C. Within 24 business hours -

Complete a Supervisor Incident Investigation Report and email or fax to the Claims Administrator at Sedgwick Claims Management Services. Fax number: 952 826 3785 or email 211@sedgwickcms.com

If an Employee reports an on-the-job injury which may not be compensable, the First Report of Injury form must still be submitted. Contact the Claims Administrator with any questions regarding claim compensability.

6. Information Provided to Physician

The employee's supervisor or department will collect and transmit the following information to the examining physician:

- Identification of the hazardous substance(s) to which the employee may have been exposed;
- A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and
- A description of the signs and symptoms of exposure that the employee is experiencing, if any.

7. Information Provided to the University of Minnesota

Supervisors should request that the examining physician provide them with a written report including the following:

- Any recommendation for further medical follow-up;
- The results of the medical examination and any associated tests;
- Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

The written opinion will not reveal specific findings of diagnoses unrelated to occupational exposure.

Chapter 8 - Personnel

The following individuals and groups have responsibilities for implementation of various aspects of the University of Minnesota's Laboratory Safety Plan.

1. Research Safety Professionals

The University of Minnesota's Research Safety Professionals are:

Anna Sitek, 612-624-8855, engl0131@umn.edu, for the College of Science and Engineering

Sabine Fritz, 612-625-7227, fritz017@umn.edu

Greg Hansen, 612-301-1158, hanse245@umn.edu

Jodi Ogilvie, 612-301-1214, jogilvie@umn.edu

Kate Greenberg, 612-626-2707, kgreen15@umn.edu

2. College or Departmental Safety Officer

The Departmental Safety Officer for LacCore is Jessica Heck. The duties of this DSO are included in Appendix L.

3. College or Departmental Safety Committee

The designation of a safety committee to assist the safety officer in his/her required duties is strongly encouraged. The safety committee members are: Joe Labuz <jlabuz@umn.edu>, Nicole Pilman <npilman@umn.edu>, Kathy Wabner <wabne001@umn.edu>, Mugurel Turos <turos001@umn.edu>, Jessica Heck <jheck@umn.edu>

4. Department of Environmental Health and Safety

The Department of Environmental Health and Safety offers assistance in a wide range of health and safety issues. Staff phone numbers are included in Appendix M. Address: W-140 Boynton. Phone: 612-626-6002.

5. Occupational Medicine Program

All Occupational health services for university employees in the twin cities are provided by HealthPartners. There are 3 clinic locations, Riverside clinic, St. Paul clinic and Como avenue clinic. Regular appointments can be made by calling 952-883-6999. For urgent care or after hours call 952-853-8800. A 24 hour care line is also available anytime for counseling employees on where to seek care in the event of an exposure. Call 612-339-3663 or 800-551-0859.

Chapter 9 - Additional Employee Protection for Work with Particularly Hazardous Substances

Additional employee protection will be considered for work with particularly hazardous substances. These include select carcinogens, reproductive toxins and substances that have a high degree of acute toxicity (see Appendix H - Particularly Hazardous Substances). Common chemicals designated as Particularly Hazardous Substances are listed in Tables 1-5 as the back of this document. Pp. 90-93 of the 1995 edition of Prudent Practices provides detailed recommendations for work with particularly hazardous substances. These pages may be accessed from DEHS's web site. Laboratory supervisors and principal investigators are responsible for assuring that laboratory procedures involving particularly hazardous chemicals have been evaluated for the level of employee protection required. Specific consideration will be given to the need for inclusion of the following provisions:

1. Planning;
2. Establishment of a designated area;
3. Access control
4. Special precautions such as:

use of containment devices such as fume hoods or glove boxes;

use of personal protective equipment;

isolation of contaminated equipment;

practicing good laboratory hygiene; and

prudent transportation of very toxic chemicals.

5. Planning for accidents and spills; and

6. Special storage and waste disposal practices.

Chapter 10 - Record Keeping, Review and Update of Laboratory Safety Plan

1. Record Keeping

A. Exposure evaluation

Any records of exposure evaluation carried out by individual departments (including continuous monitoring systems) will be kept within the department and also sent to DEHS. Results of exposure evaluations carried out by DEHS will be kept by DEHS and sent to the affected department. Raw data will be kept for one year and summary data for the term of employment plus 30 years.

B. Medical consultation and examination

Results of medical consultations and examinations will be kept by the University's Occupational Health provider for a length of time specified by the appropriate medical records standard. This time will be at least the term of employment plus 30 years as required by OSHA.

C. Training

Web-based training and many in-person training sessions for employees are tracked electronically in the university's learning management system. Paper records are still acceptable, and must include the name and title of the trainer, the trainee(s), the date, and the content of the training. Training records must be kept in an individual's department or college for five years. Training records for laboratory volunteers must also be maintained for at least five years. Hard copy and/or electronic forms must be available in the event of an audit by the University Audit Department or state or county regulators. A lab-specific training document is available in Appendix K.

D. Fume hood monitoring

Data on annual fume hood monitoring will be kept in the Department of Environmental Health and Safety. Fume hood monitoring data are considered maintenance records and as such the raw data will be kept for one year and summary data for 5 years.

E. Eyewash Records

Eyewash user logs should be kept on file for 1 year, because they are considered maintenance records.

F. Laboratory audits and reports

Departmental Safety Officers must coordinate and/or conduct formal audits of laboratories in their sphere of responsibility, annually or bi-annually depending on level of risk. Risk levels are made in collaboration with your DEHS Research Safety Professional. A checklist is available in Appendix J. Checklists and reports should be kept for at least 5 years.

G. Accident investigation reports

Departmental Safety Officers work with PIs and researchers to complete the Accident Investigation Form in Appendix C. Reports should be kept for at least 5 years.

H. Incidents and Near misses

Report all accidents and injuries immediately (Amy, Anders, Brady, Ryan, Jess, or Mark).

Report all near misses too! A near miss is any event, action, or condition, which under slightly different circumstances could have resulted in injury or illness to people, equipment loss, or harm to the environment.

Why report near misses:

- Help others learn from our mistakes.
- Prevent future injury in similar circumstances.
- Keep track of areas that need improvement.

2. Review and Update of Laboratory Safety Plan

On an annual basis, this Laboratory Safety Plan will be reviewed and evaluated for effectiveness by DEHS and updated as necessary. Any changes in the Laboratory Safety Plan will be transmitted to college and Departmental Safety Officers, who are responsible for carrying out a similar review and modification of their plans, and may submit a revised copy to DEHS.

3. Annual Training checklist

Email the DSO with the dates of completion of the following items and include any requested detail. Bill to ISO/ESO.

- Read this entire document
- Complete the following required web courses, if you have not done so.
    - http://dehs.umn.edu/training_locator.htm
        - Introduction to Research Safety (only required once at time of hire)
        - Chemical safety training (only required once at time of hire)
        - Radiation Safety Orientation (only at time of hire, regardless of use of radiation sources this is required if you have a key to CivE spaces)
        - GHS (only required at time of hire)
        - Chem waste management (**annual,** only if you handle chemical waste)
        - MERTKA (**annual**)
        - Respiratory protection (**annual**)
    - Browse DEHS safety training and let the DSO know if you want to take any of those courses.
- Read the SDS for all the chemicals you use (at least once on an annual basis)
    - Located in Transfers/SOPs/SDS
    - If SDSs are missing then please find them on the internet, read them, save them to the above directory, and email them to the DSO.
    - Pay close attention to the signs and symptoms that indicate exposure and the exposure limits.
    - List SDS read.
- Read all SOPs that you use on a regular basis

- Discuss any changes/updates you would like to make with the SOP owner.
- Think of a list of SOPs that you would like to have, but do not currently exist.
- List SOPs read.

- Review the Chemical Inventory
  - Transfers/SOPs/Safety/Chemical Inventory
  - Email the DSO if anything needs to be added or removed.

Table 1 - Poisonous Gases

The gases on this list are either on the Department of Transportation's Category 1 list, or the Linde Specialty Gases Company's Group 6 – Very Poisonous list. These chemicals are highly toxic gases at ambient temperature and pressure. They have an extremely high potential for causing significant harm if not adequately controlled.

Arsine	Boron trichloride	Chlorine pentafluoride
Chlorine trifluoride	Cyanogen	Cyanogen chloride
Diborane	Dinitrogen tetroxide	Fluorine
Germane	Hydrogen selenide	Nitric oxide
Nitrogen dioxide	Nitrogen trioxide	Nitrosyl chloride
Oxygen difluoride	Phosgene	Phosphine
Phosphorus pentafluoride	Selenium hexafluoride	Stibine
Sulfur tetrafluoride	Tellurium Hexafluoride	Tetraethyldithiopyrophosphate
Tetraethylpyrophosphate		

Guidance: Departments may choose to add other chemicals to the above list. For example, sulfur-containing compounds such as mercaptans can cause significant odor problems when used in the laboratory. Pre-approval of the conditions under which they can be used may prevent odor complaints.

LacCore does not currently use any of the Table 1 gases.

Table 2 - Shock Sensitive Chemicals

The classes of chemicals listed below may explode when subjected to shock or friction. Therefore users must have appropriate laboratory equipment, information, knowledge and training to use these compounds safely.

Acetylenic compounds, especially polyacetylenes, haloacetylenes, and heavy metal salts of acetylenes (copper, silver, and mercury salts are particularly sensitive)

Acyl nitrates

Alkyl nitrates, particularly polyol nitrates such as nitrocellulose and nitroglycerine

Alkyl and acyl nitrites

Amminemetal oxosalts: metal compounds with coordinated ammonia, hydrazine, or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate, or other oxidizing group

Azides, including metal, nonmetal, and organic azides

Chlorite salts of metals, such as AgClO2 and Hg(ClO2)2

Diazo compounds such as CH2N2

Diazonium salts, when dry

Fulminates such as mercury fulminate ($Hg(CNO)_2$)

Hydrogen peroxide (which becomes increasingly treacherous as the concentration rises above 30%, forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals. LacCore orders hydrogen peroxide up to 30%, but not over 30%.

N-Halogen compounds such as difluoroamino compounds and halogen azides

N-Nitro compounds such as N-nitromethylamine, nitrourea, nitroguanidine, and nitric amide

Oxo salts of nitrogenous bases: perchlorates, dichromates, nitrates, iodates, chlorites, chlorates, and permanganates of ammonia, amines, hydroxylamine, guanidine, etc.

Perchlorate salts (which can form when perchloric acid mists dry in fume hoods or associated duct work. Most metal, nonmetal, and amine perchlorates can be detonated and may undergo violent reaction in contact with combustible materials)

Peroxides and hydroperoxides, organic

Peroxides (solid) that crystallize from or are left from evaporation of peroxidizable solvents (see the following Section 3)

Peroxides, transition-metal salts

Picrates, especially salts of transition and heavy metals, such as Ni, Pb, Hg, Cu, and Zn

Polynitroalkyl compounds such as tetranitromethane and dinitroacetonitrile

Polynitroaromatic compounds especially polynitrohydrocarbons, phenols, and amines (e.g., dinitrotoluene, trinitrotoluene, and picric acid)

Note: Perchloric acid must be used only in specially-designed perchloric acid fume hoods that have built-in wash down systems to remove shock-sensitive deposits. Before purchasing this acid, laboratory supervisors must arrange for use of an approved perchloric acid hood.

Table 3 - Pyrophoric Chemicals

The classes of chemicals listed below will readily oxidize and ignite spontaneously in air. Therefore, users must demonstrate to the department that they have the appropriate laboratory equipment, information, knowledge and training to use these compounds safely. Please see the Pyrophoric Chemicals Fact Sheet for further information.

Grignard reagents, RMgX

Metal alkyls and aryls, such as RLi, RNa, R_3Al, R_2Zn

Metal carbonyls such as $Ni(CO)_4$, $Fe(CO)_5$, $Co_2(CO)_8$

Alkali metals such as Na, K

Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr

Metal hydrides such as NaH, $LiAlH_4$

Nonmetal hydrides, such as B_2H_6 and other boranes, PH_3, AsH_3

Nonmetal alkyls, such as R_3B, R_3P, R_3As

Phosphorus (white)

Table 4 - Peroxide-Forming Chemicals

The chemicals listed below can form explosive peroxide crystals on exposure to air, and therefore require special handling procedures after the container is opened. Some of the chemicals form peroxides that are violently explosive in concentrated solution or as solids, and therefore should never be evaporated to dryness. Others are polymerizable unsaturated compounds and can initiate a runaway, explosive polymerization reaction. All peroxidizable compounds should be stored away from heat and light. They should be protected from physical damage and ignition sources. A warning label should be affixed to all peroxidizable materials to indicate the date of receipt and the date the container was first opened. Due to these special handling requirements, users must have the appropriate laboratory equipment, information, knowledge and training to use these compounds safely.

1. Severe Peroxide Hazard with Exposure to Air (discard within 3 months from opening)

- diisopropyl ether (isopropyl ether)
- divinylacetylene (DVA)
- vinylidene chloride (1,1-dichloroethylene)
- potassium metal
- sodium amide (sodamide)
- potassium amide

2. Peroxide Hazard on Concentration

Do not distill or evaporate without first testing for the presence of peroxides (discard or test for peroxides after 6 months):

- acetaldehyde diethyl acetal (acetal)
- cumene (isopropylbenzene)
- cyclohexene
- cyclopentene
- decalin (decahydronaphthalene)
- diacetylene (butadiene)
- dicyclopentadiene
- diethyl ether (ether)
- diethylene glycol dimethyl ether (diglyme)
- dioxane
- ethylene glycol dimethyl ether (glyme)
- ethylene glycol ether acetates
- ethylene glycol monoethers (cellosolves)
- furan

- methylacetylene
- methylcyclopentane
- methyl isobutyl ketone
- tetrahydrofuran (THF)
- tetralin (tetrahydronaphthalene)
- vinyl ethers

3. Hazard of Rapid Polymerization Initiated by Internally-Formed Peroxides

- Liquids (discard or test for peroxides after 6 months):
- Chloroprene (2-chloro-1, 3-butadiene)
- vinyl acetate
- styrene
- vinylpyridine

4. Gases (discard after 12 months):

- butadiene
- vinylacetylene (MVA)
- tetrafluoroethylene (TFE)
- vinyl chloride

Table 5 - Carcinogens, Reproductive Toxins or Highly Toxic Chemicals

The chemicals listed below are extremely hazardous. Workers must have knowledge of the dangers of these chemicals prior to use, and documentation of training in safe working procedures.

Biologically active compounds:

- protease inhibitors (e.g. PMSF, Aprotin, Pepstatin A, Leopeptin);
- protein synthesis inhibitors (e.g. cycloheximide, Puromycin);
- transcriptional inhibitors (e.g. a-amanitin and actinomycin D);
- DNA synthesis inhibitors (e.g. hydroxyurea, nucleotide analogs (i.e.
- dideoxy nucleotides), actinomycin D, acidicolin);
- phosphatase inhibitors (e.g. okadaic acid);
- respiratory chain inhibitors (e.g. sodium azide);
- kinase inhibitors (e.g. NaF);
- mitogenic inhibitors (e.g. colcemid); and
- mitogenic compounds (e.g. concanavalin A).
- Castor bean (Ricinus communis) lectin: Ricin A, Ricin B, RCA toxins

- **Diisopropyl fluorophosphate:** highly toxic cholinesterase inhibitor; the antidote, atropine sulfate and 2-PAM (2-pyridinealdoxime methiodide) must be readily available
- Jaquirity bean lectin (Abrus precatorius)
- **N-methyl-N'-nitro-N-nitrosoguanidine:** carcinogen (this chemical forms explosive compounds upon degradation)
- **Phalloidin from Amanita Phalloides:** used for staining actin filaments
- **Retinoids:** potential human teratogens
- **Streptozotocin:** potential human carcinogen (See SOP Template example)
- **Urethane (ethyl carbamate):** an anesthetic agent, potent carcinogen and strong teratogen, volatile at room temperature

***See the DEHS Web site for appendices.**