Chemical Hygiene Plan

This Plan Applies to:

Department: _____

Principal Investigator: _____

Building & Room Location(s): _____

Person Making Amendments: _____

Note: The most up-to-date version of the CHP can be found on the Environmental Health & Safety website.

The University of Iowa
Environmental Health & Safety
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Iowa City, IA 52242-1000
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Date Revised/Reviewed: 12/2019

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Preface

The University of Iowa is committed to providing its employees, students and visitors with an environment where the laboratory use of hazardous chemicals is done safely. Attainment of this goal requires the cooperation and commitment of all persons involved.

This generic Chemical Hygiene Plan was written to fulfill uniform requirements applicable to most University labs. The generic CHP must have location specific information, and possibly amendments, added to complete it for the department and lab locations to which it will apply. Additional chemical hygiene resources are available at the Environmental Health & Safety's (EHS) Chemical Safety site.

This generic Chemical Hygiene Plan supersedes previous University generic chemical hygiene plans.

Revision History

1. Revision Description: _____
2. Revision Location: _____
3. Revision Date: _____

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Spill Response Information

In the event of a small spill, take action as outlined in your lab's spill plan or contact your supervisor.

Emergency and Trouble Calls Information

Major Chemical Spill - 911

Other Emergencies

Public Safety - 335-5022 or 911

- Ambulance
- Break-Ins and Illegal Entry
- Fire
- Personal Injuries
- Theft

Building Emergency

FM@YourService

- Elevator Problems
- Floods
- Heating/AC Problems
- Power Outages
- Storm Damage
- Snow Removal/Roads

1.0 Scope and Application

The Federal OSHA Lab Standard, 29 CFR 1910.1450, was adopted by the Iowa Occupational Safety and Health Administration (IOSH) and therefore applies to The University of Iowa. It applies to all employees working on laboratory scale operations involving laboratory use of hazardous chemicals and requires the implementation of a written Chemical Hygiene Plan by each employer with the applicable laboratory employees.

1.1 How to Use This Plan

- This revised chemical hygiene plan is not required to be printed and maintained as a hard copy document. However, this plan must be easily accessible to all laboratory employees and workers during their working hours.
- Assure that new employees receive required lab safety training and review this plan prior to beginning work with chemicals in the lab.
- Laboratory employees must review this plan annually.

1.2 Things you need that are not in the plan

- Lab-specific training;
- Lab-specific operating procedures developed with safety information for more hazardous chemicals or processes;
- Resources to complement the plan (listed as links throughout the plan but are separate from the plan); and
- Additional chemical hygiene resources, available at EHS Chemical Safety.

1.3 Additions to This Plan

- Site-specific information or procedures unique to a lab should be added to the end of the Chemical Hygiene Plan as an addendum to facilitate the yearly review.

2.0 Purpose

The intent of this document, The University of Iowa Chemical Hygiene Plan (UI CHP), is to protect employees from chemical health hazards (limit exposure to hazardous chemicals at the lowest practical level) and to comply with the OSHA Standard for Occupational Exposures to Hazardous Chemicals in Laboratories, Title 29 Code of Federal Regulations 1910.1450.

This UI CHP contains policies, procedures, and work practices necessary to protect personnel working in laboratories. The plan has been developed based on best laboratory practices identified in various sources but most notably in “Prudent Practices for Handling Hazardous Chemicals in Laboratories,” published by the National Research Council, 2011. It is not intended to be all-inclusive. It cannot address specific chemical handling procedures for all chemicals but describes general protective guidelines for working with hazardous chemicals or categories of chemicals in laboratories.

The UI CHP must be readily available to employees. The most current version of this document is available from the Environmental Health & Safety (EHS) web site. Laboratory supervisors

must assure this is accessible during all lab work hours.

Laboratories that use chemicals with particularly hazardous characteristics may need to develop specific guidelines and procedures, approved by the Principal Investigator/Laboratory Supervisor, to supplement this general plan. Provisions of the UI CHP include:

- Information contained in chemical Safety Data Sheets (SDS) and the results of monitoring will be used to select appropriate control measures designed to develop these guidelines or procedures.
- Medical examinations and consultations will be provided for employees if exposure levels are found to be in excess of legal limits, if employee shows symptoms of overexposure, or if a spill or other event results in the likelihood of overexposure.
- Personnel Protective equipment will be provided at no cost to the employee.
- Routine laboratory inspections will be performed to ensure that engineering controls (e.g., chemical fume hoods) is functioning properly

3.0 Definitions

3.1 Action Level
A concentration designated in 29 CFR 1910 for a specific substance, calculated as an 8-hour time weighted average (TWA) which initiates certain required activities to ensure exposure levels are controlled.

3.2 Chemical Hygiene Plan
A written program developed and implemented which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in the laboratory.

3.3 Designated Area
An area that may be used for work with select carcinogens, reproductive toxins or substances that have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood or glove box.

3.4 Employee
An individual employed in a laboratory workplace that may be exposed to hazardous chemicals in the course of their assignments.

3.5 Hazardous Chemical
A chemical for which there is statistically significant evidence, based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees.

Mixtures containing 1% of a hazardous chemical or 0.1% of a carcinogen are also defined as hazardous chemicals. The term “health hazard” includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems and agents which damage the lungs, skin, eyes or mucous membranes.

3.6 Laboratory
A facility where the laboratory use of hazardous chemicals occurs. It is a workplace where

relatively small quantities of hazardous chemicals are used on a non- production basis. See also laboratory scale and laboratory use definitions.

3.7 Laboratory Scale

Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person.

3.8 Laboratory Use of Hazardous Chemicals

The handling or use of such chemicals in which all of the following conditions are met:

1. Chemical manipulations are carried out on a laboratory scale;
2. Multiple chemical procedures or chemicals are used;
3. The procedures involved are not part of a production process nor in any way simulate a production process; and
4. Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

3.9 Particularly Hazardous Substance

A term that includes select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity.

Assistance with how to determine these substances is located in Appendix B, Guidance for identification of highly hazardous chemical substances.

3.10 Personnel Protective Equipment and Protective Equipment

Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits.

Protective equipment, more commonly known as engineering controls, eliminate or reduce exposure to a chemical or physical hazard through the use or substitution of engineered machinery or equipment. Examples include self-capping syringe needles, ventilation systems such as a fume hood, sound-dampening materials to reduce noise levels, safety interlocks, and radiation shielding.

3.11 Physical Hazard

A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.

3.12 Prior Approval

Circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer before implementation. The intent is to ensure individuals have knowledge and procedures in place to safely perform the task.

4.0 Responsibilities

The University is responsible for providing a safe workplace for employees and complying with OSHA regulations. The University has a designated University Chemical Hygiene Officer who is

qualified by education and experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. The University Chemical Hygiene Officer will review this generic plan at least annually and update it as necessary.

4.1 Departments

Each department is responsible for implementing this Chemical Hygiene Plan (or its equivalent) within their department. The department should assure that Laboratory Units under their administrative control implement the plan at the laboratory level and support this implementation. Generally, one or more individuals in the department provide administrative liaison for EHS by serving as the Departmental Health and Safety Coordinator.

4.2 Laboratory Units

Principal Investigators, faculty, and laboratory supervisors are responsible for chemical hygiene in their laboratories and must:

- Possess a knowledge of chemical hygiene plan requirements;
- Identify hazardous conditions or operations in the laboratory or facility containing hazardous chemicals, determine safe operating procedures and controls, and implement and enforce standard safety procedures;
- Add laboratory-specific information or amendments to the chemical hygiene plan if they are not already addressed in the general plan;
- Determine required levels of protective equipment and ensure adequacy of facilities and equipment;
- Determine if there are chemicals or activities that require prior supervisor approval before conducting experiments and communicate information about these to lab workers;
- Ensure all lab workers are trained and follow procedures of the plan;
- Perform periodic reviews of their chemical hygiene program and equipment;
- Promptly correct problem areas;
- Maintain a current chemical inventory/list using the EHS Assistant inventory system; and
- Ensure that the lab has methods to secure the hazardous materials used and stored in the lab.

4.3 Laboratory Personnel

All laboratory personnel conducting work with hazardous materials or equipment are responsible for planning and conducting all operations in accordance with the chemical hygiene procedures in their respective Chemical Hygiene Plan. Deviation from these procedures requires prior approval from the lab supervisor. Responsibilities include:

- Being aware of the hazards of the materials s/he is working with, and handling those chemicals in a safe manner;
- Developing good chemical hygiene habits (chemical safety practices and procedures);
- Informing laboratory coworkers of special hazards of materials, they may encounter in the lab but are not personally using and for which the user of that material is the most knowledgeable;
- Reporting unsafe conditions to the Principal Investigator, immediate laboratory supervisor, or the Environmental Health & Safety department;
- Completing all required safety training;
- Collecting, labeling and storing chemical hazardous waste properly; and
- Informing visitors entering their laboratory of the potential hazards and safety rules/precautions.
- Utilizing provided engineering controls
- Utilizing PPE HAT to determine mandated PPE as appropriate.

4.4 Environmental Health and Safety Department

The Environmental Health and Safety Department (EHS) has the following responsibilities:

- Maintaining the general UI Chemical Hygiene Plan
- Consulting and working with Principal Investigators, laboratory employees, administrators, and other employees to develop and implement responsible chemical hygiene policies and practices;
- Providing chemical safety review and training programs for research laboratories;
- Providing technical assistance for complying with the Chemical Hygiene Plan, and answering chemical safety questions for employees
- Assisting Principal Investigators in the selection of appropriate laboratory safety practices and engineering controls for new and existing projects and procedures;
- Conducting or overseeing exposure assessments when needed;
- Administering a Chemical Inventory database program; and
- Administering the chemical fume hood testing program.

4.5 Visitors in the Workplace

University employees should exercise supervision over visitors who enter their workplace to ensure personal safety and minimize disruption of work-related activities.

"Visitor" includes personal visitors, such as family members, as well as students, patients, customers, vendors, or professional colleagues.

"Workplace" refers to all University facilities that may be used as laboratories, studios, classrooms, hospitals and clinics, or offices, as well as any other spaces used in carrying out the University's threefold mission of teaching, research, and service.

"Personal safety hazards" that may exist in University workplaces include both physical and material hazards (chemical, radioactive, and/or biological) related to the functions of the various working environments at the University.

Visitors to UI laboratories will be under the supervision of the host laboratory. The host is responsible for laboratory security during the visitation, visitor training and notification of potential hazards, and oversight of visitor compliance with applicable safety practices and procedures contained in the Chemical Hygiene Plan.

4.6 Minors in the Workplace

Any visit involving minors, other than a brief, occasional visit by a family member, requires appropriate supervisory or departmental administrative approval.

Minors are not permitted in high-risk areas except where specifically allowed otherwise by University policy. Examples of high-risk areas generally include, but are not limited to:

1. Power plants, shops, mechanical rooms, confined spaces, food preparation areas;
2. Any areas, indoors or out, containing power tools or machinery with exposed moving parts or rotating equipment (e.g., mechanical rooms or construction areas);
3. Areas with heavy-duty or other motorized equipment;
4. Laboratories or specialized work areas that include chemical hazards, biological hazards, radioactive hazards, flammables, explosives, compressed gases, sharp objects, lasers, research animals, electrical hazards, hazardous wastes, or other environmental hazards; and
5. Other high-risk areas (rooftops, construction zones, etc.).

4.7 Students in the Workplace

Students working in research labs are expected to observe all applicable safety practices and procedures contained in the Chemical Hygiene Plan, attend designated training sessions, and report any unsafe or hazardous conditions to the lab supervisor, PI, or EHS.

4.8 Volunteers in the Workplace

University departments/units are responsible for oversight of all volunteers and their activities, regardless of whether those activities occur on-campus or at an off-campus location. This responsibility includes the assessment of any known risks associated with the volunteer activities, as outlined in these Volunteer Program Guidelines.

A volunteer provides time and effort to or on behalf of the university where there is no legal duty to the University to do so, and no express or implied promise of compensation or consideration (except expense reimbursement) for the time and effort provided. Further information regarding University of Iowa policies for volunteers can be found here: Volunteers

5.0 Planning Before Work with Chemicals and Other Hazardous Materials

In order to safely work with chemicals and other hazardous materials in a laboratory, it is necessary to pre-plan before conducting experiments. Understanding the hazards of the materials, equipment, and what things could go wrong if not addressed in advance is key to practicing safe science in the lab. National Research Council's Press' *Prudent Practices in the Laboratory* suggests that lab workers ask themselves a hypothetical question before starting lab work: "What would happen if…?" The question forces workers to consider possible contingencies and make preparations to take appropriate emergency actions. The authors provide the examples of loss of electrical power or water pressure. However, these are only examples and there are many possible scenarios that the lab worker should think about before beginning work with chemicals or other hazardous materials.

Preparations should not only include emergency planning but also planning control methods to reduce risk of exposure to the worker performing the experiment and to others in the laboratory.

5.1 Procuring Chemicals

Workers should review the hazards of the chemical prior to ordering in order to assure there are appropriate controls available to safely work with it before purchase. Many materials require special authorization to purchase, use, and store. Include these ordering procedures as part of your process planning to increase laboratory safety, decrease procurement delays, and reduce potential regulatory deficiencies. Prior to ordering:

- Obtain any necessary permits, licenses or registrations. Examples include DEA controlled substances which require DEA registration for purchase. Some DEA-listed chemicals that are not controlled substances will require a signature by a departmental authority on the chemical vendor's forms as part of the purchasing process
- Carefully plan and outline specific safety precautions in an SOP approved by the laboratory supervisor, especially if the material (chemical, biological, or radiological) has higher hazards.
- Look for substitutions of less hazardous chemicals.
- Check the Department of Homeland Security (DHS) Chemicals-of-Interest (COI) list for the appearance of the chemical. Contact EHS prior to ordering COIs because there are DHS requirements that can affect your lab or building for chemicals at or above DHS reportable quantities.
- Ensure adequate safety equipment is available.

- Determine the minimum quantity of chemical, biological and radiological materials required. Excess material often leads to future safety issues.

Prior to receipt of the substance, prepare the laboratory (i.e., establish a storage location, post appropriate signs, obtain necessary personal protective equipment, etc.).

5.2 Chemical Inventory

Procured chemicals must be included in the chemical inventory for the lab. EHS hosts the Environmental Health & Safety Assistant (EHSA) program for recording chemical inventories. Chemical inventories need to be maintained. Regulatory reporting requirements for chemicals above certain threshold quantities exist. Therefore, chemical inventories should be reviewed and a “Chemical Review Statement” signed at least annually, allowing accurate reporting by the University, as needed. Contact EHS Chemical Safety to arrange access to EHSA.

Resource: Chemical Inventory System

5.3 Standard (Safe) Operating Procedures

Standard (Safe) Operating Procedures (SOP) that include safety information are very important when pre-planning lab experiments. This general chemical hygiene plan, along with safety data sheets (SDS), may be sufficient as the primary source of information for pre-planning certain simple lab activities or experiments. However, others may require surveying additional safety information and preparation of a SOP that describes the hazards of the activity or material(s) as well as the safety measures needed to control the hazards. Developing approved SOPs with safety information is especially important when the material or process possesses inherently higher hazards or is regulated by OSHA or another regulatory entity. When determining what chemical or process needs an SOP, start with materials and processes that have the highest potential for fire, exposure, acute adverse health effects, or injury.

Labs may use a standard SOP template provided in Appendix A or create an equivalent document. Safety information can also be incorporated directly into each step of a written protocol for a particular procedure that the lab already possesses; in this case, a separate SOP is not necessary.

The SOP needs to be approved by the PI or the lab supervisor. Each lab worker who will conduct an experiment covered by an SOP needs to have been trained using the SOP as training material. The approved procedures should be kept with the lab safety information. The SOP needs to contain the following information at a minimum:

- Description of the purpose for the SOP and what it covers;
- List the hazardous chemicals;
- Describe the potential hazards from chemicals or equipment;
- List specific engineering controls or containment devices needed to control exposure to hazards;
- Describe safe work, handling and storage practices necessary to control the hazards ;
- List specific personal protective clothing or equipment needed to minimize exposure to material hazards;
- Describe spill management supplies to obtain prior to work and applicable spill and injury management procedures;
- Describe waste management/disposal procedures if they are different than described in the EHS Waste Management Guidelines and Procedures document;
- List specific approvals required before using the material or conducting the process, if applicable;
- If the work requires a higher level of control, designate a specific location where the work will be conducted; list how hazards of the work will be communicated to all lab staff;

- Describe specific procedures necessary to clean work areas or equipment after use or to keep hazardous material fully contained in the designated/controlled work area, if applicable; and
- Document training on the SOP.

Developing approved SOPs with safety information is especially important when the material or process possesses inherently higher hazards or is regulated by OSHA or another regulatory entity. Examples of materials with higher hazards are listed below. More detailed examples of materials or categories of materials with higher hazards, OSHA-regulated chemicals and additional guidance are described in Appendix B.

5.4 Toxic chemicals, including carcinogens

Include chemicals with the following hazards:

- Carcinogenicity
- Acute Toxicity (Oral, Dermal, Inhalation)
- Skin and Eye Corrosion or Damage
- Respiratory or Skin Sensitization
- Specific Target Organ Toxicity
- Reproductive Hazards (mutagens, teratogens, developmental reproductive toxicity)
- Biological toxins with acute health hazards

To find this information quickly, most chemicals with one or more of these health hazard categories will have the OSHA signal word “Danger” on the chemical label or safety data sheet.

5.5 Other potential or known hazardous chemical substances (physical and/or health hazards)

- Chemicals with OSHA Signal Word “Danger” including
  - Air-reactive, water-reactive, self-reactive other highly reactive chemicals;
  - Explosive chemicals;
  - Organic Peroxides;
  - Flammable Gases, Liquids, Aerosols, Solids;
  - Pyrophoric chemicals; and
  - Oxidizing Gases, Liquids, Solids.
- Engineered Nanomaterials/Nanoparticles
- OSHA-regulated chemicals

5.6 Example processes with potential physical or health hazards

- Processes under very low or high pressure
- Processes under extremes of temperature
- Processes using large volumes of chemicals

5.7 Spill Preparedness Planning

Spill preparedness is an essential step in pre-planning work with chemicals or other hazardous materials. This step is discussed in more detail in Section 13.0 Spill and Emergency Plans.

6.0 Training and Information

Everyone who works with, or is exposed, to potentially hazardous chemicals in a laboratory must receive training on the Occupational Exposure to Hazardous Chemicals in Laboratories Standard (also known as the ‘Lab Standard’). The intent of training is to assure that all individuals are informed about hazards and protection when working in the lab.

6.1 Chemical Related Training Requirements

Initial training is required upon assignment to the lab and includes basic orientation for lab chemical safety plus laboratory-unique (site-specific) information and training. Basic lab chemical safety orientation training in online format is available through the EHS ICON course "Lab Chemical Safety" W008CM. The checklist for the required lab-specific portion of the chemical safety training is included with the online course. For more information, contact EHS at 335-9379. Upon completion of the online training course, the employee prints or is provided the EHS Lab Chemical Safety site-specific topics list. This includes training items the lab unit must provide. Other training sources may also be used as long as the training requirements of the standard are met. Section 6.2 provides some additional information for completing this training.

Additional training is required when a new hazard is introduced or when there is a need. Laboratory supervisors will provide or arrange for the additional training. Examples of a new hazard include physical or health hazards associated with chemicals, or operations for which prior training was not provided. Examples of a need for additional training may be to improve work practices, address measures to prevent a spill or accident from recurring, or to provide training for work with highly hazardous substances. Labs are encouraged to routinely include chemical health and safety topics in lab meetings or other communications with employees. (A specific interval for refresher training is not specified in the Lab Standard.)

Fire extinguisher training is voluntary for employees. For training arrangements, contact the UI Fire Safety Coordinator at 335-5389.

6.2 Content of Required Training in the 'Lab Standard'

- Provisions of the Laboratory Standard.
- The location and availability of the Chemical Hygiene Plan.
- Hazardous chemicals in the work area.
- Physical and health hazards of the hazardous chemicals in the work area.
- Protective measures for handling hazardous chemicals used in the work area.
- Proper chemical handling procedures for all classes of materials used.
- Labels and hazard warnings.
- How to locate, interpret, and use Safety Data Sheets.
- How to detect the presence or release of hazardous chemicals in the work area.
- Legal and recommended exposure limits.
- Correct use of engineering controls, personal protective equipment, and any other method used to reduce or eliminate exposure.
- Signs and symptoms of overexposure.
- Medical services available.
- Procedures for emergencies, spills, and first aid.

6.3 How to Complete the Lab Chemical Safety Training

The lab chemical safety training consists of two parts. Part 1 is the EHS ICON course "Lab Chemical Safety" W008CM accessed via the HR Employee Self Service web site or students' ICON. At the end of this online training module, the employee prints the Lab Chemical Safety Site-Specific training checklist, Part 2. The employee's supervisor or trainer, and the employee, must go through the checklist together, each signing the checklist to document completion. Keep this completed document with the lab safety records.

6.4 Tips for completing the EHS Lab Chemical Safety Site-Specific training checklist

The following topics are required to be provided in-person to the employee before beginning lab

work with chemicals. This is part 2 of the Lab Chemical Safety training. Explanatory information is provided in “Tips” next to some of the topics:

- The employee has read the Chemical Hygiene Plan.
- Informed of location and how to access the Chemical Hygiene Plan.
- Shown how to quickly access SDSs for materials used in the laboratory.
- Notified if supervisory approval is needed before using certain hazardous chemicals.
- Instructed to review lab SOPs or specific lab safe work practices.
- Informed that if a new hazard is introduced into the lab, additional training may be required.
- Informed of signs and symptoms associated with exposure to hazardous chemicals used in the laboratory.
    - Tip: This information can be most easily found in the SDS Hazard Identification Section 2 for the chemical used in the lab. If a chemical used in the lab has an OSHA Permissible Exposure Limit (PEL) or other established exposure limit, it is important to discuss this information with the employee. It can be located in the SDS Exposure Controls, Personal Protective Equipment, Section 8.3, of this CHP. The PELs can also be located for many materials in the NIOSH Pocket Guide to Chemical Hazards.
- Trained on method used to detect the presence or release of hazardous chemicals used in the laboratory.
    - Tip: Methods used to detect the presence or release of a chemical include visible spills, chemical odors, visual clues such as colors of gas or liquid and monitoring devices used by EHS or other specialists that detect the presence of the chemical or quantify its concentration.
- Instructed on the correct use of chemical fume hoods, biosafety cabinets, chemical storage cabinets, refrigerators, and other equipment and engineering controls specific to the laboratory.
- Instructed on the types of personal protective equipment (PPE) that are required for specific tasks, including how to obtain, use, and maintain such equipment.
- Shown the location of and how to use eyewash stations and emergency showers.
- Shown how to handle and dispose of chemical waste according to UI waste guidelines.
- Instructed on lab emergency procedures including spill response; informed of spill kit location, emergency contact list and how to access UI Emergency Procedures Guide.

7.0 Exposure Assessment and Medical Services

Many hazardous chemicals have defined exposure limits called Permissible Exposure Limits or PELs. These exposure limits can be based on an 8-hour Time Weighted Average (TWA) exposure, a 15-minute Short Term Exposure Limit (STEL), or an upper limit exposure (Ceiling). Where specific limits are given, the lab standard requires employee exposures not exceed these limits. If an overexposure is suspected, an exposure assessment is necessary. If the assessment indicates that an employee could reasonably have been exposed to a hazardous chemical in a manner that might have caused harm, the person is entitled to medical services. Services include a medical consultation and, if determined necessary, a medical examination.

7.1 Exposure Assessments

The purpose of an assessment is to determine if there was an exposure that might have caused harm to lab employees and to identify the chemical(s) involved. Exposure assessments may include interviews with the affected employee(s) and laboratory staff, air monitoring, evaluation of laboratory controls and protective equipment, and medical consultation and examination.

When to suspect overexposure:

- If an employee manifests symptom such as headache, rash, nausea, coughing, tearing, irritation or redness of the eyes, irritation of the nose or throat, dizziness, loss of motor dexterity or judgment, etc. and:
    - Some or all of the symptoms disappear when the employee is removed from the exposure area.
    - The symptoms reappear soon after the employee returns to work with the same hazardous chemicals.
- Two or more persons in the same laboratory work area have similar complaints.
- A hazardous chemical leaked, spilled or was otherwise rapidly released in an uncontrolled manner.
- A laboratory employee had direct skin or eye contact with a hazardous chemical.

Note: Odor is not a means of determining exposure levels. If there is reason to suspect that a chemical exposure limit has been exceeded, notify the lab supervisor regardless of whether or not a suspicious odor is involved.

7.2 Air Monitoring

Contact Environmental Health & Safety at 335-8501 to request air monitoring to evaluate chemical exposures. Upon completion of monitoring, employees must be notified of results in writing, either individually or by posting, within 15 days of the receipt of results. Records of monitoring results and employee notification must be kept, transferred, and made available in accordance with 29 CFR 1910.1020. If exposures are found to be over legal limits, further action will be required.

7.3 Medical Services

Medical services may consist of a medical consultation, examination, or emergency services. Pre-exposure (baseline) assessment is available upon departmental request at the University Employee Health Clinic. There is no cost to the employee for these services and employees may be medically monitored on an annual basis.

When assessment results indicate that an employee may have been exposed to a hazardous chemical, the employee should obtain a medical consultation from the UI Occupational Health Clinic in North Liberty (319-356-3335 or 800-327-5605). Consultations and examinations must be under the direct supervision of a licensed physician. The employing lab or department must inform the physician of the identity of the chemical, the conditions of the exposure, and the employee's symptoms. A written opinion must be obtained from the physician. It must be maintained as a part of the employee's record and made readily available to the employee and, upon request, to their designated representative. The written opinion must not reveal findings unrelated to occupational exposure.

The written opinion must include:

1. Follow-up recommendations.
2. Exam and test results.
3. Any medical condition found as a result of the exam that may place the employee at an increased risk as a result of hazardous chemical exposure.
4. A statement that the employee has been informed, by a physician, of the results of the consultation.

Additional information about seeking treatment for work related injuries is presented in Section 13.1 Basic Steps for Emergencies, Major Spill, and Other Problems.

7.4 Exposure and Medical Records

Records of monitoring measurements or any medical baseline, consultation or examination, including tests or written opinions, must be maintained for each employee for a period of thirty years after retirement or resignation. Records must be kept, transferred and made available in accordance with 29 CFR.1910.1020.

8.0 General Safety Practices in Labs

8.1 Standard Laboratory Attire

Various hazards are present in research laboratories at the University of Iowa, and safety practices and policies must be implemented to protect faculty, staff, students, and authorized visitors from exposure to these hazards. To protect against the latter, standard laboratory attire and personal protective equipment (PPE) must be worn by all persons in research laboratories.

Standard laboratory attire includes closed-toe, solid-top shoes and clothing that covers the legs, such as long pants or equivalent. Clothing through which skin can be seen does not provide proper protection, and therefore does not meet the definition of standard laboratory attire. Open-toe shoes, sandals, flip-flops, shorts, and similar attire that may result in skin exposure to hazards must not be worn in research laboratories.

Required PPE will vary depending on the hazards present. The PPE Hazard Assessment Tool (PPE HAT) specifies required PPE, based on specific hazards. All laboratory workers are required to review the PPE HAT once per year. Faculty and other supervisors are responsible for ensuring that staff, students, and visitors wear standard laboratory attire and required PPE while in research laboratories.

8.2 Exposure Controls

Potential exposure should be maintained at the lowest practical level and must not exceed legal exposure levels. OSHA requires engineering controls as the primary means of worker protection. A common engineering control in the laboratory is the chemical fume hood. Administrative controls such as safe work practices and personal protective equipment are other exposure controls common in labs.

8.3 Routine Safety Practices in Labs

1. Ensure emergency contact information is posted at the lab entrance.
2. Be aware of the location and proper operation of laboratory safety equipment.
3. Dress appropriately in the lab. Standard laboratory attire acts as a barrier to prevent skin exposure to hazardous material.
4. Wear personal protective equipment (see below) in lab areas only, not in public areas.
5. Do not eat, drink, adjust contacts, take medication, or apply cosmetics in chemical use areas. The University is a tobacco free campus. The Tobacco Free Campus policy defines tobacco products as including but not limited to cigarettes, cigars, pipes, water pipes (hookah), bidis, kreteks, smokeless tobacco, chewing tobacco, snus, snuff, electronic cigarettes and any non-FDA approved nicotine delivery device.
6. Ice, glassware, utensils, ovens, refrigerators, and other equipment used for lab operations should not be used for storage, handling or consumption of food and beverages.
7. Wash hands before leaving the laboratory, using the restrooms, inserting contact lenses and before eating or smoking.
8. Keep access route to exits, emergency equipment and utility controls open and unblocked.
9. Keep lab areas clean and uncluttered to help prevent unnecessary contact or personal injury from breakage and spillage of chemicals.
10. Keep lab doors closed for fire safety and to maintain proper room air pressures.

11. Visitors to the lab are to be escorted by an employee and are the responsibility of that employee.

8.4 Personal Protective Equipment

Proper use of personal protective equipment (PPE) will minimize exposure to hazards associated with many laboratory operations. PPE should satisfy performance requirements such as strength, chemical resistance and thermal resistance without inhibiting flexibility and manual dexterity.

PPE shall be selected, used, and maintained in accordance with applicable IOSH Standards and as described in EHS's "Personal Protective Equipment Procedures" Guide. This PPE compliance guide contains resources for completing the required Certification of Hazard Assessment and Training for employees. A Research Laboratory Hazard Assessment Tool for Personal Protective Equipment Use is included in this guide. This tool provides a step-by-step approach to completing a PPE hazard assessment and completing required training at the laboratory level.

8.5 Skin Protection

In addition to personal protective equipment, lab workers should plan to keep skin covered when working with hazardous materials. Skin coverage includes use of lab coats or clothing with long sleeves, long pants or skirts covering the legs, and closed-toe and closed-heel shoes to cover the feet.

Reusable protective clothing such as lab coats should be laundered on a regular basis to maintain hygiene. Laundering should be completed whenever the lab coat is visibly soiled. The frequency and manner in which lab coats are used, determine how often they should be laundered. Laundering of reusable protective clothing may be performed by The University of Iowa Laundry Service. Additionally departments may participate in a lab coat rental program with vendors such as Cintas. Laundering lab coats **may not** be done by lab staff members at private residences or public laundry facilities.

Any lab coat/protective clothing known or reasonably suspected to be contaminated with biohazardous material(s) must be decontaminated (i.e. autoclaved or treated with an effective disinfectant) before it is sent to laundry services. If protective clothing will be autoclaved, it must be capable of withstanding high temperatures. **Do not autoclave lab coats that are additionally contaminated with chemical or radioactive materials**; dispose of the contaminated clothing as hazardous waste. Additionally, lab coats that become grossly contaminated with biohazardous material(s) should be disposed of as biohazardous waste.

8.6 Eye and Face Protection

Eye and face protection shall be required where there is a reasonable probability that injury could be prevented by such protection. PPE shall be selected in accordance with IOSH 1910.133 "Eye and Face Protection" and shall meet requirements specified in American National Standards Institute, Z87.1, "Practice for Occupational and Educational Eye and Face Protection". Eye and face protection can be purchased from laboratory and safety catalogs and University Stores.
Prescription safety glasses are purchased through UI Optical with an interdepartmental requisition. Eye examinations and associated costs are the responsibility of the employee.

Note: Protective equipment related to lasers, X-rays, gamma rays, and microwaves, etc. are not covered by the Z87.1 standard. Departments or the user should contact the manufacturer and EHS's Radiation Safety Section (335-8501) for proper selection.

General eyewear requirements:

1. Safety glasses with permanently attached side shields are required where there is a potential of being struck by projectile objects.
2. Chemical splash goggles are required in chemical handling operations where protection is needed against mists, aerosols and sprays.
3. Face shields are required where facial skin protection is needed for chemical or physical agents. Where both eye and face protection is needed, the face shield is used in addition to the safety glasses or goggles.

8.7 Hand Protection

Skin contact is a potential source of exposure to toxic materials. Check the Safety Data Sheet for substances that can create exposure routes by skin absorption. Appropriate gloves may be selected based on the requirements listed in the PPE-Glove Selection Information in the Resource section. Gloves can be purchased from laboratory and safety supply catalogs.

General glove requirements:

1. Gloves should be worn whenever there is potential for contact with corrosive or toxic materials, or materials of unknown toxicity.
2. Gloves should be selected based on test data from the glove manufacturer.
3. Chemicals eventually permeate gloves; however, they can be used safely for limited time periods if specific use and glove characteristics, i.e., thickness, permeation rate and time, are known.
4. Gloves should be replaced periodically depending on frequency of use and permeability to the substance(s) handled.

Resource

- Personal Protective Equipment (PPE), Labs

8.8 Inhalation Protection

When a chemical is used in a way that may present an inhalation hazard, measures must be taken to control exposure. This is primarily accomplished in the laboratory through proper use of a chemical fume hood. When procedures cannot be performed in a fume hood or ventilation is not adequate to provide protection against inhalation hazards, respiratory protective equipment may be necessary. Respirators should be the last option chosen for controlling inhalation hazards.

8.9 Respirators

Departments or laboratories that issue, recommend, or provide respirators for employee protection are required to implement a respiratory protection program in accordance with IOSH Standard 1910.134. The Environmental Health & Safety department or other qualified industrial hygiene services should be contacted for assistance in determining the need for implementation of a respirator program. Respirator program components include hazard evaluations, annual medical evaluations, fit-tests and training for individuals using respirators, and written programs including record keeping and annual reviews.

Even if employees desire to wear a respirator or dust mask for their comfort (such as to minimize odor), a respirator use evaluation is still required. Contact EHS to request a respirator use evaluation.

Resource

- EHS Respirator/Dust Masks - Required and Voluntary
- EHS Form -Laboratory Request for Respirator Use (Airborne Hazard)

Evaluation.pdf

9.0 Facility and Equipment

Chemical safety is achieved with continual awareness of chemical hazards and keeping chemicals under control by using precautions including engineering safeguards. All engineering safeguards, equipment and controls must be properly maintained, inspected on a regular basis, and never overloaded beyond their design limits. Laboratory supervisors should be alert to detect malfunction of these controls.

9.1 Ventilation

General lab ventilation shall provide airflow into the laboratory from non-laboratory areas and out to the exterior of the building. Laboratory doors should remain closed except for egress and entrance.

Local exhaust ventilation equipment is a commonly used engineering control in the lab. Usually this is a chemical fume hood but also includes ventilated bench top cabinets, spot exhaust devices, and filtered cabinets for using hazardous solids.

9.2 Chemical Fume Hoods

A fume hood is a local exhaust device whose primary purpose is to protect laboratory workers from hazards of airborne chemical contaminants. The secondary purpose is to protect people and property against small fires and explosions. The fume hood must be used appropriately to allow it to function properly and remove contaminants from the breathing area of the user. Appropriate use includes:

- Using chemicals in the hood that may generate contaminants near or above exposure limits.
- Not having sources of ignition inside the hood when flammable liquids or gases are present.
- Visually inspecting the device (and flow monitor) daily or before each use.
- Keeping all items 6 inches back from the front edge of the hood to avoid blocking the airflow path.
- Keeping slot openings at the back of the hood free from blockage with large objects or numerous containers.
- Elevating large objects 2 inches off the floor of the hood so air can pass under the object and out the back slots in the hood.
- Closing the sash when the hood is not in use
- During hood use, lowering the sash to the sash arrow sticker, below the chin and more if possible. Lower and use the sash as a safety shield when working with reactive materials or materials that may splatter.
- Not storing chemicals in the hood.

Resource

- ICON Chemical Fume Hoods Course - W485CM
- EHS Chemical Fume Hoods Information

9.3 Maintenance and Inspection of Fume Hoods

Operators should check the hood area daily for visible blockage of airflow, e.g., large items or numerous containers blocking the lower slot openings in the front and rear of the hood. Airflow monitor devices should be observed before each use to verify that the hood is functioning. If the hood does not have a monitor, secure a tissue paper strip at the opening to observe inward

directional airflow; do not allow the paper to be drawn into the fume hood exhaust. Users should keep interior hood surfaces clean.

EHS checks fume hood airflow performance annually to confirm that:

- airflow into the hood is not compromised by cross drafts;
- airflow into the hood has a uniform inward pattern; and
- average velocity of air moving into the hood is within an acceptable range.

Guidelines and results are noted on the hood sticker placed on the front of the hood. If results are not acceptable a notice will be placed on the hood sash and a repair request sent to the FM@YourService.

The sash sticker indicates the maximum sash opening for hood use (the opening used for EHS testing). In the event a hood lacks a hood or sash sticker or the test date is older than one year, contact EHS at 335-8501.

Facilities Management periodically inspects and maintains the hood system components such as lights, fans, and motors. Equipment failures or problems should be reported to the FM@YourService.

9.4 Ventilation Failure Procedures

In the event of a ventilation failure or recurring low flow alarm on the monitor, occupants should contact the FM@YourService (24 hours, 7 days).
Occupants should place lids on open containers, lower the fume hood sash, and shut down equipment and secure reactions that may be generating hazardous emissions.

9.5 Refrigerators

Individuals and/or departments purchasing refrigerators for laboratory use are expected to follow university procedures that are in accordance with requirements of NFPA 45 (National Fire Protection Association), "Standard on Fire Protection for Laboratories Using Chemicals." If flammable solvents need to be refrigerated, a flammable-safe (lab-safe) refrigerator must be purchased. In nearly all situations, this type of unit is necessary for lab use. These units will be marked to indicate they meet the requirements for flammable/combustible material storage.

Flammable-safe refrigerators are designed to eliminate ignition of flammable vapors inside the storage compartment (by locating the compressor and other circuits that can arc/create a spark on the exterior of the unit). Never use a domestic refrigerator to store flammables because they contain ignition sources that can set off explosive concentrations of flammable vapor. Vapors from a leaky stopper or a cracked container can build up to explosive concentrations and be ignited by the light switch or thermostat. Domestic refrigerators located in labs must be labeled "Do Not Store Flammables in This Refrigerator."

Cold rooms are not designed for storage of flammable or volatile materials. They may have exposed ignition sources and are not ventilated to actively remove chemical contaminants. Therefore, undesirable vapors may become concentrated if these types of materials are stored in cold rooms.

9.6 Body Showers and Eye Wash Stations

IOSH requires this equipment be provided in work areas where any person's eyes or body may be exposed to corrosive/caustic materials. The American National Standard Institute (ANSI) Standard Z358.1-2014 "Emergency Eyewash & Shower Equipment" provides the specific requirements. Facilities Management addresses construction and renovation requirements. EHS may also be contacted for additional information and consultation.

Laboratory occupants should ensure that access routes to body showers and eyewash stations are free of obstructions. Laboratory occupants should activate water flow in eyewash stations at least monthly. If problems are noted contact the FM@YourService. Annual testing of body showers are performed by Facilities Management.

Eyewash Testing Instructions.pdf

9.7 Electrical Extension Cords

The National Electrical Code and the State Fire Marshal's Office prohibit use of extension cords as a substitute for permanent wiring. Multiple plug outlet adapters are also prohibited. Extension cords should be used for a limited time period only. After use, unplug extension cords from the electrical outlet. Extension cords should be grounded, and properly sized to handle the load of equipment they are supporting. If additional electrical outlets are needed in a work area, one of two possible solutions could be used to rectify the problem:

1. The department can pay FM to install additional outlets; or
2. The department can complete a "Building Repairs Request" form and forward it to Facilities Planning. This option is contingent upon availability of funding.

The Department of Public Safety states that," *The State Fire Code prohibits the use of extension cords as "permanent wiring". Portable power strips that are UL listed (fused & grounded) may be used in applications approved by the device's manufacturer. Surge protecting power strips are to be used only on sensitive electronic equipment such as personal computers and their accessories. Surge protectors and power strips must be plugged directly into a wall outlet."* These units should be purchased at Materials Management (General Stores).

9.8 Flammable Liquid Storage Cabinets

When purchasing flammable liquid storage cabinets the following specifications must be met:

1. Cabinets must comply with NFPA and IOSH Standards.
2. Cabinet doors must have red lettering stating "Flammable Keep Fire Away".
3. Two doors are required on all cabinets except 10 and 20-gallon sizes where one door is required. Where two doors are required, they may be either bifolding or hinged on each side.
4. Cabinets must be of approved metal construction and meet minimum construction requirements:
   a. Bottom, top, sides and door(s) of cabinet shall be at least No.18 gauge sheet metal and double walled 1 1/2-inch air space.
   b. Joints must be riveted, welded or made liquid tight by some equally effective means.
5. Door must be provided with three-point latch arrangement and the doorsill shall be raised at least two inches above bottom of the cabinet to retain spilled liquid within the cabinet.

9.9 Guarding

All mechanical equipment should be adequately furnished with guards that prevent access to electrical connections or moving parts; e.g., belts and pulleys of a vacuum pump. Each laboratory worker should inspect equipment before using it to ensure that the guards are in place and function properly. Careful design of guards is vital. An ineffective guard can be worse than none at all because it can give a false sense of security. Emergency shutoff devices may be needed in addition to electrical and mechanical guarding.

9.10 Shielding

Safety shielding should be used for any operation having the potential for explosion and must

be placed so that all personnel in the area are protected from the hazard, such as whenever:

1. A reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards).
2. A familiar reaction is carried out on a larger-than-usual scale (5-10 times more material).
3. An operation is carried out under non-ambient conditions.

9.11 Gas Hose Connectors

General gas hose safety practices include:

1. Routinely inspecting burner hose/tubing and ensuring it is free of defects (cracks, holes, pinched points, etc.).
2. Assuring the hose/tubing is securely connected to the gas valve and the burner before use.
3. Keeping access to gas valves/shut-offs free of obstructions.

In general, covered flexible metal hoses manufactured for injection burner use are preferable to rubber tubing. Injection (Bunsen) burners should also be routinely inspected and free of defects.

9.12 Power Outage

In the event of an electrical (power) outage, all lab work and work with hazardous materials must come to a halt. Laboratory personnel should secure experiments or activities that may present a danger with the electrical power off or when it is restored unexpectedly. Volatile and hazardous materials should be returned to areas where they are normally stored.

There are several reasons for this:

1. Areas without landlines will no longer be able to obtain SDSs and therefore will not be OSHA compliant if hazardous materials are being used.
2. Areas without landlines will no longer have phone service available for emergency purposes.
    a. Personal cell phones are not sufficient for this purpose however department/University owned cell phones are.
3. Ventilation in the building will either be off or set back to minimum so that airflow is not sufficient for work with hazardous material.
4. Chemical fume hoods will not be operating.
5. Lighting will be out.
6. Refrigerators and freezers need to be kept shut to maintain temperature for as long as possible.
7. Electrical equipment (computers) will be unusable.

If the building is operating on partial power or emergency generator power work with hazardous materials must cease, as the ventilation and safety equipment cannot be guaranteed to be working at optimum capacity. Emergency power is a backup to keep essential equipment running, i.e -80° freezers, not a means to sustain operations throughout the building.

10.0 Chemical Handling Procedures

General procedures should be followed for handling all chemicals in addition to specific procedures for chemical hazard groups (toxins, flammables, etc.).

10.1 All Chemicals: General

General handling procedures require the individual to:

1. Obtain and review Safety Data Sheets (SDS) before ordering and using chemicals. Ensure that the material can be safely procured, stored, used, and disposed.
2. Know the hazards associated with materials you are using.
3. Be prepared for emergencies and know what action to take. Assure that necessary supplies and equipment are available for handling small spills.

4. Know the location of safety equipment such as emergency shower, eyewash, fire extinguisher, fire alarm, and emergency telephone numbers.
5. Do not work alone in the laboratory if you are working with hazardous materials.
6. Purchase minimum amounts of hazardous materials necessary to accomplish work and dispense only amounts necessary for immediate use.
7. Use hazardous materials only as directed and for their intended purpose.
8. Never smell or taste a hazardous material.
9. Avoid direct contact with any hazardous material, use protective equipment to avoid exposure, and review SDS for specific recommendations for each material used.
10. Smoking, drinking, eating, the use of contact lenses and the application of cosmetics is forbidden in areas where hazardous chemicals are in use.
11. Ensure emergency contact information is posted at the lab entrance.
12. Ensure all containers are labeled.
13. Label all secondary containers with chemical name and hazard information.
14. Assure ventilation is adequate for the materials you are using. Where possible, handle all materials in a chemical fume hood.
15. Electrically ground and bond conductive containers using approved methods before transferring or dispensing a flammable liquid from a large container.
16. Store chemicals in compatible categories.
17. Only permit reactions to run unattended when the reaction is well understood, provisions are in place to contain toxic substances in the event of a utility failure, and emergency contact information is posted at the lab entrance.
18. Dispose of waste properly according to EHS's "Waste Management Guidelines and Procedures Manual." See resource in Section 12.0.
19. When transporting chemicals outside the lab, use precautions to avoid dropping or spilling chemicals. Use bottle carriers for glass containers and use carts with edges to prevent containers from falling off the cart and breaking.

10.2 Toxins

10.2.1 Hazards

The effects of exposures to toxic chemicals are either acute or chronic. Acute effects are characterized by prompt or slightly delayed health effects, such as burns, allergic reactions, and immediate damage to organs such as eyes. Chronic effects occur over a long periods of time and are characterized by cumulative damage to organs which include carcinogenic effects.

Minimizing or eliminating exposure provides protection from toxic hazards. To minimize exposure it is necessary to determine the route by which exposure may occur, i.e., inhalation, skin contact, ingestion, and injection or puncture.

10.2.2 Precautions

Precautions to take when working with toxins:

1. Know the hazards of the material you are using. Review the SDS and do additional research if necessary. Use less toxic materials when possible.
2. Use and store toxic chemicals in established areas and in the smallest possible amounts.
3. Store and transport toxic chemicals in secondary containment.
4. Use these materials in containment devices such as fume hoods and glove boxes.
5. Use appropriate protective equipment.
6. Be prepared for spills and know when to take emergency action.
7. Wash hands and arms immediately after working with toxic materials.
8. Never eat, drink, smoke, apply cosmetics, take medication, adjust contacts, or store food

in areas where toxic substances are being used.
9. Dispose of wastes in accordance with procedures in the EHS Manual Guidelines and Management of Hazardous Waste. As appropriate, perform chemical decontamination of washes and materials from experiments.
10. Consider whether additional precautions are needed for substances with high toxicity. See also Section 10.3.

10.3 Carcinogenic, Reproductive and Highly Toxic Chemicals

OSHA defines certain carcinogens, reproductive toxins, and substances with high acute toxicity as Particularly Hazardous Substances (PHS) and requires that employers consider the need for precautions in addition to those for handling toxic substances.

Check the SDS to see if materials meet definitions below. Many chemicals will have the signal word “Danger” listed on the SDS and the “Health Hazard” pictogram as well as the “Danger” signal word on the container label. More information about chemical hazard categories is presented in Appendix B.

10.3.1 Definitions

Select Carcinogen – any substance that meets one of the following criteria:

1. It is regulated by OSHA as a carcinogen;
2. It is listed under the category “Known To Be Human Carcinogens” in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest editions);
3. It is listed under Group 1 (Carcinogenic To Humans) by the International Agency for Research on Cancer Monographs (IARC) (latest editions);
4. It is listed in either Group 2A (Probably Carcinogenic To Humans) or 2B (Possibly Carcinogenic To Humans) by IARC or under the category, “Reasonably Anticipated To Be Human Carcinogens” by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

    a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime, to dosages of less than 10 mg/m^3.
    b. After repeated skin application of less than 300 (mg/kg of body weight) per week.
    c. After oral dosages of less than 50 mg/kg of body weight per day.

Reproductive Toxins - substances that can affect reproductive capabilities such as mutagens, which cause chromosome damage, and teratogens, which cause harm to the fetus, and reproductive hazards, which may affect female or male reproductive health.

10.3.2 Highly Toxic Chemicals -

A substance (poison) that falls within any of the following categories:

1. Median lethal dose (LD50) administered orally is <50 mg.
2. LD50 administered by continuous contact is <200 mg.
3. Median lethal concentration administered by inhalation is <200 ppm
4. Any chemical whose properties are unknown.

10.3.3 Precautions

Precautions to take when working with carcinogens, reproductive, or highly toxic chemicals:

1. As a minimum, follow Precautions, section 10.2, of this guide.
2. Post the area for use. Inform lab occupants of the designated area with Lab Posting Sign

pdf. Consider factors such as potency, concentration, quantity, physical properties and conditions surrounding the use of the substances.

3. Precautions to take when working with carcinogens, reproductive, or highly toxic chemicals:
    a. areas to be designated for use and posted, e.g., fume hood, glove box, or entire room;
    b. containment devices (e.g., fume hood or glove box);
    c. procedures for decontamination and waste disposal; and
    d. additional training or personal protective equipment for material users.
4. List designated areas where additional precautions are needed.

10.3.4 Resource: Antineoplastic Agents Lab Safety

10.4 Flammables and Combustibles

Flammable/combustible materials can generate sufficient vapor to cause a fire in the presence of an ignition source. They are categorized based on flash point--the minimum temperature at which a liquid gives off vapor in sufficient concentrations to allow the substance to ignite.

As of 2012, OSHA's Hazard Communication Standard revised the criteria to determine the flammability hazard and does not use the term "combustible", however, the term flammable and combustible are both used in other OSHA regulations. These categories are what will be listed on chemical labels and safety data sheets to convey hazard information. According to these criteria below, the lower the liquid's flash point, the higher the degree of flammability. This was the case before 2012 as well but the new criteria creates the 4 categories of flammability shown below. You can see that Category 1 has the highest degree of flammability (and therefore hazard) and Category 4 the least.

Category	Criteria
1	Flash point <23°C (73.4°F) & initial boiling point ≤ 35°C (95°F)
2	Flash point <23°C (73.4°F) & initial boiling point > 35°C (95°F)
3	Flash point ≥ 23°C (73.4°F) & ≤ 60°C (140°F)
4	Flash point > 60°C (140°F) & initial boiling point ≤ 93°C (199.4°F)

OSHA Category 1 flammable liquids, with the highest degree of flammability, are ignitable at concentrations of <13% by volume at ambient temperatures OR have wide flammable concentration ranges of at least 12 percentage points. For comparison, these chemicals will also be rated with a red 3 or 4 on the NFPA hazard diamond.

10.4 1 Hazards

The liquid does not itself burn; it is vapors from the liquid that burn. The rate of vapor generation depends upon the liquid's vapor pressure, which increases with temperature. The degree of fire hazard depends upon the ability of vapors to mix with air to form combustible or explosive mixtures and the ease of ignition of these mixtures.

Category 1 Flammables are more hazardous because they are more volatile than the other Categories. Safe handling procedures are based upon controlling one or more of the elements necessary to initiate a fire: fuel, ignition source, and oxygen.

Flammable solids may cause fire by friction, absorbing moisture, spontaneous chemical change, retention of heat, or being easily ignited and burning in such a way to cause a serious hazard.

10.4.2 Precautions

Precautions to take when working with flammables and combustibles:

1. Eliminate ignition sources such as open flames, smoking materials, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity.
2. Minimize the quantity kept in the work the area.
3. Store in approved flammable liquid containers (safety cans) and storage cabinets or in a special storage room designed for that purpose. Store away from oxidizers.
4. Flammable liquids stored in glass containers shall not exceed one quart unless chemical purity must be protected. In that case, one gallon is permissible.
5. Refrigerators and freezers used for storage of flammables shall be explosion-safe and labeled as such.
6. Assure proper bonding and grounding when transferring or a dispensing flammable liquid from a large container.
7. Contact Department of Public Safety-Fire Safety to assure appropriate sprinklers or fire extinguishers are in the area.

10.5 Corrosives

A corrosive chemical is one that causes visible destruction or irreversible alterations of living tissue by chemical action at the site of contact. They can be in solid, liquid or gaseous form and act on body tissues by direct contact, inhalation or ingestion. Corrosives can be categorized as a strong acid, strong base, dehydrating agent, oxidizing agent, or water-reactive. Corrosive liquids are responsible for most corrosive-based injuries. Corrosive gases are the most serious because they can be readily absorbed into the body by dissolution with skin moisture and by inhalation.

10.5.1 Precautions

Precautions to take when working with corrosives:

1. Eye protection and gloves should always be worn when handling corrosive materials. A face shield, rubber apron, and rubber boots may also be appropriate, depending upon the work performed (check the Safety Data Sheet for personal protective equipment requirements).
2. Always add acid to water. Dehydrating agents such as sulfuric acid, sodium hydroxide, phosphorus pentoxide, and calcium oxide should be mixed with water by adding the agent to water to avoid violent reaction and splattering.
3. An eyewash and safety shower must be immediately accessible in areas where corrosives are used and/or stored as specified in OSHA 1910.151(c). In the event of skin or eye contact, immediately flush the area of contact with cool water for 15 minutes and remove all affected clothing. Get medical help immediately.
4. Strong oxidizing agents such as chromic and perchloric acids should be stored and used in glass or other inert containers (preferably unbreakable); corks and rubber stoppers should not be used
5. Safety rubber bottle carriers or non-breakable bottles (PVC-coated) should be used for the transport of strong acids and bases from one location to another.

10.5.2 Storage

1. Containers and equipment used for storage should be corrosion resistant.
2. Acids and bases should be stored separately. Strong oxidizing acids should be stored separately from other acids and bases.

10.6 Compressed Gases

10.6.1 Definition

"Compressed gas" is a generic term frequently used for different types of gas products including compressed gases, liquefied gases, refrigerated liquefied gases, and dissolved gases. OSHA classification criteria for gases under pressure include:

Compressed Gas - A gas which when under pressure is entirely gaseous at -50°C (-58°F), including all gases with a critical temperature1 ≤ 50°C (-58°F).

Liquefied Gas - A gas which when under pressure is partially liquid at temperatures above -50°C (-58°F). A distinction is made between:

a. High pressure liquefied gas: a gas with a critical temperature between -50°C (-58°F) and +65°C (149°F); and
b. Low pressure liquefied gas: a gas with a critical temperature above +65°C (149°F).

The critical temperature is the temperature above which a pure gas cannot be liquefied, regardless of the degree of compression.

Refrigerated Liquefied Gas [also known as Cryogenic liquids (cryogens)]- A gas which is made partially liquid because of its low temperature.

Dissolved gas - A gas which when under pressure is dissolved in a liquid phase solvent.

10.6.2 Hazards

Compressed gases may be grouped into different hazard categories based upon their physical or health properties, or both. Any gas could be placed into more than one category. A gas could be corrosive, flammable, toxic, an oxidizer, or act as an asphyxiant by displacing oxygen. An additional hazard is due to the fact that gases are stored under high pressure.

Cryogens create unique hazards including fire, pressure, embrittlement of materials, and skin or eye burns upon contact with the liquid. Cryogens also condense oxygen from air creating an oxygen rich atmosphere and increasing potential for fire if flammable or combustible materials and an ignition source are present. Pressure is a hazard because of the large expansion ratio from liquid to gas, causing pressure build up in containers. Many materials become brittle at extremely low temperatures. Brief bodily contact with materials at extremely low temperatures can cause burns similar to thermal burns.

10.6.3 Precautions

Precautions to take when working with compressed gases:

1. Never drop cylinders or permit them to strike each other violently.
2. The valve-protection cap should be left on each cylinder until it has been secured against a wall, bench, or placed in a stand and is ready to be used.
3. Avoid dragging, rolling, or sliding cylinders, even for a short distance. Use a cylinder hand truck to move them.
4. Never tamper with safety devices in valves or cylinders.
5. No part of a cylinder should be subjected to temperatures higher than 125° F. A flame should never be permitted to come in contact with any part of a compressed gas cylinder.
6. Do not store full and empty cylinders together.
7. Do not empty a cylinder lower than 25 psi. Serious suck-back can occur when an empty cylinder is attached to a pressurized system.
8. Bond and ground all cylinder, lines, and equipment used with flammable compressed gases.

9. Use compressed gases only in well-ventilated areas. Toxic, flammable, and corrosive gases should be handled in a hood. Only small cylinders of toxic gases should be used.
10. Flammable gases should stored away from oxidizing gases.
11. When discharging (bubbling) gas into a liquid, a trap or suitable check valve should be used to prevent liquid from getting back into the cylinder or regulator.
12. When returning empty cylinders, close the valve before shipment, leaving some positive pressure in the cylinder. Replace any valve outlet and protective caps originally shipped with cylinder. Mark or label cylinder "empty" and store in a designated area for return.
13. Before using a cylinder, read all label information and safety data sheets associated with the gas being used. Check the SDS for required personal protective equipment and hazard information before use.
14. For flammable cryogens, the precautions detailed in Section 10.4 should be followed.
15. When handling cryogens always wear safety goggles. If there is a splash or spray hazard, personnel protective clothing should also include a face shield, impervious apron or coat, trousers without cuffs, and shoes that cover the feet. Gloves should be impervious and be thermally insulated.
16. Containers and systems containing cryogens should have pressure relief mechanisms.
17. Containers and systems should be capable of withstanding extreme cold without becoming brittle.

10.6.4 Resource: Compressed Gas Safety Guide

10.7 Peroxide Formers

10.7.1 Definition

Peroxide formers, or peroxidizables, are materials which react with oxygen to form peroxides which can explode from impact, heat, or friction.

10.7.2 Hazard Categories

Peroxide-forming compounds can be divided into three hazard categories. Storage times are based on time after opening the container. Most chemicals will have an expiration date on the chemical label based on the type of chemical. Examples are shown below.

1. Compounds forming peroxides that can spontaneously decompose during storage.
   - Maximum storage time is 3 months. Examples include divinyl acetylene, isopropyl ether, potassium metal, sodium amide, and vinylidene chloride.
2. Compounds forming peroxides that require the addition of a certain amount of energy (distillation, shock) to explosively decompose.
   - Maximum storage time is 12 months. Examples include acetyl, cyclohexene, diacetylene, dicyclopentadiene, diethyl ether, dioxane, 1,2-dimethoxyethane, methyl acetylene, methyl cyclopentane, methyl isobutylketone, tetrahydrofuran, vinyl ethers, and tetrahydronaphthalene.
3. Compounds that have the potential to form peroxide polymers, a highly dangerous form of peroxide that precipitate from solution easily and are extremely heat- and shock-sensitive.
   - Maximum storage time is 12 months. Examples include acrylic acid, acrylonitrile, butadiene, chloroprene, chlorotrifluoroethylene, methyl methacrylate, styrene, tetrafluoroethylene, vinyl acetate, vinyl chloride, and vinyl pyridine.

10.7.3 Precautions for Peroxide Formers

All labs should actively manage peroxide-forming chemicals. Utilize the following practices:

1. Date all peroxidizables upon receipt and opening. Unless the manufacturer has added an inhibitor, materials should be disposed of in a timely manner.
2. Periodically test contents for peroxides using peroxide test strips; record test date and results on container. Chemicals must be disposed of before reaching 25 ppm of peroxides.
3. Do not open any container with evidence of peroxide formation such as obvious crystal formation around the lid or in the liquid, or visible discoloration.
4. Keep peroxide-forming chemicals in their original containers to minimize conditions that accelerate peroxide formation.
5. Other precautions are similar to those used for flammables.

10.7.4 Resources

- Examples of Peroxide-Forming Chemicals
- Waste Disposal for Peroxide-Formers (e.g. ethers)

10.8 Reactive Chemicals

Definition of Hazards
The category "Reactive" is a term given to a chemical class that displays a broad range of reactions. This category includes explosives, oxidizers, reducers, water-sensitive, acid-sensitive, air-sensitive and unstable chemicals. These substances are capable of producing toxic gases, explosive mixtures, being explosive, reacting with water violently, or they may contain cyanide or sulfide. Reactive chemicals exhibit moderate to extremely rapid reaction rates and include materials capable of rapid release of energy by themselves (self-reaction or polymerization), and/or rates of reaction that may be increased by heat or pressure or by contact with incompatible substances.

Reactives may be broadly classified into two groups: those that may explode and those that do not. Reactivity of individual chemicals in specific chemical classes (e.g., alkali metals) varies considerably. This rate of activity may also vary as a result of aging or contamination. Reactives may be further subdivided and placed into eight classes based upon their chemical behavior.

10.8.1 Class I

Chemicals normally unstable that readily undergo violent change without detonating.

Properties

1. Pyrophorics--spontaneous ignition in contact with air. Examples: metal alkyls, phosphorus, finely divided metal powders such as magnesium, aluminum, and zinc. Prevent contact with air or water - use and store in inert environments.
2. Polymerizables--spontaneous polymerization in contact with air. Examples: divinyl benzene. Keep cool and avoid contact with water.
3. Oxidizers--violent reaction in contact with organic materials or strong reducing agents. Examples: perchloric, chromic and fuming nitric acid. Use minimum amounts for procedure; do not keep excessive amounts of material in the vicinity of the process. Store properly, away from organic materials, flammable materials and reducers.

10.8.2 Class II

Chemicals that react violently with water.

Properties
Causes large evolution of heat in contact with water, decomposes in moist air, and violently decomposes with liquid water. Examples: Sulfuric acid, chlorosulfonic acid, oleum, phosphorous trioxide and pentoxide, acetyl halides, phosphorus halides, titanium tetrachloride, and glyoxal.

Precautions
1. Handle materials like corrosives. Use protective acid-resistant rubber or plastic clothing with gloves and face shield.
2. Keep away from moisture.
3. Handle materials in a fume hood since fuming in moist air can result in exposure to corrosive and/or toxic gases.

10.8.3 Class III
Chemicals that form potentially explosive mixtures with water.

Properties
Chemicals decompose violently in water with evolution of heat and flammable gases, which may ignite if exposed to an ignition source. Evolution of heat with water may be sufficient to cause auto-ignition (and explosion). Examples: alkaline metals, alkaline earth metals, alkaline metal hydrides, and alkaline metal nitrides.

Precautions
1. Provide ventilation to disperse flammable gases.
2. Use dry sand to smother materials - use of water as a fire extinguisher may aggravate fire.
3. Avoid contact with and handle away from water sources.

10.8.4 Class IV
Chemicals that, when mixed with water, generate toxic gases, vapors or fumes in quantities sufficient to present a danger to human health or the environment.

Properties
Reacts rapidly with water with the production of gases or vapors, which are acutely toxic to human health. Examples: alkaline metal phosphides, phosphorus halides, aluminum phosphide, and toluene diisocyanate.

Precautions
1. Provide adequate ventilation when handling.
2. Keep containers sealed.
3. Do not handle near water.

10.8.5 Class V
Cyanide or sulfide bearing chemicals.

Properties
Acid-sensitive cyanides and sulfides that produce extremely toxic hydrogen cyanide or hydrogen sulfide gases upon contact with acids, or materials which form acids, in the presence of moisture or liquid water.

Examples: metal cyanide salts, organic cyanide compounds, metal sulfide salts, organic sulfides and mercaptans.

Precautions

1. Do not store in cabinets with acids and/or oxidizers.
2. Isolate from other reactive chemicals.
3. Protect sulfide salts from moisture.
4. Provide adequate ventilation due to the severe inhalation hazard of hydrogen cyanide and hydrogen sulfide and acute toxic effects from skin contact with hydrogen cyanide.

10.8.6 Class VI

Chemicals capable of detonating or exploding when subjected to a strong initiating source or when heated under confinement.

Properties

Detonation or explosion can occur if heated above ambient temperature; or if exposed to an initiating source such as shock, mechanical shock, spark or flame, or a catalyst that accelerates decomposition. Examples: lead amide, sodium amide, thallous nitride, metal azides, brominated organic compounds, benzene diazonium salts, ammonium picrate, ammonium tetra-chromate, metal periodates, organic perchlorates, isoamyl nitrite, ammonium nitrate and chlorate.

Precautions

1. Protect containers from physical damage, heat and incompatible chemicals.
2. Chemicals in this class exhibit a wide range of other properties, i.e., flammability, acid or water or light sensitivity. Know the properties of the materials being worked with.
3. Check the SDS for information on incompatibles when storing.

10.8.7 Class VII

Chemicals readily capable of detonation, explosive decomposition, or reaction at standard temperature and pressure.

Properties

Chemicals capable of detonation or explosive decomposition under ambient temperature and pressure without any external initiating source. Examples: ammonium chlorate, organic azides, metal azides, benzoyl peroxide, and peroxidized ethers.

Precautions

1. Materials should only be handled by knowledgeable and trained individuals.
2. Evaluate chemicals periodically to determine whether deterioration has occurred. If so, dispose of properly by contacting Environmental Health & Safety.
3. Check the SDS for information on incompatibles for storage and chemical properties of materials handled.
4. Follow recommendations on the SDS for personal protective equipment.

10.8.8 Class VIII

Forbidden explosives, Class A explosives, and Class B explosives as defined in 49 CFR 173.

Properties

Forbidden explosives are capable of detonation or explosive decomposition under ambient conditions, considered too dangerous for transportation. Forbidden explosives examples: diethylene glycol dinitrate, unstabilized nitroglycerine, and nitrocellulose.

Class A Explosives: TNT, mercury fulminate, diazo-dinitrophenol, and lead 2,4-dinitroresorcinate. Class B Explosives: stabilized nitrocellulose and stabilized nitroglycerin.

Precautions
Materials should only be handled by experienced and properly equipped persons. To use such compounds the researcher must have undergone and passed a screening process by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). The procurer of the explosives then must obtain a permit issued by the ATF to purchase said compounds.

Resource: Pyrophoric Reagents Handling in Research Labs

11.0 Storage Procedures

Proper storage of chemicals is important to reduce the possibility of chemical reactions that may create hazardous exposure situations, cause fires, or damage equipment and property. The laboratory should select a storage scheme that achieves segregation of incompatible materials. Sample storage schemes are available at Chemical Storage Information. Storage guidance may also be found in laboratory and safety catalogs, Safety Data Sheets, and container labels.

Resource:

- ICON Chemical Storage Safety Course - W126CM
- Chemical Compatibility Chart.xls
- Compatible Chemical Storage Reference pdf

In order to develop and ensure proper storage of chemicals, individuals should:

1. Maintain a list of hazardous chemicals used or stored.
2. Assure all containers are in good condition and properly labeled.
3. Review stored items at least yearly, more frequently for age-sensitive materials. Ensure containers and caps are in good condition. Ensure materials are stable.
4. Not store chemicals in alphabetical order unless they are already segregated by hazard category.
5. Not store incompatible chemicals in close proximity to each other.
6. Avoid floor chemical storage.
7. Provide anti-roll lips on shelves.
8. Provide shelving that can be cleaned and will not soak up spilled chemicals.
9. Store liquid chemicals below eye level.
10. Not store chemicals on top of shelving units or on top of flammable storage cabinets.
11. Store severe poisons in a dedicated unit.
12. Store oxidizing acids in secondary containers.
13. Label storage areas by chemical group.
14. Store flammable liquid quantities over 10 gallons in flammable storage cabinets. See also Procedures, in Section 12.2, for flammable and combustible liquids.

11.1 Flammable and Combustible Liquids

Term	Class	Flash Point	Boiling Point	NFPA Rating
Flammable	IA	<73° F	<100° F	4
Flammable	IB	<73° F	≥100° F	3
Flammable	IC	73° F - <100° F		3
Combustible	II	100° F - <40° F		2
Combustible	IIIA	140° F - <200° F		2
Combustible	IIIB	≥200° F		1

Procedures
The following storage requirements apply to most university academic and research buildings. For flammable storage vaults, warehouses, and industrial operations, contact EHS (335-9379) as other requirements may apply.

Whenever possible, flammable liquids should be placed in storage cabinets.
Maximum quantity of Class IA, IB and IC flammable liquids, in any combination, in a fire area (room with approved walls and doors) outside of approved storage cabinets or safety cans is 10 gallons.

Maximum quantity of Class II, Class IIIA and IIIB combustible liquids, in any combination, in a fire area (room with approved walls and doors) outside of approved storage cabinets or safety cans is 30 gallons.

For maximum amount of Class IA, IB and IC flammable liquids in any combination, in a fire area (room with approved walls and doors) that can be stored inside approved storage cabinets or safety cans please contact Bruce-McAvoy@uiowa.edu 335-5389.

12.0 Waste Disposal Procedures

Laboratory personnel are responsible for determining if their wastes are hazardous and for properly labeling and packaging waste such that may be disposed in a manner that is safe for the environment and for other personnel handling the waste. Detailed waste disposal instructions are found on the EHS website Waste/Environmental section or in the resource below.

Resource: Chemical Waste Disposal Guide

13.0 Spill and Emergency Plans

This section focuses on planning and responding to spills or releases of chemicals and hazardous materials.
A spill is the release of a hazardous material to an undesired location, resulting in increased hazard or potential hazard to people, property or environment. When a spill occurs or is discovered, action appropriate for the circumstances must be initiated.
Note: University-wide emergency procedures are addressed in the University of Iowa Emergency Procedures Guide, which applies to all University units. Units should supplement the plan if/as needed to address individual needs of the unit while remaining in compliance with the plan.

Resource: UI Emergency Procedure Guide

13.1 Basic Steps for Emergencies, Major Spill, and Other Problems

Any Emergency - Call 911
Emergencies include fire, explosion, rescue, and evacuation. The call will generate a police and ambulance response.

Major Spill (Uncontrolled Release) – Call 911
A major spill is one that is spreading rapidly, presents inhalation or fire hazards, is of an unknown substance, involves multiple substances, poses a significant risk to personnel, has entered the environment, or exceeds the capability of the user to respond. An individual should:

- Alert others to leave the spill area.
- Remove ignition sources, shut down equipment, close fume hood sash, and open windows, as appropriate and if safe to do so.
- Close doors to room.
- Assemble at a safe distance and location.
- Wait for and provide information to Emergency Responders.

Personal Injury

Body or Eye Splashes

- Assist the affected person with use of the body shower and/or eye wash equipment.
- Flush body and/or eyes with water for at least 15 minutes.
- Remove contaminated clothing while under body shower.
- Wash skin with mild soap and water - do not use neutralizing agents, creams, lotions or salve unless otherwise instructed by the SDS. For example Hydrofluoric Acid
- Seek medical attention.

Medical Treatment Needs

Emergencies
Report to UIHC Emergency Treatment Center (24 hours, 7 days).

Vehicle Transport Assistance
If needed, call Department of Public Safety, 335-5022.

Non-emergency work-related needs
For UI Employees:
During normal business hours, go to UI Occupational Health Clinic (319-356-3335) located at 3 Lions Drive off Highway 965 in North Liberty. Outside of normal business hours, report to the UIHC Emergency Treatment Center. For bloodborne pathogen-related injuries, report to the University Employee Health Center in Boyd Tower.

For Non-Paid Workers (ex: unpaid students):
Report to Student Health Services in Westlawn.

Inhalation Hazards

Rescue or Evacuation
Call 911

Non-emergency evacuation
Call 335-5022, Department of Public Safety

Non-emergency technical assistance
Call 335-8501, Environmental Health & Safety.

Radioactive Materials Notification
Notify EHS of all radioactive materials spills and instances of personal contamination immediately. During normal business hours call 335-8501. After hours call Department of Public Safety at 335-5022.

Note: Radioactive materials spill response procedures must be developed and readily available to personnel. Contact EHS when developing radioactive materials emergency and spill response information pertinent to your lab, or call 335-8501.

Environmental Release and Oil Spill Notifications
For suspected or known release to the environment (air, water, land, or drains) notify EHS, 335-8501 or the Facilities Management Environmental Compliance Manager during regular business hours. After hours call Department of Public Safety at 335-5022 for non-emergencies or 911 for emergencies. Notifications must be made to regulatory agencies immediately and not later than six hours for actual or suspected environmental releases.

Power Outages
Contact the FM@YourService (24 hours/7 days). Individuals should:

- Place lids on open containers of volatile chemicals.
- Lower the sash on chemical fume hoods.
- Turn off ignition sources.
- Shut down equipment (leave cooling water, purge gases on as necessary).
- Secure or isolate reactions that are underway (boiling liquids, distillations).

13.2 Preparing Spill Plans

Each laboratory should be prepared to respond to a spill. Laboratory staff should:

- Review your chemical inventory to identify hazards of chemicals used and stored in your area.
- Purchase or assemble a spill kit appropriate for your chemicals. Consider special needs for air- and water-reactives, poisons, mercury, and hydrofluoric acid.
- Ensure emergency contact information or call lists are posted at the entrance(s) to the area.
- Post the Hazardous Materials Spill Guide at an easily accessible location in the work area, e.g., near the telephone or with the spill kit.
- Train lab occupants on area spill procedures.

13.3 Spill Kit Supplies

A list of spill supplies pdf is available at University Biochemistry Stores. Pre-assembled kits are available that can be customized with the necessary neutralizers, etc. for your specific lab needs. Supplies are also available from lab and safety catalogs.

Basic Kit Supplies include:

- Chemical Resistant Container for Kit
- Universal Absorbents
- Goggles
- Gloves
- Disposable Coverall or Apron
- Shoe Covers

- Dust Pan and Whisk Broom for Solids
- Hazardous Waste Labels

Add as needed in your area:

- Personal protective equipment such as face shields, aprons, or boots.
- General neutralizing agents such as sodium bicarbonate for acids, and citric acid or sodium bisulfate for bases.
- Agent-specific neutralizers for acids, bases, formaldehyde and solvents.
- Mercury collection sponges.
- Specialized supplies for air- or water-reactive chemicals and hydrofluoric acid.
- Only add respirators if additional training and program requirements have been met.

Resource: **Spill Management**

13.4 Spill Training

Spill training for your area should include:

- Recognition (sight, smell, alarms, etc.)
- First aid for chemical injuries that may occur in your area
- Handling emergencies (notification, action)
- Prevention/Containment (secondary containment, spill limitation)
- Clean-up (personal protection, use of equipment, preventing damage, etc.)
- Packaging and handling of residue.

Resource: ICON Spill Preparedness and Response Course - W142CM, **EHS Safety Training**

13.5 How to Prevent and Minimize Spills

General spill prevention practices include:

- Storing hazardous liquid containers in a pan or tray big enough to hold the contents if the container breaks or leaks.
- Buying liquids in plastic coated bottles.
- Using bottle carriers for protection and containment.
- Putting pans under experiments.
- Using traps on vacuum lines.
- Using carts designed to prevent materials from sliding off the cart.
- Having sink stoppers and drain covers handy to prevent material from entering drains.

Tip: Use the Spill Response Quick Guides as training tools for the lab (see Resource for Spill Clean-up Procedures, Section 13.6, below).

13.6 Spill Clean-Up Procedures

Small, Simple Spills

A simple spill is not spreading rapidly, does not endanger people or property except by direct contact, and does not endanger the environment outside of the building. Users of chemicals are able to neutralize, absorb or otherwise manage small spills. If there are questions about safe or appropriate clean up measures check with your supervisor or EHS first.

General Clean Up Procedures

Individuals responding to a spill should:

1. Refer to the Concise Hazardous Material Spill Response Guide, if needed (see Resource for this section).
2. Always wear eye and hand protection and choose additional protective equipment appropriate for the situation.
3. Contain the spill. Gently apply absorbent from the outer edge of the spill in.
4. For solids, gently brush particles into a container or dustpan. If the spilled material is not water-reactive, wet wipe the area.
5. Deposit hazardous debris in a rigid non-reactive container with a lid.
6. If debris may off-gas, place the container in a chemical fume hood. Open the lid slightly to avoid pressure buildup or container rupture.
7. Complete hazardous waste label and request container pickup.

Mercury
For small spills such as a thermometer, use an aspirator bulb, suction device or mercury sponge. Place debris in a sealed rigid container, not a plastic bag. If vapor inhalation is a potential problem, i.e., larger spills, spills in small unventilated spaces, or spills in ovens or heating baths, contact EHS.

Acid Chlorides
Avoid water and sodium bicarbonate. Use dry sand, Oil-Dri, or an equivalent product.

Alkali Metals
Do not use water. Smother in dry sand and place debris in a hood.

Highly Hazardous or Toxic Materials
Certain substances such as hydrofluoric acid or extremely poisonous substances may necessitate having special clean-up supplies or antidotes in the work area.

Resource: **Chemical Spill Guides** (Store a copy of these guides with the lab spill kit.)

14.0 Injury Reporting Procedures

Refer to Illness and Injury Procedures on the EHS web site; Illness and Injury Procedures . The main requirements are:

- All injuries must be reported immediately by the injured employee to their supervisor.
- The supervisor must submit the First Report of Injury Form within 24 hours. This form is available through HR Employee Self-Service. Questions on the form or claim should be directed to the Staff Benefits Office.

Supervisors and/or departments should investigate the cause or causes of incidents to prevent reoccurrence. Contact EHS for assistance, if needed. Follow-up should be done by the department to ensure that corrective action have been taken.

Departments may request an accident/incident summary for their area from EHS. This summary includes the incident date, type and description, name, occupation, and days lost.

15.0 Record Keeping Requirements

Records of monitoring measurements or any medical consultation or examinations, including tests or written opinions, must be maintained for each employee. Such records must be kept, transferred, and made available in accordance with 29 CFR 1910.1020 and, as applicable, record requirements in other select OSHA standards.

16.0 Lab Health and Safety Review Program

EHS maintains a Safety Advisor Team Program to support research labs by providing consultation, education, and services to enhance safety and health compliance and practice. This team conducts annual reviews of research laboratories. Information about the Safety Advisor Team and the Annual Lab Review programs can be located in the resource below. The resource describes the program and provides links to the topics that EHS staff review during each visit.

Resource: **EHS Safety Advisor Team Program**

17.0 Laboratory Close-Out Procedure

Procedures have been developed to assist with the process of closing down a laboratory or moving to another laboratory location. These procedures are designed to assure that the space is cleared of hazardous equipment and materials and the laboratory facility is left in a safe condition when the space is vacated. The procedures provide information about various categories of hazardous materials, a step-by-step timeline for when activities should be conducted, and forms used to implement the process, and contacts to assist with the process.

Resource: **Laboratory Close-out Procedure**

18.0 Additional Resources

- Department of Homeland Security - Chemicals of Interest
- Guidance for Identification of Highly Hazardous Chemical Substances pdf
- Standard Operating Procedure (SOP) - Template