THE UNIVERSITY of NEW ORLEANS

OFFICE OF RESEARCH

Chemical Hygiene Plan

Table of Contents

Purpose

The purpose of this document is to provide general guidance to all laboratory employees regarding the safe handling, use, and storage of hazardous chemicals. It is the goal of the faculty, staff, and students at the University of New Orleans (UNO) to comply with all state and federal regulations that protect individuals against workplace hazards and the potential for exposures or injuries. This goal is to be accomplished through the implementation of hazard controls such as elimination, substitution, engineering and administrative controls, and where necessary, the use of personal protective equipment (PPE) as prescribed in the OSHA Laboratory Standard (29 CFR 1910.1450). This standard requires the development of a Chemical Hygiene Plan (CHP) to achieve this goal.

1. How to Use This Manual

The CHP is a reference for the safe handling of hazardous chemicals in the laboratory. The CHP applies to all engaged in laboratory use of hazardous chemicals. The information contained in the CHP is prescribed by the OSHA Lab Standard and supersedes, for laboratories, the requirements of all other OSHA health standards in Subpart Z. Most relevant are: Section 8 on Laboratory Practices; Section 9 on Safety Handling, Storage, & Use of Hazardous Chemicals; Section 12 on Medical Consultation & Medical Examinations; and Section 13 on Emergency Procedures. Appendix A provides an overview on toxicology, the effects that chemical exposure can have on the body.

2. Scope

The CHP applies to all who work in laboratories or laboratory-related work areas (ex. Equipment rooms, common cold rooms, chemical storage rooms, etc.) where hazardous chemicals are handled, used, and/or stored.

The CHP does not directly apply to UNO employees who do not work in laboratories or laboratory-related work areas. Those employees should be protected according to the OSHA Hazardous Communication Standard.

3. Responsibilities

University of New Orleans (UNO)

UNO and its employees, referencing the Occupational Safety and Health Act of 1970, Section 5 (General Duty Clause), have a shared responsibility for working safely in their work environment. UNO must ensure that each of its employees is provided a place of employment that is free from recognized hazards that have the potential to cause death or serious physical injury by adopting all applicable occupational safety and health standards.

UNO employees must practice safe working behaviors and comply with all occupational safety and health standards, rules, and regulations. This CHP, as indicated in the Scope, applies to individuals working in laboratories or related areas, and will focus on these standards, rules, and regulations.

UNO Environmental Health & Safety Office (EHSO)

The EHSO serves as an advocate for safety and health at UNO and ensures regulatory compliance with all applicable rules, regulations, and standards that apply to UNO in general.

UNO Laboratory Safety Officer

The Laboratory Safety Officer serves as an advocate for safety and health in UNO laboratory settings and ensures regulatory compliance with all applicable rules, regulations, and standards that apply to UNO in laboratories or laboratory-related work areas. The Laboratory Safety Officer is responsible for ensuring compliance through the following:

- Provision of safety manuals and guidelines, including the CHP.
- Development and provision of training programs to Principle Investigators (PIs), Laboratory Managers, Students, and Laboratory Staff.
- Development and implementation of a laboratory inspection program to document areas of non-compliance and to recommend corrective actions.
- Review and approval of chemical safety protocol applications for working with hazardous chemicals.
- Providing guidance to laboratory personnel regarding safe laboratory practices.

Institutional Biosafety Committee (IBC)

The IBC is charged under federal regulations with the oversight of all teaching and research activities involving recombinant or synthetic DNA when this research is the beneficiary of NIH funding. This also includes use of these materials at other research sites accessed by UNO faculty, staff, researchers, and non-university staff researchers under grants and contracts. IBC is authorized to take all actions that are necessary, including inspection of research facilities, approval of research practices and procedures and the enforcement of cessation of research activities in the event of an unresolved safety hazard. IBC consists of administrators, faculty, staff, and an outside representative to ensure that proper procedures and precautions are followed.

UNO Radiation Safety Officer (RSO)

The RSO is the person responsible for radiological safety in conjunction with the use, handling, and storage of radioactive materials at UNO. They are also responsible for establishing, maintaining, enforcing, and controlling the UNO Radiation Safety Program and act as the contact person for all regulatory agencies, including the United States Nuclear Regulatory Commission (NRC) and the Louisiana Department of Environmental Quality (DEQ) Emergency & Radiological Services Division.

Department Chairs

Department chairs serve as representatives of their respective departments. Their responsibilities include (but are not limited to):

- Communicating with PIs, laboratory managers, students, and laboratory staff regarding laboratory safety issues.
- Providing the Laboratory Safety Officer with support to implement protocols and guidelines and maintain the CHP.
- Reporting any potentially hazardous conditions within the department to the Laboratory Safety Officer.

Principal Investigators (PIs)

PIs are directly responsible for laboratory personnel (laboratory managers, staff, and students). Their responsibilities include (but are not limited to):

- Providing the necessary training for each individual based on laboratory-specific requirements including each research project or experiment in which he/she will use chemicals.
- Ensuring that all laboratory personnel know how to access this CHP and understand the content within the CHP.
- Ensuring that laboratory personnel complete required UNO Laboratory Safety Training modules and any other required training and remain current with refresher training requirements.
- Completing all safety training modules that any member of their laboratory is required to take.
- Wearing minimum PPE, including a laboratory coat, gloves, closed-toe shoes, and eye protection, along with additional PPE as required.
- Providing the appropriate PPE to protect employees from laboratory hazards, including chemical hazards.
- Ensuring that all required chemicals used in the laboratory have written standard operating procedures (SOPs) or hazard assessments and have been registered with the Laboratory Safety Officer if necessary.
- Reporting any potentially hazardous conditions within the laboratory to the Laboratory Safety Officer.
- Ensuring that laboratory personnel report any accidents, incidents, or near-misses to EHSO via SciShield.

Laboratory Managers

Laboratory Managers are delegated by PIs to oversee the daily operations of a research lab. They serve as the points of contact for the Laboratory Safety Officer, and their responsibilities include (but are not limited to):

- Following all protocols and guidelines covered in the CHP and required by the Laboratory Safety Officer.
- Ensuring that all laboratory personnel working in the laboratory understand and follow the guidelines and protocols covered in the CHP as required by the Laboratory Safety Officer.

- Ensuring that all individuals (self-included) have completed all required safety training, remain current with refresher training requirements, and maintain laboratory safety records.
- Ensuring all personnel wear minimum PPE including a laboratory coat, gloves, closed-toe shoes, and eye protection, along with additional PPE as required.
- Working in a safe and efficient manner as to avoid harm or injury to oneself or other personnel.
- Reporting any potentially hazardous conditions within the laboratory to the PI and Laboratory Safety Officer.

Laboratory Staff, Students, Volunteers, & Visitors

All individuals who participate in research activities and use chemicals have responsibilities that include (but are not limited to):

- Reading and following all protocols and guidelines covered in the CHP and required by the Laboratory Safety Officer.
- Completing required UNO Laboratory Safety Training modules and any other required training, then remaining current with refresher training requirements.
- Wearing the minimum PPE including a laboratory coat, gloves, closed-toe shoes, and eye protection, along with additional PPE as required.
- Working in a safe and efficient manner as to avoid harm or injury to oneself or another individual.
- Reporting any potentially hazardous conditions within the laboratory to the Lab Manager, PI, and Laboratory Safety Officer.

4. Rights of Employees

UNO employees have the right to be made aware of any hazardous materials they may be required to use during work activities, and to be provided information and training on how to safely use these materials prior to working with them. UNO employees also have the right to work in an environment that is free from recognized hazards, and to be protected from those hazards while working.

5. Availability

This CHP is available for all UNO faculty, staff, and students at https://www.uno.edu/research/funding/compliance under Chemical Safety.

6. Information & Training

All laboratory personnel and employees at UNO must be provided with information and training that addresses the hazards they will encounter when working in a laboratory environment. This information must make them aware of the hazards present, including their risk of exposure to these hazards, and how to protect themselves from these hazards. This information also must include how to work with present hazards safely, and

the procedures to follow if they are exposed to these hazards. An overview of industrial toxicology is presented in Appendix A – Industrial Toxicology Overview. The information in the appendix clarifies the variety of effects that hazardous chemicals can manifest.

Information

Employees must be informed of the chemicals that they will be working with and of all the hazards associated with these chemicals. The information must be accessible to them prior to beginning work (initial assignment) and whenever there are changes in job function that also change exposure conditions. The information includes, but is not limited to:

- The OSHA Laboratory Standard and all its parts.
- How to locate the UNO CHP.
- Where and how to find permissible exposure limits for both OSHA regulated and non-regulated materials.
- Signs and symptoms associated with exposure to these chemicals.
- How to find Safety Data Sheets (SDSs) for chemicals in SciShield.
- Performing job hazard analysis to identify hazards and risks of planned experiments.

Training

Training must be received prior to beginning work (initial assignment) and whenever there are changes in job function that also exchange exposure conditions. Employees must also receive annual refresher training, as well as continuing education training throughout each year. Training, referencing the OSHA Laboratory Standard, must include (but not limited to) the following:

- The details of the CHP.
- Physical and health hazards of chemicals in the work area.
- Methods to detect the presence or release of chemicals in the work area.
- Protective control measures against hazards.
- Standard operating procedures (SOPs).
- Prudent practices for laboratory safety.
- Emergency procedures.
- PPE.

To meet the requirements above, UNO offers UNO Lab Safety Training modules to all faculty, staff, students, and volunteers who work in laboratories. This training is available online and includes a survey to inform on which training modules are required. The training is to be completed before work in the lab begins, and refresher training is an annual requirement.

Other forms of training that are required are laboratory-specific and should be provided by the PI or laboratory supervisor/manager of the lab. This training should include, but is not limited to:

- Lab-specific SOPs.
- Lab-specific methods of handling emergencies.
- Training in the operation of equipment.
- Exposure prevention of recognized hazards.
- Any other training appropriate for lab specific work.

Record Keeping

Training required in keeping with the OSHA Laboratory Standard must be documented and retained. UNO Lab Safety Trainings are offered online through Canvas. After completing the training module(s), the training date is tracked and retained by the system. Records for other required training courses offered through an entity other than the Laboratory Safety Officer must also be retained and should be done by filing (electronic or hard copy) a confirmation completion page or certificate of completion.

Program Review

In keeping with the OSHA Laboratory Standard, the CHP must be reviewed annually to evaluate the effectiveness of this plan. It should be updated as necessary to reflect any changes in the laboratory standard or changes in safety measures or processes.

7. Laboratory Practices

General Laboratory Safety

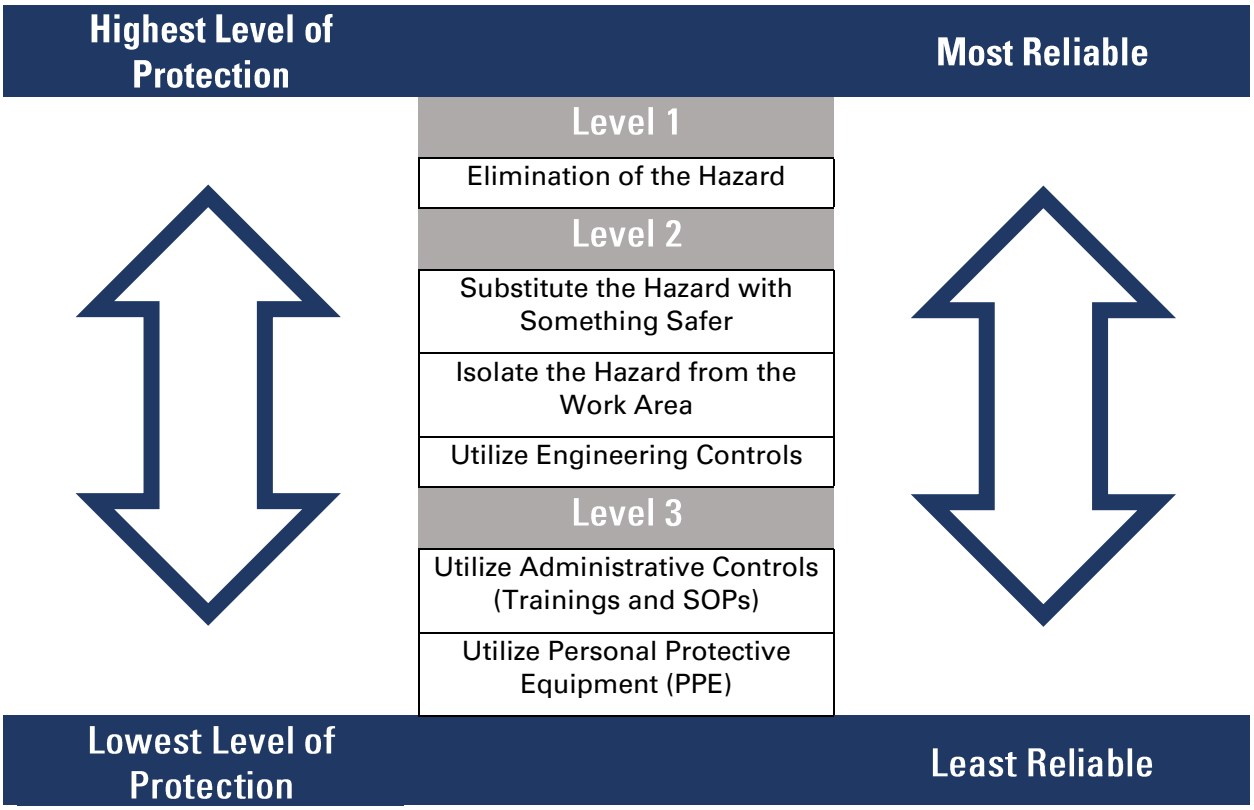
When working in a laboratory, it is important for the faculty, staff, students, and volunteers to use prudent laboratory practices and to maintain a safe work environment. The items below are some basic guidelines to follow and should be considered the minimum requirements to maintain safety in the lab.

- Prior to working with any chemical for the first time, read the SDS to identify what the hazards are and how to safely handle and store the chemical.
- When working with chemicals, always use the available engineering controls, when possible, to eliminate or minimize exposure. (ex. Chemical fume hoods, sharps containers, etc.)
- Always wear the appropriate PPE. The UNO PPE Assessment is available at https://www.uno.edu/research/funding/compliance under Personal Protective Equipment (PPE) and must be filled out by each laboratory annually to ensure the appropriate PPE is available and worn in the corresponding laboratory.
- Avoid wearing overly loose clothing. Long hair must be pulled back.
- All laboratory refrigerators, freezers, and microwaves must be labeled with a "No Food/No Drink" label.

- After working in any laboratory, wash hands thoroughly and dry them completely. This must be done after removing PPE, prior to leaving the laboratory, and prior to consuming food, drinks, and applying cosmetics.
- Never work alone. Always ensure that at least one other person is in the work area; this person can assist you in the event of a laboratory exposure or injury.
- Always use chemicals and equipment for their intended purposes.
- Always be aware of the hazards around you. If someone in the laboratory is using chemicals, avoid startling or distracting them.
- Know where the emergency equipment is located in your laboratory. This includes emergency showers, emergency eyewash stations, fire extinguishers, and fire alarm pull stations.
- In the event of an emergency or chemical spill, know the appropriate emergency response procedures for your laboratory. Emergency response procedures are listed in Section 12. Emergency Procedures below.
- Never pipette any materials by mouth.

Recognizing Hazards & Risks

Figure 1. Hazard Controls



The basic risk analysis combines hazard recognition, hazard assessment, and identification of protective measures. Laboratory personnel must be able to recognize

common hazards within the laboratory and be familiar with how these hazards are communicated based on the Global Harmonization System (GHS) of hazard classification. In addition to recognizing the hazards, assessing the risk of the hazards presented by chemicals used is vital to prevent accidents, injuries, and exposures. Examples of hazards to consider include:

Laboratory Hazard	**Examples**
Chemical Hazards	Strong Acids or Bases, Flammables
Physical Hazards	Strong Oxidizers, Pyrophorics, Air or Water Reactives, High Pressure or Low-Pressure Systems, Vacuum Systems, Compressed Gases
Electrical Hazards	Electrical Equipment
Cryogenic Hazards	Liquid Helium, Liquid Nitrogen, Dry Ice
Health Hazards	Toxic Substances, Carcinogens, Mutagens, Teratogens, Nanomaterials
Reaction Hazards	Energy Sources, Heat Sources, Scale-Up Reactions, Catalytic Effects

Table 1. Common Laboratory Hazards

Unattended Operations

Plan to conduct experiments that involve chemicals during normal working hours. When unattended operations are necessary, follow these practices:

- Leave laboratory lights on during overnight experiments.
- Post information about the experiment nearby that includes the chemicals used, their associated hazards, and the name and number of the point of contact.
- Periodically check on the experiment, especially when heating and/or using water cooling equipment.

Food & Drinks in Laboratory Areas

At UNO, it is prohibited to consume food and drinks, to smoke, or to apply cosmetic materials in any laboratory area. It is also prohibited to store food in refrigerators that are used to store chemicals, and to use microwave ovens that are used for research purposes to heat food. Based on risk assessment performed by the UNO Laboratory Safety Officer, certain areas within a laboratory may be designated as appropriate to consume food and drinks.

General Housekeeping

Cleanliness and order in the laboratory work environment are the result of good laboratory housekeeping practices. These practices support safety in the laboratory. The following is a list of good housekeeping practices for laboratories:

- Chemicals must always be stored in their appropriate locations, not on the floor or in cabinets under the sinks.
- Chemicals must be stored by compatibility to avoid unwanted chemical reactions.
- Liquid chemicals must be stored within secondary containment.
- The floor, particularly high traffic areas, must be cleared of all trip hazards (boxes, electrical cords, loose paper, etc.) to prevent trips and falls.
- All spills must be contained, and the contaminated area should be decontaminated immediately according to the appropriate spill response procedures for each laboratory.
- All materials used to decontaminate spills must be discarded into the appropriate waste stream (ex. Materials used to decontaminate chemical spills must be disposed of as chemical waste in accordance with the UNO Regulated Waste Guidelines).
- Doorways, exits, fire extinguishers, emergency eyewash stations, and emergency showers must never be obstructed with items.
- Call UNO Facilities (504-280-6675) and EHSO (504-280-6675) if there is a spill. Follow the emergency response procedures listed in Section 12. Emergency Procedures below.

Use of Engineering Controls

Engineering controls are provided in UNO laboratories and are designed to protect users from hazards by physically separating the user from the hazard. The following is a list of engineering controls used at UNO and guidance regarding how they should be used.

- **Chemical Fume Hoods**
  Chemical fume hoods can be found in most research labs and should be used when pouring volatile chemicals or for procedures that have the potential to produce chemical vapors, dusts, or mists—all of which are inhalation hazards. Chemical fume hoods provide protection from chemical hazards only. Therefore, avoid working with biological agents in chemical fume hoods. When using a chemical fume hood, users must stand directly in front of the hood with the sash positioned at 18 inches or less from the work surface. Chemical fume hoods are always ducted. They provide protection by "pulling" air around the user and carrying both the air and harmful vapors through a series of ducts where they are exhausted outside of the building. Chemical fume hoods must also satisfy the following requirements:
    - They must be certified at least annually.
    - They must have a label that indicates the certification date, the due date for the next certification, and the signature or initials of the certifier.
    - They must operate at a flow date between 80-120 laminar feet per minute (lfm).

  - They should not be used for storage of chemicals, waste, or other materials.
  - The flow rate must not be affected by any materials or equipment inside.
  - The sash must not be broken or cracked.
  - If there is an audible alarm to alert malfunction, it must not be muted.

- **Biological Safety Cabinets (BSCs)**

  BSCs can be found in labs where biological agents are used for research. BSCs must be used when working with biological materials. Hazardous chemicals should not be used in BSCs as they provide minimal protection from most chemical hazards. Chemical use in BSCs can also damage the functioning of these types of hoods.

- **Gloveboxes**

  Gloveboxes are usually found in labs on campus that handle pyrophorics, water-reactive, or otherwise air-sensitive chemicals or materials. These are enclosed units with several openings and are usually under an inert atmosphere of noble gas. The user manipulates samples and equipment though arm-length gloves. When handling nanomaterials or particularly hazardous substances, the exhaust from these systems should be filtered or scrubbed before release.

- **Emergency Showers**
  Emergency showers must be available in all areas where hazardous chemicals are used. The showers are used if there is a chemical exposure to the body. At UNO, emergency showers are located either inside of the laboratories or in the hallways, and they must meet the following requirements:
  - They must be accessible within ten seconds of being exposed to a hazard.
  - They must provide 20 gallons of water per minute for 15 minutes.
  - They must be tested monthly (testing performed by a designee from the lab).
  - When tested, the date and initials of the tester must be documented.
  - They must never be obstructed from access.

- **Emergency Eyewash Stations**
  Emergency Eyewash Stations must be available in all areas where chemicals are used. In accordance with ANSI standards, eyewash stations must be hands-free operated and of the double ocular design. Eyewash stations are to be used if there is a chemical exposure to the eyes or face. At UNO, emergency eyewash stations can be located near most sinks inside of the laboratories or in the hallways. They must meet the following requirements:
  - They must be accessible within ten seconds of being exposed to a hazard.

        - This translates to no more than 55 feet away from the hazard.
    - They must provide 3 gallons of water per minute for 15 minutes.
    - They must be tested monthly (testing performed by a designee from the lab).
    - When tested, the date and initials of the tester must be documented.
    - They must never be obstructed from access.

- **Sinks**
  Sinks for hand washing must be available in all laboratory and laboratory-related areas. The following requirements must be met:
    - The sink area must always be stocked with soap and paper towels.
    - Sinks must be free of debris that could possibly lead to drain stoppage.
    - Surfaces in and around the sink should be free of chemical residue.

- **Sharps Containers**
  Sharps containers must be available in laboratories and laboratory-related areas where sharps (ex. Razor blades, syringes, scalpels, etc.) are used. For guidance on proper disposal of sharps, refer to the UNO Regulated Waste Guidelines at https://www.uno.edu/research/funding/compliance under Regulated Waste. The following requirements must be met:
    - The containers must be hard-walled and tightly lidded (alternative disposal containers are not acceptable).
    - The lid must be closed unless adding sharps to the container.
    - The biohazard symbol must be displayed on the outside of the container.

- **Broken Glass Disposal Boxes**
  Broken glass disposal boxes must be made available in laboratories and laboratory-related areas if there is a need to dispose of clean, broken glassware (ex. Beakers, flasks, graduated cylinders, etc.). The boxes can be purchased from a vendor. The box must: be labeled as "Broken Glass for Disposal," contain a thick, plastic liner, and must be able to be closed and secured for disposal. For guidance on proper disposal of broken glass boxes, refer to the UNO Regulated Waste Guidelines.

Hazard Assessment & Standard Operating Procedures

Hazard assessment is an important, ongoing process to help identify hazards, assess risks, and incorporate controls to eliminate hazards and reduce risk of accident or injury. One method of hazard assessment—a standard operating procedure (SOP)—is a step-by-step written procedure that documents how to complete a specific task both safely and effectively.

An SOP can be developed for a variety of tasks, including, how to complete a process, conduct a specific experiment, or use a specific hazardous chemical. The following should be included when writing SOPs:

- Administrative Information: PI name, lab contact, building, and room number, title of the procedure, the purpose of the procedure, and brief description of the process or experiment
- Experimental Information: step-by-step explanation of the process or experiment
- Safety Information: Control measures to protect against hazards (engineering controls, PPE), emergency procedures (spills, exposures)

SOPs are required to be written for processes that use hazardous chemicals. The procedures must be made available to all laboratory personnel for reference and training purposes. All laboratory personnel must be trained in applicable SOPs and must sign an agreement to follow them

Use of Personal Protective Equipment

Personal protective equipment (PPE) must be worn by employees when working with hazardous chemicals and when engineering controls do not provide adequate protection from hazards. Each PI/lab manager must complete the UNO PPE Assessment annually at a minimum, or whenever a new hazard is introduced into the laboratory.

The following requirements must be met regarding wearing PPE in the laboratory:

- Minimally, closed-toe shoes, long pants/skirts, lab coats/gowns, ANSI (Z87.1)-approved eye protection, and task appropriate gloves must be worn (for additional guidance, see Prudent Practices in the Laboratory).
- Where there is a potential for impact hazards, safety glasses must be worn.
- Where there is potential for splashing or the production of aerosols, splash goggles must be worn.
- Always inspect PPE prior to donning it to ensure that there are no holes, breaks, or tears that will lead to an exposure.
- If PPE is disposable, use once and discard into the appropriate laboratory waste stream.
- Always wear the correct size and fit to avoid removal and/or damage while wearing.
- If PPE can be reused, it must be cleaned and stored appropriately after use.
- PPE must be removed prior to leaving the laboratory.
- PPE must not be worn in areas outside of the laboratory (ex. Break rooms, bathrooms, eating facilities, etc.)
- If respirators must be worn (ex. N95 particulate masks, air-purifying, self-contained breathing apparatus), the following is required:
    - Training

- Medical Clearance
- Fit Testing

Security

Laboratory areas contain hazardous chemicals, expensive equipment, and important research documentation; therefore, security measures should be implemented when possible. Potential security risks include, but are not limited to, the following:

- Theft of computers, electronics, and other expensive equipment.
- Theft, misuse, and/or intentional release of hazardous chemicals.
- Demonstrations from activist groups.
- Inappropriate use or loss of sensitive/confidential information.
- Unauthorized laboratory experimentation.

To prevent security breaches in laboratory areas, it is important to secure all doors appropriately. This can be accomplished by closing and locking all doors during periods of inactivity.

Transportation of Hazardous Chemicals

Department of Transportation (DOT) regulates the transportation of hazardous materials. Personnel involved in the transportation of these materials must be trained to ensure that the material is packaged safely.

There is an exception that covers many hazardous materials known as the "materials of trade" (MOT) exemption. Under the MOT exemption, there is a limit to what can be transported based on the quantity, hazard class, and packing group.

Under the MOT exemption, the material being transported must be used for the following purposes:

- To protect the health and safety of the vehicle operator or passengers (ex. Fire extinguishers, flares, or insect repellant);
- To support the operation or maintenance of the vehicle (ex. Fuel additives, spare batteries, gasoline);
- To support the principal business of a private motor carrier (ex. Landscapers, painters, or other businesses carrying supplies).

All MOT transports or shipments must comply with the hazard class and quantity limitations specified by the DOT. Allowable hazard classes include:

- Flammable Liquids (Class 3);
- Corrosives (Class 8);
- Miscellaneous Hazardous Materials (Class 9);
- Toxic (Poison) (Class 6, Division 6.1);
- Oxidizers (Class 5, Division 5.1).

The allowable quantity limitations under the MOT exemption are as follows:

- 1 lb or 1 pint of Packing Group I Materials;
- 66 lbs or 8 gallons of Packing Group II Materials;
- 440 lbs aggregate gross weight of all MOTs in a motor vehicle.

MOTs must be:

- In the manufacturer's original packaging or a package of equal strength and integrity;
- Packaged in leak-tight containers for liquids and silt-proof containers for solids;
- Securely closed, secured against movement, and protected from damage;
- Marked with the proper shipping name or common name.

Explosives, radioactive materials, and compressed gas cylinders are not permitted in private motor vehicles.

Before shipping hazardous chemicals, contact the UNO Laboratory Safety Officer for assistance with determining if the package is regulated and the requirements for shipping.

Disposal Practices for Waste Materials

Proper disposal of chemical waste includes the following general steps (including, but not limited to):

- Dispose of contaminated materials in UNO Laboratory Safety Officer-approved containers.
- If a compatible container was previously used for storing something other than waste, the original label must be removed or defaced prior to use as a waste container.
- Ensure that each container has the UNO Hazardous Waste Label and any applicable pictograms attached to it.
- Fill out the UNO Hazardous Waste Label and apply the pictograms when the waste is first added to the container.
- Ensure that all waste containers are closed unless actively adding waste.
- Schedule a Hazardous Waste pickup in SciShield and waste will be removed from your location.

For further guidance on the disposal of all chemical waste and other regulated waste streams at UNO, refer to the UNO Regulated Waste Guidelines.

8. Hazard Identification

Some chemicals have inherent properties that can produce hazards or adverse effects, and therefore have been defined by OSHA as hazardous.

Hazardous chemicals can be distinguished by four basic characteristics:

- Flammability
- Corrosivity
- Reactivity/Instability, and
- Toxicity

Laboratory personnel must be able to identify hazardous chemicals and understand their properties. In addition, a current hazardous chemical inventory shall be available in SciShield to keep track of which hazardous chemicals are on hand and the amounts available.

Chemical inventory information must be available at all times and kept up to date in SciShield.

Classifying the hazards of a mixture depends on the information available for each component and the mixture itself. Generally, if a mixture's components are hazardous, then the mixture is assumed to be hazardous. Mixtures diluted with solvents of equal or lower toxicity are assumed to have hazards of the original mixture. Mixtures that have components with a range of hazards are assumed to have all of those known hazards.

Safety Data Sheets (SDSs)

One of the most critical prerequisites for lab personnel when working with hazardous chemicals in the laboratory is having the ability to recognize or identify them. It is every employee's right to know the hazards associated with their work and what can be done to protect themselves from those hazards. Hazard identification at UNO is made possible by three main methods: reading the SDSs, chemical labeling, and laboratory signage.

SDSs are documents that are made available by the manufacturer with every hazardous chemical. These documents provide specific information regarding the specific properties of the chemical and guidance for the storage, use, and handling of the chemical. SDSs also provide information on what PPE should be worn while using the chemical, as well as suggestions on what should be done in emergency situations involving the chemical.

In keeping with the OSHA Laboratory Standard, the following are required regarding SDSs:

- Facilities must maintain any SDSs that correspond to chemicals in their area in SciShield.
- All personnel must know how to access and/or locate SDSs in the work area and be given access to SciShield where applicable.
- All personnel must read and understand the content of SDSs for each chemical that is to be used in their work.
- Labs can maintain hard copies of SDS.
- Labs must post signage indicating where the SDSs are located for their area.

Laboratory Signage

At UNO, the entrance to all laboratories and laboratory-related work areas are required to be posted with laboratory signage. Each sign lists the emergency contacts of the lab as well as the chemical hazards that are found inside the lab. If there are multiple occupants in the lab, the sign displays the total combined hazards from all occupants. Once space hazards are updated in SciShield, the program shall be used to generate a door sign for each laboratory space at UNO.

Chemical Labeling

Labeling is essential in the identification of all chemical substances, both hazardous and non-hazardous. Effective labeling prevents confusion when distinguishing between containers with chemical substances. In the lab, there are two types of chemical labeling that are mandatory:

- Labeling of incoming (commercial) containers of chemicals (whether purchased from a manufacturer or received from another entity), and
- Labeling of laboratory containers (includes beakers, flasks, bottles, glass tubes, etc.).

All commercial containers of chemicals must meet the following requirements regarding labeling:

- The label must contain the full chemical name and/or signal word, hazard statement, pictogram (immediate visual recognition), precautionary statements, and the manufacturer's contact information.
- The label must be in English.
- The label must be legible.
- The label must never be removed, altered, or obscured in any way.

All laboratory containers that contain chemicals must be legibly labeled in English and meet the following requirements:

- The container must have the full chemical name, preferably the name from the stock bottle (abbreviations, chemical formulas, and chemical structure drawings are not sufficient). – ex. Ethanol
- If the chemical is hazardous, the label must include the hazard(s). If the container is small, the primary hazard should receive precedence. – ex. Flammable
- If there is more than one chemical in the container, the label must include the chemical name of each chemical, and of each hazard, as applicable and feasible.
- The label must only be removed when the container is empty.

Note: There is only one exception to the labeling requirements. Labeling is not required for a laboratory container only if the total volume of material in the container will be used immediately in an experiment (during the work shift).

Global Harmonization System (GHS) Pictograms

OSHA has aligned the Hazard Communication Standard (HCS) with the Global Harmonization System (GHS), an international chemical classification system. The GHS is the system used for the classification of health, physical, and environmental hazards. GHS specifies the information that must be included on chemical labels and SDSs to communicate hazard information.

To ensure a safe workplace, information about the identify and hazards of the chemicals must be available. The OSHA pictograms in the table below conform to GHS and are used worldwide. These pictograms are required to be on all stock bottles of chemicals where they apply.

Some hazard classes such as flammables, oxidizers, and carcinogens follow a GHS hierarchy, but the same pictogram is used to represent that hazard on the chemical label. Each hazard class uses hazard statements and signal words to organize the hazard information from high hazard to low hazard.

Pictogram	Distinct Hazard	What it Means	Hazard Classes
	Exploding Bomb	This chemical can react instantaneously, releasing large amounts of gas and/or heat.	• Explosives • Self-Reactive • Organic Peroxides
	Flame	This chemical and/or its vapor can ignite easily and could burst into flames.	• Flammable Liquids • Combustible Liquids • Pyrophorics • Self-Heating • Flammable Gas • Flammable Solids • Emitters • Self-Reactive • Organic Peroxides

Pictogram	Distinct Hazard	What it Means	Hazard Classes
	Flame over Circle	This chemical is oxidizing. It can react with other materials causing them to ignite, burn, or explode.	• Oxidizing Liquids • Oxidizing Solids • Oxidizing Gases
	Corrosion	This chemical can cause serious damage to skin and eyes. It can also destroy clothing, working surfaces, and metal.	• Acids • Bases • Some Organic Solvents
	Skull and Crossbones	Exposure to this chemical can cause possibly serious health problems. This chemical is highly toxic in small quantities.	• Acute Toxins
	Health Hazard	Prolonged or chronic exposure to this chemical can cause health problems including, but not limited to: cancer, asthma, birth defects, or infertility.	• Carcinogens • Mutagens • Teratogens (Reproductive Toxins) • Respiratory Sensitizers Target Organ Toxins • Aspiration Toxins

Pictogram	Distinct Hazard	What it Means	Hazard Classes
	Exclamation Mark	Exposure to this chemical may cause immediate health effects including, but not limited to: skin rash, contact dermatitis, respiratory irritation, eye irritation, and chronic or prolonged exposures can lead to possible allergy.	• Irritants (Eye and Skin) • Skin Sensitizers • Respiratory Tract Irritants
	Gas Cylinder	If the container is ruptured, leaking, or heated, it can explode.	• Compressed Gas or Gases Under Pressure
	Environment and Aquatic Toxicity	This chemical can cause damage to aquatic organisms. This includes, but is not limited to: fish, crustaceans, and aquatic plants.	• Compounds known to cause injury to aquatic organisms or bioaccumulate in aquatic environments

Table 2. GHS Pictograms

Permissible Exposure Limits (PELs)

OSHA regulates the use of some hazardous chemicals and assigns permissible exposure limits (PELs) for their use, as specified in 29 CFR 1910, Subpart Z. These limits are set to protect individuals using the chemicals from overexposure, which has the potential to cause adverse effects. When regulated chemicals are used in the lab, the PELs must never be exceeded.

For any OSHA Health Standard, controls are implemented to prevent skin or eye contact and limit employee exposure to the specific PEL.

OSHA also uses action levels to indicate the concentration of a harmful or toxic substance/activity that requires an employer to start medical surveillance, exposure monitoring, or biological monitoring.

When an action level or PEL is unavailable, it is supplemented with relevant exposure limits from national consensus standards such as the Threshold Limit Value (TLV) of the American Conference of Governmental Industrial Hygienists (ACGIH) or the Recommended Exposure Limits (RELs) of the National Institute for Occupational Safety and Health (NIOSH).

For laboratory use of OSHA regulated substances, the PELs must never be exceeded.

Exposure assessments, exposure monitoring, and medical surveillance programs may be necessary to limit exposure to chemicals which present a health hazard. Exposure assessments and monitoring are conducted based on duration of use, frequency of use, and concentration. Some OSHA Health Standards require monitoring if it is believed that the PELs or action levels of these chemicals are being routinely exceeded. The results of initial monitoring will disclose if employee exposures are over the action level or PEL. In those instances, UNO may need to perform additional monitoring or medical surveillance activities as required by the relevant OSHA health standard.

If using regulated chemicals in the lab, and there is a reasonable expectation that the PELs of these chemicals are routinely exceeded, contact the UNO Lab Safety Officer. A risk assessment must take place. Since each regulated chemical has unique requirements, the risk assessment may involve exposure monitoring, to be conducted in accordance with the applicable OSHA standard. If monitoring has been completed, the monitored employee will be notified in writing within 15 days.

Monitoring is terminated when it is determined that exposure levels fall below the established PEL or action level.

Participation in the Respiratory Protection Program may be necessary to maintain employee exposure below PELs or action levels. The appropriate respiratory equipment must be provided upon completion of respiratory fit testing, training, and medical clearance. Contact the UNO Lab Safety Officer if you believe you may need to be added to the Respiratory Protection Program.

To ensure employees and other interested parties are aware of the occupational exposure limits that OSHA uses to protect workers, the following link is a table with OSHA PELs and the comparable consensus standards from NIOSH, ACGIH, and California Occupational Health and Safety (CAL/OSHA).

OSHA Permissible Exposure Limits

9. Hazardous Chemicals – Safe Handling, Storage, & Use

Chemicals are used in most laboratories at UNO. In addition to being informed about chemical hazards, it is also important that lab personnel are able to put their knowledge into practice while performing their daily duties.

When working with chemicals, all lab personnel employ the following general practices:

- Store all chemicals according to compatibility groups. (ex. Acids must not be stored with bases.)
- Do not mix chemicals that are not compatible with one another.
- Minimize the volume of chemicals used where possible (only use what is needed).
- If a less hazardous chemical can be used to achieve the same results as a highly hazardous chemical, use the less hazardous chemical.
- When pouring chemicals, use them inside a chemical fume hood as much as feasible.
- Always wear appropriate PPE.

Flammable Materials

If misused, handled, or stored incorrectly, flammable materials can cause fires in the presence of oxygen and an ignition source.

Examples: ethanol, diethyl ether, methane, and xylene.

Flammable and Combustible Liquids

A flammable liquid is any liquid that has a flash point below 100°F and a vapor pressure that does not exceed an absolute pressure of 40 pounds per square inch (psi) at 100°F. A combustible liquid is any liquid that has a flash point at or above 100°F.

Flammable Solids

A flammable solid is any solid substance other than a blasting agent or explosive that can cause fire from friction or retained heat from manufacture, that has an ignition temperature over 212°F, or that burns so vigorously or persistently when ignited that it creates a hazard.

Flammable Gases

A flammable gas is a material that is a gas at 68°F or less at an absolute pressure of 14.7 psi, can be ignited at an absolute pressure of 14.7 psi when in a mixture of 13 percent or less with air, or has a flammable range at 14.7 psi with air of at least 12 percent, regardless of lower explosive limit (LEL). Above the defined upper explosive limit (UEL), the vapor in air is too rich to propagate a flame. Flammable gases are usually found in compressed gas cylinders, and if there is a leak or any escape from the cylinder, an explosion hazard can be created in the work area.

Flammables	
GHS Hazard Symbol	
Storage Requirements	Flammables must be stored in cabinets that help to protect the material from fire. In the event of a fire, the flammable liquids cabinet will contain and protect the material from fire. Labs may also utilize the flammable liquid storage areas under the Chemical Fume Hoods inside the laboratories. If the space under the chemcial fume hood is inadequate, liquid containers must be stored in an NFPA- and OSHA-approved flammables cabinet with the appropriate warning labels. If stored in places other than the NFPA- and OSHA-approved flammables cabinet, the volume must not exceed 16 liters (approximately 4 gallons) within 100 square feet of lab space. If the materials must be refrigerated, ensure that flammable and volatile liquids are stored in a flammable materials refrigerator or they must be stored in explosion proof refrigerators. Never store these materials inside of conventional refrigerators or freezers.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Flammables are incompatible with oxidizers and must be stored separately. Flammables and oxidizers can be physically separated by the use of secondary containment. Avoid ignition sources such as open flames, hot plates, sparks, etc. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Lab personnel should wear flame-resistant lab coats, safety glasses, and gloves. In addition, personnel must wear closed-toe shoes and long pants. Personnel should also refrain from wearing clothing made of synthetic fibers when working with chemicals at high risk of ignition.

Flammables	
Emergency Procedures	In the event of a fire, lab personnel must be aware of the location of the nearest fire extinguisher. In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed. Seek medical attention following rinsing. In the event of a spill, alert personnel in the area. Contact EHSO for assistance with spill cleanup. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in SciShield.

Table 3. Flammables

Compressed Gases

A flammable gas is a material that is a gas at 68°F or less at an absolute pressure of 14.7 psi, can be ignited at an absolute pressure of 14.7 psi when in a mixture of 13 percent or less with air, or has a flammable range at 14.7 psi with air of at least 12 percent, regardless of lower explosive limit (LEL). Above the defined upper explosive limit (UEL), the vapor in air is too rich to propagate a flame. Flammable gases are usually found in compressed gas cylinders, and if there is a leak or any escape from the cylinder, an explosion hazard can be created in the work area.

Compressed Gases	
GHS Hazard Symbol	

Compressed Gases	
Storage Requirements	Proper storage of gas cylinders is paramount to the safety and health of anyone using compressed gas cylinders. Follow these simple guidelines to ensure that cylinders are guarded against damage: • Store cylinders upright in well-ventilated areas and out of inclement weather. • Place cylinders in a location where they will not be subject to damage, heat or electrical contact. Do not store cylinders in exits or egress routes, like public hallways or other unprotected areas. • Store gases with the same hazard class in the same area. Inert gases are compatible with all other gases and may be stored together. • Mark the storage area with proper precautionary signs, such as no smoking, fuel gas storage, or oxidizer storage. • Properly secure tanks to a stable object using chains, straps, or cages. Fix or secure tanks at approximately 2/3 the height of the cylinder—secured above the midpoint but below the shoulder. Cylinders less than 18" tall may be secured by approved stands or wall brackets. • Never store acetylene cylinders on their sides. • Completely close the valves, and keep the valve protection caps on cylinders when not in use or attached to a system. • Keep oxygen cylinders at least 20 ft. away from all flammable, combustible, or incompatible substances. • Store empty cylinders separately from full cylinders. • Ensure that empty tanks are labeled or tagged indicating that the tank is “empty” and that the valves are closed with the protective cover in place.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Most accidents or injuries involving cylinders happen when moving or handling gas cylinders. Use the right equipment, follow the correct procedures, and use the sufficient number of personnel to lift or move cylinders to avoid personal injury and cylinder damage. **Handling and Use Requirements** • Keep cylinders upright and away from heat, sparks, fire, physical damage, or electrical circuits to avoid rupture. • Clean valves of any dust or dirt before attaching the regulator and always use the correct regulator for the specific gas intended.

Compressed Gases	
Work Practices (cont.)	• Never force connection fittings and do not tamper or alter the regulators. • Stand off to the side of the cylinder when opening a valve. • Inspect the regulator and cylinder valves for grease, oil, dirt, and solvent. Never use grease or oil to lubricate regulators or cylinder valves because they can cause an explosion. • Position the cylinder so that the valve handle at the top is easily accessible. • When using toxic or irritating gas, the valve should only be opened while the cylinder is in a working fume hood. • Always open valves slowly and only use wrenches or tools that are provided by the cylinder supplier. Never use screwdrivers or pliers to open a cylinder valve. • Use in a well-ventilated area to avoid gas accumulation. • Do not bring cylinders into a confined space. • Never use copper fittings or tubing on acetylene tanks—an explosion may result. • Close the cylinder valve and release all pressure before removing the regulator from the cylinder. • Never leave pressure in a regulator when it is not in use. • If you suspect that a cylinder is leaking, use soapy water. Never use a flame to detect a gas leak. **Transport Requirements** • Wear protective footwear, safety glasses or goggles, face-shield, and protective gloves specific to the hazard of the chemical in the cylinder. • Transport cylinders in a special cylinder cart and make sure the cylinder is securely in place before moving it. Never drag, slide, or roll a cylinder. • Always have the protective cap securely in place (for cylinders that accept caps). Never transport the cylinder with the regulator attached. • Do not drop cylinders or strike them against each other. • Never use the valve cover to lift cylinders; they could be damaged and become unattached. If the cylinder is dropped on a hard surface it can cause an explosion. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.

Compressed Gases	
PPE	Ensure that personnel handling or using compressed gas cylinders wear PPE appropriate for the specific hazards of the cylinder or its contents, including: • Eye protection – safety glasses or goggles • Foot protection – closed-toe or steel-toe shoes or boots • Face protection – face shield • Hand protection – gloves
Emergency Procedures	In order to quickly close the valve in the event of an emergency, keep wrenches and other recommended tools on the valve while the container is in use. Ensure emergency showers and eyewash fountains are available in areas where corrosive gases are used. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in SciShield.

Table 4. Compressed Gases

Corrosives

Corrosive chemicals produce destruction of skin tissue, namely visible necrosis through the epidermis and into the dermis. Corrosive effects not only occur on the skin but can also affect the eyes and respiratory tract. Corrosives can be acidic or basic in nature and can also destroy (or react with) plastics, metals, and other materials when contact occurs. Strong dehydrating agents and strong oxidizing agents can also have corrosive effects on the skin and eyes.

Examples: sulfuric acid, hydrochloric acid, phosphorus pentoxide, concentrated hydrogen peroxide, and sodium hydroxide.

Corrosives	
GHS Hazard Symbol	
Storage Requirements	Containers should be stored in corrosive cabinets. Containers must be stored in secondary containment. Secondary containment must be able to: • Contain the volume of material in the event of a spill • Resist corrosion of the material (ex. Polypropylene bins) Acids and bases must be stored separately from one another, below eye level, and preferably inside of a corrosives cabinet. Secondary trays or containers must be used to separate incompatible acids within the corrosives cabinet.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. When mixing concentrated acids with water, add the acid slowly to the water and mix slowly to avoid splattering and possible chemical reaction. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Ensure that personnel handling or using compressed gas cylinders wear PPE appropriate for the specific hazards of the cylinder or its contents, including: • Eye protection – safety glasses or goggles • Foot protection – closed-toe or steel-toe shoes or boots • Face protection – face shield • Hand protection – gloves

Corrosives	
Emergency Procedures	In order to quickly close the valve in the event of an emergency, keep wrenches and other recommended tools on the valve while the container is in use. Ensure emergency showers and eyewash fountains are available in areas where corrosive gases are used. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in SciShield.

Table 5. Corrosives

Oxidizers

Oxidizers are chemicals that readily yield oxygen or other oxidizing gas, or that readily react to promote or initiate combustion or combustible materials. The main hazard of oxidizers is that they accelerate the rate of combustion in fires. Oxidizing gases pose a unique hazard because they can become concentrated in a room or poorly ventilated space. Oxidizers can lower flash points and ignition temperatures of flammable gases and liquids. When working with oxidizers, it is important to remember that they must not be stored around fuels or any other flammable/combustible materials. Some of the common types of oxidizing compounds include: Bromine, Bromates, Nitrates, Nitrites, Chlorates, Chromates, Hydroperoxides, Hypochlorites, Inorganic Peroxides, Perchlorates, Periodates, Permanganate, and Persulfates.

Oxidizers	
GHS Hazard Symbol	
Storage Requirements	Oxidizers must be physically separated from flammable and combustible materials as well as ignition sources. Oxidizers must be physically separated from reducing agents such as formic acid, zine, and alkaline metals.

Oxidizers	
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Special care should be taken when oxidizing compressed gases are used to ensure that gauges, piping systems, gas lines are free of contamination. Gases should be used inside of a chemical fume hood or well ventilated space if possible. Combine oxidizers with other materials according to established protocols. Avoid using oxidizing chemicals outside of accepted temperature ranges. Collect waste from oxidizing materials into an inert container such as glass or plastic. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines.
PPE	Lab personnel should wear flame-resistant lab coats, safety glasses, and gloves. In additon, personnel must wear closed-toe shoes and long pants.
Emergency Procedures	In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where oxidizers are used. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in SciShield.

Table 6. Oxidizers

Water Reactive Chemicals

Water-reactive chemicals react violently with water to produce a gas that is flammable or poses a health hazard. Some materials also produce flammable hydrogen gas which can cause fires or explosions when in the presence of air. Store water-reactive chemicals away from water and moisture and ensure they are kept dry.

Examples: lithium metal, sodium metal, magnesium powder, and zinc powder.

Water Reactives	
GHS Hazard Symbol	
Storage Requirements	Avoid storing reactive chemicals near flammable material. Store according to the SDS. An inert gas-filled desiccator or glove box are suitable storage locations.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Specific SOPs for experiments using these chemicals must be written and available to lab employees who will conduct the experiments. These SOPs must be stored in the Lab Safety Binder. Handling water-reactive material is considered a high-risk activitiy. Lab personnel must receive adequate training and supervision before being allowed to work with water reactive chemicals. Lab personnel must demonstrate proficiency in proper lab technique before working without direct supervision. Ensure that water reactives are used in an inert atmosphere that excludes air or moisture. Glove boxes are an engineering control and containment device that can be used for this purpose. Transferring water-reactive compounds from the parent container into a secondary container must be done using small volumes or an engineered system. A blast shield must be used if working inside or outside of the chemical fume hood. The sash position of the fume hood must be at the lowest position feasible. Do not return excess chemical to the original containers. Small amounts of impurities can be introduced into the container that may cause a fire or explosion. Empty containers should be rinsed three times with inert, dry, compatible solvent. The rinse solvent must be added and removed from the container in an inert atmosphere. The rinse solvent must be neutralized. Collect waste from water-reactive materials into an inert container such as glass or plastic. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.

Water Reactives	
PPE	Gloves must be worn when working with water-reactive chemicals. Disposable nitrile gloves provide adequate protection for handling small quantities. If prolonged or direct contact with a chemical is required, then labs should contact the UNO Laboratory Safety Officer for advice on chemical-resistant gloves. Safety goggles, flame-resistant lab coat, and gloves must be worn. In addition, synthetic clothing is strongly discouraged; cotton or wool clothing is strongly recommended. Closed-toe shoes must be worn. Lab coats need to be buttoned and fit properly to cover as much skin as possible.
Emergency Procedures	In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where water reactives are used. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in SciShield.

Table 7. Water Reactives

Pyrophorics

Pyrophoric chemicals spontaneously ignite in the air due to rapid oxidation by oxygen or moisture in the air. They should be stored in an inert environment and away from flammable/combustible materials and oxidizers.

Examples: tert-butyl lithium, silane, and white or yellow phosphorus.

Pyrophorics	
GHS Hazard Symbol	
Storage Requirements	Pyrophoric materials must be stored in tightly closed containers under an inert atmosphere or liquid. All transfers and manipulations of them must also be carried out under an inert atmosphere or liquid.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Specific SOPs for experiments using these chemicals must be written and available to lab employees who will conduct the experiments. These SOPs must be stored in the Lab Safety Binder. Employees must be trained on the SOPs and training completion must be recorded. Individuals working with pyrophorics must never work alone. Perform activities in a glove box or chemical fume hood. If working inside the fume hood, use a blast shield. Reactions need to be carried out using glass apparatuses infused with inert gas such as nitrogen or argon. Laboratory glassware should be warmed in an oven to remove any moisture prior to contact with air-sensitive reagents. Transfer small quantities of air-sensitive reagents using oven-dried syringes and needles. On-hand quantities must be minimized in laboratories, and the smallest amounts possible must be used in experiments. Ensure that air-sensitive reagents are disposed of properly. Never leave waste containers open and exposed to the atmosphere. Unwanted or unused reagents must be hydrolyzed or neutralized prior to disposal. All materials including gloves, paper towels, and wipes that are contaminated must be treated as hazardous waste. Remove residue from needles, syringes, and other equipment before storing.

Pyrophorics	
Work Practices (cont.)	Collect waste from pyrophoric materials into an inert container such as glass or plastic. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Required PPE includes flame-resistant lab coats, face shields in conjuction with safety glasses, and nitrile gloves.
Emergency Procedures	In the event of a fire, Class D fire extinguishers are needed for combustible metals. The standard fire extinguisher can be used for other reagents. In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where pyrophorics are used. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 8. Pyrophorics

Peroxide-Forming Chemicals

Peroxide-forming chemicals (PFCs) form peroxides upon exposure to oxygen in the air over time. Accumulated peroxides can explode upon exposure to heat, friction, or force/impact. Violent reactions can be initiated by light, heat, introduction of a contaminant, oxygen, or the loss of an inhibitor. Some PFCs have inhibitors such as butylated hydroxytoluene (BHT) to slow the formation of peroxide crystals. Most peroxide crystals are sensitive to heat, shock, or friction. Accumulation of peroxide crystals can cause explosions.

Some examples of PFCs include, but are not limited to:

- **Can form explosive levels of peroxide within 3 months:**
  - Butadiene
  - Isoproyl Ether
  - Tetrafluoroethylene
- **Can form explosive levels of peroxides within 12 months:**
  - 2-Butanol
  - 2-Propanol
  - Cyclohexene

- **Can auto polymerize as a result of peroxide accumulation:**
  - Acrylonitrile
  - Vinyl Chloride
  - Vinyl Pyridine

Organic Peroxides	
GHS Hazard Symbol	
Storage Requirements	Visually inspect containers for visual discoloration, crystal formation, or liquid stratification. If any of these conditions are observed, do not attempt to open or move the container. Store containers in a cool, dark area and avoid heat/ignition sources. Unopened containers are typically stable for up to 18 months when stored in cool, dark locations. Once a container reaches the expiration date, the chemical must be transferred to the Hazardous Waste Room. Always date the container upon receipt and upon opening. Opened containers should be disposed of through EHSO after 6 months.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Specific SOPs for experiments using these chemicals must be written and available to lab employees who will conduct the experiments. These SOPs must be stored in the Lab Safety Binder. Employees must be trained on the SOPs. Work with PFCs in a chemical fume hood. Maintain the sash height as low as feasible to provide physical barrier and prevent fumes from escaping. Carefully monitor processes involving PFCs (ex. Distillation) to ensure that process does not dry out and overheat. Always handle containers carefully, even if unopened.

Organic Peroxides	
Work Practices (cont.)	Never force open a cap that becomes stuck on a PFC. Do not attempt to move or open a container if there are visible crystals around the lid, inside the container, or if the container is deformed; opening the lid could cause an explosion. If the container tests positive for peroxides then the chemcial must be disposed of by containing the UNO Laboratory Safety Officer. Labs should purchase peroxide formers with inhibitors added by the manufacturer, when possible. Containers can be periodically tested with peroxide strips. Chemical fume hoods or other exhaust ventilation must be used. Blast shields should also be available if the reaction will be vigorous. Collect waste from organic peroxides into an inert container such as glass or plastic. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Required PPE includes flame-resistant lab coats, face shields in conjuction with safety glasses, and nitrile gloves.
Emergency Procedures	In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. In the event of a spill, alert all personnel in the area and contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where organic peroxides are used. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 9. Organic Peroxides

Explosive Materials

OSHA defines an explosive as any chemical, mixture, or device, for which its primary or common purpose is to function by explosion and with a substantial instantaneous release of gas and heat. There are other materials commonly used in laboratories that have the potential to explode when dry or when exposed to shock or heat. These materials are not typically found in the laboratory setting; however, there are other materials commonly

used in laboratories that have the potential to explode when dry or when exposed to heat or shock.

Examples of explosive materials in laboratories include, but are not limited to, peroxide-forming chemicals, chemicals whose name includes “azide” or “nitro”, (dry) benzoyl peroxide, and (dry) picric acid. Explosive materials also include compounds containing functional groups azide, acetylide, diazo, nitroso, haloamine, peroxide, and ozonide.

Explosive Materials	
GHS Hazard Symbol	
Storage Requirements	When storing, always date the containers when received and opened. Be aware of any potential explosive compounds that appear to exhibit the following signs or characteristics: • Deterioration of the outside of the container. • Precipitate formation either in or outside of the container. • Discoloration of the chemical.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Specific SOPs for experiments using these chemicals must be written and available to lab employees who will conduct the experiments. These SOPs must be stored in the Lab Safety Binder. Employees must be trained on the SOPs. Safety shielding must be used for any operation having the potential for explosion, especially in the following circumstances: • When a reaction is attempted for the first time. • When a familiar reaction is carried out on a larger-than-usual scale (ex. 5-10 times more material). Use the smallest quantities possible in experiments. Amount of explosives should be used in quantities of less than 1 gram. Work should always be done in a chemical fume hood (may be necessary to use a properly rated safety shield).

Explosive Materials	
Work Practices (cont.)	Blast shields must be placed so that all personnel in the area are protected. Conduct experiments in a designated area. Signage should be used to indicate that explosives are in use. Ensure that potentially explosive material remains labeled at all times. Be sure to remove any excess equipment and other chemicals (particularly highly toxic and flammable) away from the immediate work area. Avoid using metal devices when transferring potentially explosive compounds (to reduce the chance of creating a spark). Solid waste should be generated to minimize the potential for detonation. Limited amounts of organic waste may contain explosives. Collect waste from explosive materials into an inert container such as plastic. Containers must be stored in secondary containment. Explosive wastes must be stored separately from other waste. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Always wear a flame-retardant lab coat, safety glasses, and full face shield when performing any reactions that may lead to explosion. Consider blast protective clothing depending on the amounts and stability of compounds used.
Emergency Procedures	In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where explosive materials are used. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 10. Explosive Materials

Cryogenic Materials

Cryogenic materials are liquefied gases that have a boiling point of less than -130°F at an absolute pressure of 14.7 psi. Cryogens are extremely cold, and direct exposure to the liquids or vapors causes frostbite to skin or can cause materials to become weakened and/or brittle. There are several other hazards associated with cryogens, which include, but are not limited to:

- Asphyxiation – caused by rapid expansion of liquid to gas inside enclosed areas to create an oxygen-deficient environment.
- Pressure build-up – caused by rapid expansion of liquid to gas inside of a vessel.
- Fire or explosion – caused when cryogenic liquids such as oxygen and hydrogen and flammable gases combine in air to create an oxygen-rich environment. In the presence of flammable materials, the potential for fire/explosion becomes greater.

Examples of cryogenic material include but are not limited to: inert gases (ex. Nitrogen, helium, neon), flammable gases (ex. Hydrogen, methane), and oxygen.

Cryogenic Materials	
GHS Hazard Symbol	
Storage Requirements	Do not store containers where they may come into contact with moisture. Store all cryogenic liquid containers upright in well-ventilated areas. Handle them carefully, and avoid dropping, rolling, or tipping them on their sides. Containers must be able to withstand extreme cold temperatures without becoming brittle or weakened. Cylinders containing cryogens must be equipped with pressure release valves. Store cylinders and use liquids in a well-ventilated area.

Cryogenic Materials	
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Ensure that ice does not form in the neck of flasks. Dewar flasks are not pressure vessels, so if the opening is blocked, pressure can slowly build up. Eventually, the pressure may cause a violent rupture. If the neck of the Dewar flask is blocked by ice or "frozen" air, follow the manufacturer's instruction for removing it. Ice can also cause pressure relief valves to malfunction or become blocked. Keep Dewar flasks covered with a loose-fitting cap. This method prevents air or moisture from entering the container, yet allows pressure to escape. Use only the stopper or plug supplied with the container. Do not stand over a dewar or liquid gas containing aparatus for extended periods. This is to reduce the risk of loss of conciousness due to inhalation of escaped vapors. When transferring from one container to another, always pour slowly to prevent splashing or boiling. Never overfill vessels or containers with cryogenic liquids to avoid rupturing (rapid expansion of gas). Always start filling slowly to allow the vaporization to chill the receiving container. After the vaporization and liquid boiling has decreased, fill the container at the normal rate. Never fill containers higher than the indicated level. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	When handling, wear PPE that protects against splashing and extreme cold temperatures (cryogenic gloves, splash goggles, face shield, long sleeves, and lab coat). Use tongs or proper gloves to handle objects that are in contact with cryogenic liquids.
Emergency Proceedures	If contact does occur, immediately flush the area with large quantities of warm (not hot) water. If the skin is blistered or the eyes have been exposed, obtain medical attention immediately. In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where cryogenic materials are used. In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed

Cryogenic Materials	
Emergency Procedures (cont.)	and disposed of as hazardous waste. Seek medical attention following rinsing. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 11. Cryogenic Materials

Light Sensitive Materials

Light sensitive materials are chemicals that undergo changes or degradation or may react when exposed to light. Some reactions could result in the production of hazardous byproducts or building of pressure inside the container. Store these materials in a cool, dry place away from exposure to light.

Non-Ionizing Radiation

Lasers

Laser devices and laser systems are types of equipment that emit intense laser light by stimulated emission. These high-energy devices can be divided into one of several categories from Class I to Class IV, with Class 1 lasers being the least hazardous, and Class 4 being the most hazardous. Of concern are the lasers that are classified as Class IIIB and Class IV, as they have the potential to cause severe injury to the eyes and skin, and in the most extreme cases, can cause fires and explosions. Class IIIB and IV lasers are used on UNO's campus in various forms of research. For more guidance on the safe use of Class IIIB and Class IV lasers, access the Laser Safety Guidelines, available at https://www.uno.edu/research/funding/compliance under Laser Safety.

Ultraviolet Radiation

Ultraviolet radiation comes from various sources, and it can be hazardous to both the eyes and skin if exposure is not minimized. Most individuals are exposed to UV radiation, primarily from direct sunlight. However, in laboratory settings, there are other sources of UV radiation that are far more concentrated, which makes exposure more hazardous. Therefore, it is very important to use control measures to limit exposure. For more guidance on the safe use of UV radiation, access the UV Radiation Safety Fact Sheet, available at https://www.uno.edu/research/funding/compliance under Lab Safety Fact Sheets.

Ionizing Radiation

Ionizing radiation has sufficient energy to ionize atoms and the potential to cause damage to living tissue. Forms of ionizing radiation include alpha particles, beta particles, gamma rays, x-rays, and neutrons. Ionizing radiation is used in research laboratories in the form

of radioactive isotopes. Examples include, but are not limited to: phosphorous-32, iodine-125, sulfur-35, and tritium. For more guidance on the safe use of ionizing radiation, access the Radioactive Materials Management Guidelines, available at https://www.uno.edu/research/funding/compliance under Radioactive Materials Safety.

Particularly Hazardous Substances

Some chemicals used in laboratories present much greater hazards than others, and therefore, special provisions must be made for their use and disposal. The OSHA Laboratory Standard considers carcinogens, reproductive toxins, and substances with a high degree of acute toxicity as Particularly Hazardous Substances (PHSs).

OSHA defines PHSs as chemicals that are known to have immediate or long-term toxic health effects. The OSHA Laboratory Standard (29 CFR 1910.1450) defines PHSs as chemicals that are either: carcinogens, reproductive toxins, mutagens, acute toxins, or specific organ toxins.

In addition, the OSHA Laboratory Standard requires that special provisions be made for the use of these substances.

Laboratory personnel must be specifically trained on the potential hazards associated with PHSs. The training should include a description of the hazards that the chemicals may present and the operations with exposure potential. Staff must be aware of emergency response, proper decontamination procedures, the location of designated areas where these chemicals are used, and proper waste disposal procedures.

The following provisions must be made for the use of PHSs:

- Establishment of a designated area.
- Use of containment devices (chemical fume hoods or glove boxes).
- Procedures for safe removal of contaminated waste.
- Decontamination procedures.
- Standard operating procedures (SOPs).

Establishing a Designated Area

When establishing a designated area for use only with a PHS, it may be appropriate to designate an entire room or a particular area within a lab. In doing so, the area should be clearly marked to communicate which materials can be used there. It is also important to inform all lab personnel of the designated area(s), its restrictions, and any special PPE requirements for the area. One way of communicating this information is by posting warning signs inside and outside of the area.

Use of Containment Devices

Working with PHSs may also require the use of engineering controls and containment devices such as chemical fume hoods or glove boxes. These containment devices provide additional protection to lab personnel. Depending on the substance being used, it may be appropriate to limit the use of the fume hood or glove box to only that particular substance. Closed systems, like syringes or cannulas, can also be used to handle these

types of chemicals. This also needs to be communicated to all lab personnel and reinforced by posting signs in the area.

Procedures for Safe Removal of Contaminated Waste

Disposal of waste materials that are contaminated with PHSs may require unique procedures to ensure personnel safety and proper disposal. These special procedures need to be emphasized in the SOPs for the use of the material. Also, additional training should be administered to all laboratory personnel who use the materials. For additional guidance on waste disposal, access the UNO Regulated Waste Guidelines and the P-Listed Chemicals and Hazardous Wastes Fact Sheet, available at https://www.uno.edu/research/funding/compliance under Lab Safety Fact Sheets.

Decontamination Procedures

When working with PHSs, it is necessary to decontaminate the work surfaces in the area after work is completed. Decontamination of these areas may require unique procedures or the use of particular cleaning agents. There must be procedures for decontamination of the equipment or the tools that are used. Labs can clean instruments and glassware using a mild detergent. Work surfaces should be wiped down with a mild detergent after any spills and at the end of each work day.

Refer to the SDSs or other reliable reference materials to determine if special decontamination procedures are required. Any such requirements need to be emphasized in the SOPs for the use of the material. Also, additional training should be administered to all laboratory personnel who use the materials.

When assessing risk, personnel should be able to estimate the severity of an experiment or activity using knowledge of hazards present. The risk of an activity can be minimized by using the Hierarchy of Controls (Figure 1).

Carcinogens

As defined by the OSHA Laboratory Standard, a carcinogen, or select carcinogen, is any substance that causes cancer, is suspected to cause cancer, and meets one of the following criteria:

- It is regulated by OSHA as a carcinogen.
- It is listed under the category “known to be carcinogens” in the Annual Report on Carcinogens published by the National Toxicology Program (NTP).
- It is listed under Group 1 (“carcinogenic to humans”) by the International Agency for Research on Cancer Monographs (IARC).
- It is listed in either Group 2A or 2B by IARC or under the category, “reasonably anticipated to be carcinogens” by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
    - 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.

- After repeated skin applications of less than 300 (mg/kg of body weight) per week.
- After oral dosages of less than 50 mg/kg of body weight per day.

The health effects of carcinogens are evident only after a long latency period. An individual's risk of developing cancer varies based on personal characteristics and other environmental factors.

Monitoring in certain laboratory areas may be required based on the amount and frequency.

Laboratory workers' potential for exposure is determined by the types of carcinogens used, frequency/type of research procedures, and amounts/concentrations used.

There is no safe level of exposure to carcinogenic compounds. The lab must ensure that exposure is reduced as much as possible.

To evaluate exposure potential, consider the physical state of the chemical being used and the possible routes of exposure. Additionally, consider the quantity of material and the experimental procedure being conducted.

Carcinogens	
GHS Hazard Symbol	
Storage Requirements	Designated areas (ex. An entire laboratory, an area of a laboratory, or a device such as a fume-cupboard) should be identified where carcinogens are used or are to be used. Doors into areas where carcinogenic chemicals are used should be marked to identify the nature of the hazard.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Utilize engineering controls such as chemical fume hoods, glove boxes, or isolation boxes for procedures involving carcinogens. Respiratory protection may be necessary depending on the experimental procedure. Designated areas can be a chemical fume hood, specific bench top, or another location where carcinogens are handled or stored.

Carcinogens	
	Work surfaces should be cleaned with a mild detergent following an experiment. Disposable bench paper can also be used to ensure work surfaces remain free from contamination. Wash hands and exposed portions of the forearm with soap and warm water following glove removal. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Lab coat, safety glasses, and gloves are considered minimum PPE for working with carcinogens. Glove selection depends on the physical state of the compound.
Emergency Procedures	In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where carcinogens are used. In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 12. Carcinogens

Reproductive Toxins

Reproductive toxins cause adverse effects on the health of reproductive organs, endocrine system, or gametes (eggs or sperm). Exposures can result in effects that may include menstrual dysfunction, male and female infertility, or the inability to maintain a pregnancy. Women and men of childbearing age must adhere to the recommended administrative, engineering, and personal protective equipment hazard controls to reduce the potential for exposure.

Occupational health consultations and assessments are available for individuals expecting a child or who have plans to conceive. Individuals may contact the UNO Laboratory Safety Officer to receive safety information about reproductive hazards or developmental hazards posed by potential exposures at any time. Individuals are not required to declare an actual, suspected, or planned pregnancy.

There are three main types of reproductive toxins: mutagens, embryo toxins, and teratogens.

The OSHA Laboratory Standard defines "mutagen" as a chemical that causes permanent changes in the genetic structure or amount of genetic material in cells. Since mutagens can increase the frequency of mutations within cells, mutagens are typically also carcinogens. "Teratogens" are chemical substances that have adverse or lethal effects on fetuses. Embryo toxins are chemicals that are toxic to embryos. Embryo toxins are agents that may kill, deform, retard the growth, or adversely affect the development of an unborn child. Teratogens may cause a birth defect in the child or cause termination of pregnancy. Please consult the Laboratory Pregnancy Protection Fact Sheet available at https://www.uno.edu/research/funding/compliance under Lab Safety Fact Sheets for further information.

Reproductive Toxins	
GHS Hazard Symbol	
Storage Requirements	Ensure that secondary containers labeled with the chemical name and associated hazards as well as the product containers. Handle in a designated area. Signs can be posted to indicate where reproductive toxins are handled.
Work Practices	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Wash hands following glove removal or after touching work surfaces. Ensure that personnel perform all chemical manipulations in a fume hood. The fume hood should be used with the sash in the proper operating position. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Use proper PPE to prevent exposure. Lab coat, gloves, and safety glasses must be worn to prevent contact with skin, eyes, and mucous membranes.

Reproductive Toxins	
Emergency Procedures	In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where reproductive toxins are used. In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 13. Reproductive Toxins

Acutely Toxic Chemicals

Chemicals that are acutely toxic have the potential to cause adverse effects after a single exposure. These adverse effects can be local, systemic, or both. Acutely toxic chemicals are known to be hazardous in small doses.

Acutely toxic chemicals are classified by oral LD50 toxicity (rat) of less than 50 milligrams per kilogram, an inhalation LC50 toxicity (rat) of less than 2 milligrams per liter, or a dermal LD50 toxicity (rabbit) of less than 200 milligrams per kilogram or is otherwise capable of causing or significantly contributing to an increase in serious irreversible, or incapacitating reversible, illness.. Adverse health effects can occur after a single exposure, multiple exposures, or doses within a 24-hour period. GHS descriptions of acutely toxic compounds include the following statements on chemical labels and SDSs:

- Fatal if swallowed
- Fatal in contact with skin
- Fatal if inhaled

Acute Toxins	
GHS Hazard Symbol	

Acute Toxins	
Storage Requirements	Designated area(s) are required for use and storage of Acute Toxins. Such areas must be clearly marked with signs that identify the chemical hazard and include an appropriate warning.
Work Practices Work Practices (cont.)	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Use the smallest amount of chemical that is needed for the experiment. Use engineering controls and containment devices, such as a chemical fume hood for weighing chemicals, creating solutions from a powder, or heating solutions. All open chemical handling should be done inside the chemical fume hood.If a chemical fume hood or other containment device is unavailable, then contact the UNO Laboratory Safety Officer for review of ventilation needs. Decontamination procedures will vary depending on the material. All surfaces should be wiped with the appropriate cleaning agent. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Lab coats, safety glasses, and gloves are required. Chemical-resistant gloves may be needed depending on the physical state of the compound. Immediately after working, remove gloves and wash hands and exposed portions of the forearm with warm water and soap. Long pants and closed-toe shoes must be worn.
Emergency Procedures	In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where acute toxins are used. In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 14. Acute Toxins

Hydrofluoric Acid

Hydrofluoric acid (HF) is especially hazardous to handle. It is a highly corrosive liquid that has the ability to cause deep tissue damage and systemic toxicity. The vapor from concentrated solutions is also dangerous. HF users must be familiar with the appropriate first aid response in case of an exposure.

HF is very toxic because the acid readily penetrates skin, causing severe burns. HF exposure is also associated with hypocalcemia (low calcium levels), hyperkalemia (high potassium levels), hypomagnesemia (low magnesium levels), and sudden death. Concentrated HF burns can be fatal depending on how much of the body's surface area is exposed.

HF contact with eyes can cause burns and destruction of the cornea. Inhalation of HF vapors may cause spasms in the respiratory tract, coughing, chest tightness, and acute edema.

Hydrofluoric Acid	
GHS Hazard Symbol	
Storage Requirements	Never store HF in glass containers. Use containers made of polyethylene or Teflon. Ensure all containers are clearly labeled. Keep vials, flasks, and containers securely closed to prevent exposure to HF vapors.
Work Practices	Read chemical SDS before working with any chemical. Specific SOPs for experiments using these chemicals must be written and available to lab employees who will conduct the experiments. These SOPs must be stored in the Lab Safety Binder. Train lab employees on these SOPs. Obtain a Calgonate first aid kit and become familiar with the first aid procedures. The first aid kit must contain 2.5% calcium gluconate gel or Zephiran solution. Ensure that there are enough tubes of the gel and solution based on the volume of HF typically used. Review expiration dates and replace the tubes before they expire. Both must be available to treat skin or eye exposures. Always handle HF inside of a chemical fume hood. The fume hood should be marked as a "designated area". A sign stating "Danger: Hydrofluoric Acid Used in this Area" is sufficient.

Hydrofluoric Acid	
	When transporting, place HF into a chemically compatible container and then don a fresh pair of gloves. Place the container inside of a carrying container or inside of a secondary container. Avoid touching door handles and other objects with gloved hands. Use the buddy system to facilitate navigating common areas. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	When using HF, wear a lab coat and an acid-resistant apron, closed-toe shoes, long pants, safety goggles, and chemical resistant gloves with extended cuffs. Nitrile gloves with extended cuffs are acceptable for dilute concentrations. Double gloving is strongly recommended. Concentrated HF requires chemical resistant gloves such as neoprene gloves or Butyl rubber gloves.
Emergency Procedures	In the event of an exposure, apply immediate first aid. Flush the area with water for 15 minutes and apply the Calcium gluconate gel (2.5%) to the affected site or the solution to the affected eye area. Do not allow the affected individual to go home or return to work without medical examination. In the event of a spill, contact UNO EHSO. Ensure that others in the work area are notified of the spill. Block the area by closing the lab doors to prevent exposure to the vapors. Alert nearby coworkers and evacuate the laboratory or building to a safe distance. Ensure emergency showers and eyewash fountains are available in areas where hydrofluoric acid is used. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 15. Hydrofluoric Acid

Perchloric Acid

Perchloric acid is a very strong mineral acid and strong oxidizing agent. When concentrated, it can become unstable. It can also become shock sensitive upon drying. If mixed with flammable or combustible material, it may ignite. Exposure to concentrated solutions can result in skin burns. Repeated dermal exposure to dilute concentrations can

result in dermatitis due to sensitization. Exposure to the acid's vapor can cause irritation to the eyes and respiratory tract, chest pains, and nasal congestion.

Perchloric Acid	
GHS Hazard Symbol	
Storage Requirements	Perchloric acid is incompatible with acetic acid, hydrochloric acid, flammable and combustible materials, and organic compounds. Inspect containers of perchloric acid monthly for discoloration. Ensure that bottles are dated upon receipt and dated once they are opened. Dispose of perchloric acid one year from the date of opening. Best practice is to dispose of chemical when a small amount is still remaining in the container. This will prevent the residue from drying and becoming extremely shock sensitive. Store the smallest amount of perchloric acid.
Work Practices	Read chemical SDS before working with any chemical. Specific SOPs for experiments using these chemicals must be written and available to lab employees who will conduct the experiments. These SOPs must be stored in the Lab Safety Binder. Train lab employees on these SOPs. Handle perchloric acid in a designated area. Ensure that work surfaces are decontaminated following use with 10% sodium carbonate solution. Work requiring heating of perchloric acid in concentrations above 72% must be conducted in a specially-designed perchloric acid hood equipped with a wash down system. Work requiring heating of perchloric acid in concentrations below 72% can be conducted in a standard chemical fume hood. Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Use nitrile gloves with extended cuffs when working with perchloric acid. Double gloving is strongly recommended.

Perchloric Acid	
	Safety goggles, lab coat, acid-resistant apron, long pants, and closed-toe shoes are required.
Emergency Procedures	In the event of a spill, contact UNO EHSO. Ensure emergency showers and eyewash fountains are available in areas where acute toxins are used. In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 16. Perchloric Acid

Nanomaterials

Nanomaterials are structures that have at least one dimension that is between 1 and 100 nanometers. Nanoparticles typically have all three dimensions on the nanoscale. Nanoparticles can be dry, suspended in solution (as a nanocolloid), embedded in a matrix (as a nanocomposite), or suspended in gas (as a nanoaerosol).

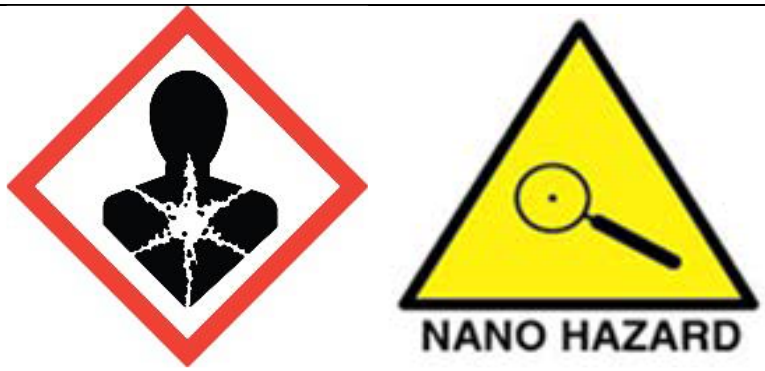
There are many unknowns regarding the health risks and health effects following exposure to nanoparticles. There are no national or international consensus standards on measuring an individual's exposure to nanoparticles in the workplace.

Certain characteristics of nanoparticles can influence their effects in biological systems. Some of these characteristics include:

- Charge
- Chemical reactivity
- Degree of agglomeration
- Shape
- Size
- Solubility
- Surface area
- Surface composition

Before working with nanomaterials, a hazard assessment should be performed by safety personnel in conjunction with research personnel. Assessments help to identify appropriate work procedures, controls, and necessary PPE to ensure worker safety.

- The most common route of exposure is inhalation.
- Ingestion is a route of exposure through unintentional hand-to-mouth transfer.
- Nanomaterials may enter the body through the skin, but the health effects are unknown.

Nanomaterials	
GHS Hazard Symbol	
Storage Requirements	Use in designated areas such as a chemical fume hood or biological safety cabinet. Nanomaterial storage containers should have a designation that the material is “nanoscale” or a “nanomaterial.”
Work Practises	Read chemical SDS before working with any chemical. Follow written laboratory procedures. Chemical fume hoods are the recommended containment device for all tasks with potential for aerosolizing nanomaterials in liquid or powder form. Containment devices with HEPA filters are also effective to remove nanoparticles from the environment. Equipment that is too large to be enclosed in a fume hood can be set up such that specially-designed local exhaust ventilation can capture contaminants. Place inside sealed containers for transport to other locations. If nanomaterial product from a reactor is bound or adhered to a substrate, the substrate may be removed and put in a transport container. After the conclusion of procedures involving nanomaterial, avoid dry sweeping or using pressurized air to clean the area. Wet wiping methods or a HEPA-filtered hand-held vacuum cleaner should be used to clean. Respiratory protection is recommended if a potential for aerosol exposure exists. Before wearing a respirator for use with nanoparticle research, the lab must contact the UNO Laboratory Safety Officer.

Nanomaterials	
Work Practices (cont.)	Ensure the waste is managed in accordance with the UNO Regulated Waste Guidelines. Do not mix with incompatible waste streams.
PPE	Safety glasses, lab coats, gloves, long pants, and closed-toe shoes are required. Two pairs of gloves can be worn if extensive skin contact is anticipated. If contamination of clothing is a concern, use disposable lab coats and dispose of as hazardous waste.
Emergency Procedures	In the event of a spill, contact UNO EHSO. If the spill is minor (5mg of solid material or 5mL of solution), the nanomaterials should be wet-wiped with a cloth/paper towel that has been dampened with soapy water. Affected surfaces should be wiped three times to ensure appropriate cleaning. Dispose of the spill debris as hazardous waste. Ensure emergency showers and eyewash fountains are available in areas where acute toxins are used. In general, any skin or eye exposures must be flushed with water for at least 15 minutes. Contaminated clothing must be removed and disposed of as hazardous waste. Seek medical attention following rinsing. Dial 911 and UNO Campus Police (x6666) if the severity of an injury is unknown, if there is a medical emergency, or if there is a fire. If a fire or explosion occurs, activate the fire alarm and follow building evacuation procedures. Report any accident, injury, or illness to your supervisor and submit notification of the incident in Workday.

Table 17. Nanomaterials

10. Lab Decommissioning and Equipment Decontamination

Lab Decommissioning

Prior to a change of occupancy or use, a laboratory must be decommissioned to ensure that it is safe for re-occupancy or repurposing (such as converting a lab into an office). This process entails:

- Removal of hazardous waste
- Removal of samples
- Surface decontamination

- Equipment decontamination

Contact the UNO Laboratory Safety Officer for additional laboratory decommissioning requirements or for assistance with decommissioning.

Equipment Decontamination

Laboratory equipment that contains or is exposed to hazardous material must be decontaminated prior to the following events or actions:

- Redistribution
- Disposal
- Relocation (within campus or off-campus)
- Repairs or maintenance with an outside vendor

To aid in the process, UNO has created an Equipment Hazard Tag, which must be completed and attached to equipment prior to these events or actions. The UNO Equipment Hazard Tag is available at https://www.uno.edu/research/funding/compliance under Lab Moves, Relocations, and Decommissioning.

In some cases, it may be necessary to utilize a service to perform equipment decontamination. Contact the UNO Laboratory Safety Officer for more information.

11. Medical Consultation and Medical Examinations

There are two types of exposures that are most often used when referring to hazards: acute and chronic.

Acute health effects are due to short-term exposure and happen in a short period of time.

Chronic health effects are due to long-term exposure and happen over a longer period of time.

Chemicals enter the body through inhalation, skin or eye contact, or ingestion.

Inhalation exposure can occur through breathing chemical gases, mist, or dusts in the air.

Skin or eye contact can occur if vapors from chemicals contact the eyes or chemicals get on the skin or in the eyes.

Chemicals can damage the skin or be absorbed through the skin into the bloodstream.

Ingestion can occur when chemicals have spilled or settled onto food, beverages, beards, or hands.

Injection can occur through the physical penetration of the skin barrier by a contaminated sharp object such as a needle.

The following table provides an overview of the symptoms that may be caused by chemicals. There is also an appendix within this document (Appendix A – Industrial Toxicology Overview) that provides more detailed information regarding chemical toxicity:

Symptoms that May Be Caused by Chemicals			
Affected Body Part	**Symptoms**	**Common Causes**	**GHS Hazard Class**
Head	Dizziness, headache	Organic solvents, corrosive vapors	Flammables, corrosives
Eyes	Red, watery, irritated, grainy-feeling	Vapors from acids, various dusts, and particulate matter	Corrosives, irritants
Nose and Throat	Sneezing, coughing, sore throat, shortness of breath	Vapors from solvents and acids	Corrosives, irritants
Chest and Lungs	Wheezing, coughing, shortness of breath, lung cancer	Solvent vapors, metal fumes, various dusts and particulate matter	Corrosives, irritants
Stomach	Nausea, vomiting, diarrhea	Long-term lead exposure, solvent vapors	Target organ toxins
Skin	Redness, dryness, rash, itching, burns	Solvents, detergents, acids/bases	Irritants, sensitizers, corrosives
Nervous System	Loss of balance, loss of coordination, tremors, sleeplessness	Long-term solvent exposure, long-term lead exposure	Target organ toxins
Reproductive System	For men: Low sperm count, damage to sperm For women: Irregularities to menstruation; miscarriage; damage to egg(s), embryo, or fetus	Organic solvents, lead	Mutagens, reproductive toxins

Table 18. Symptoms Caused by Chemicals

Consultations and/or examinations will be authorized under the following conditions:

- When an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in a laboratory.
- When a spill, leak, explosion, or other emergency causes exposure to a hazardous chemical.
- Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA-regulated substance for which there are exposure monitoring and medical surveillance requirements.

The following information should be provided to the healthcare provider by the employee:

- The identity of the hazardous chemical(s) to which exposure may have occurred accompanied by an SDS.
- A description of the conditions under which the exposure occurred, including quantitative exposure data, if available.
- A description of the signs and symptoms of exposure the employee is experiencing, if any.

For examination or consultations required under the plan, UNO must receive a written opinion from the examining physician, which shall include the following:

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

The written opinion shall not reveal specific findings or diagnoses unrelated to occupational exposure. Copies of any reports and laboratory examination results made available to the University shall also be made available to the employee and the employee's private physician upon request.

12. Emergency Procedures

Exposures and Injuries

UNO employees who work with chemicals may seek medical attention in the event of an exposure or injury. The following steps should be followed accordingly:

- Always administer first aid immediately (ex. Use emergency eye wash station, emergency shower, etc.)
- Report the incident to the immediate supervisor and call 911 if necessary.
- Seek medical attention at UNO Campus Health Services. If it is outside of working hours 8:00am to 4:30pm, seek medical attention at one of the following:
    - University Medical Center New Orleans Emergency Room
    - Tulane Medical Center Emergency Room
    - Ochsner Baptist Emergency Room
- Submit notification and a report of the incident in SciShield.
- Notify the UNO Laboratory Safety Officer of a chemical exposure as soon as feasible.

Note: As a follow-up, the UNO Laboratory Safety Officer will conduct an accident investigation to obtain information regarding the incident. The accident investigation is a tool to assist the research community in developing methods for prevention of accident reoccurrence.

Spills

In the event of a spill, it is critical to remember the following:

- Block access to any drains, sinks, or fume hoods immediately.
- Chemical spills should be cleaned by laboratory personnel only if the personnel have been trained to do so.
- Chemical spills that cannot be safely mitigated by laboratory personnel are considered major spills and should immediately be reported to EHSO and campus police.
- Notify all lab personnel and evacuate the lab.

EHSO provides information regarding how to properly handle emergencies. For more information, visit EHSO's website.

13. Contacts

UNO Police Department
unopd@uno.edu
Emergency: (504) 280-6666
Office: (504) 280-6371
www.uno.edu/upd/

UNO Environmental Health & Safety Office:
darichar@uno.edu
24/7: (504) 329-9878
Work: (504) 280-6670
www.uno.edu/ehso/

UNO Laboratory Safety Officer:
labsafety@uno.edu
Office: (504) 280-4759
www.uno.edu/research

UNO Office of Property Control Management:
pcm@uno.edu
Office: (504) 280-7299
www.uno.edu/pcm/

UNO Facility Services:
fsadmin@uno.edu
Emergency: (504) 884-8366

Office: (504) 280-6675
www.uno.edu/facility-services

UNO Radiation Safety Officer:
labsafety@uno.edu
Office: (504) 280-4759
www.uno.edu/research

UNO Campus Health Services:
Office: (504) 280-6387
Address: Ochsner Health Center
238 University Center
University of New Orleans
2000 Lakeshore Drive
New Orleans, LA 70148

University Medical Center New Orleans Emergency Room:
Phone: (504) 702-2138
Address: 2000 Canal Street
New Orleans, LA 70112

Tulane Medical Center Emergency Room:
Phone: (504) 988-5263
Address: 1415 Tulane Avenue
New Orleans, LA 70112

Ochsner Baptist Emergency Room:
Phone: (504) 899-9311
Address: 2700 Napoleon Avenue
New Orleans, LA 70115

14. References

OSHA Laboratory Standard – 29 CFR 1910.1450 - Occupational Exposure to Hazardous Chemicals in Laboratories

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

NFPA 30: Flammable and Combustible Liquids Code, National Fire Protection Association, Quincy, Massachusetts, 2015

NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals, National Fire Protection Association, Quincy, Massachusetts, 2011

NFPA 55: Compressed Gases and Cryogenic Fluids Code, National Fire Protection Association, Quincy, Massachusetts, 2013

NFPA 400: Hazardous Materials Code, National Fire Protection Association, Quincy, Massachusetts, 2013

15. Glossary of Terms

Action Level	A concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance
Acute	Severe, often dangerous exposure conditions in which relatively rapid changes occur.
Acute Exposure	An intense exposure over a relatively short period of time.
Acute Toxicity	Contact by skin or ingestion that produces adverse health effects within 24 hours or within 4 hours by inhalation. Can be one or more doses.
American Conference of Governmental Industrial Hygienists (ACGIH)	The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLVs) for hundreds of chemicals and physical agents and includes Biological Exposure Indices (BEI).
American National Standards Institute (ANSI)	The American National Standards Institute is a voluntary membership organization (run with private funding) that develops national consensus standards for a wide variety of devices and procedures.
Asphyxiant	A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants such as nitrogen either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.
Biohazard	Infectious agents that present a risk or potential risk to the health of humans or other animals, either directly through infection or indirectly through damage to the environment.
Boiling Point	The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. The boiling point is usually expressed in degrees Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.
"C" or Ceiling	A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value—Ceiling. (See also THRESHOLD LIMIT VALUE)
C.A.S. Number	Identifies a particular chemical by the Chemical Abstracts Service, a service of the American Chemical Society that indexes and compiles abstracts of worldwide chemical literature called "Chemical Abstracts."
Carcinogen	A substance that induces or increases cancer incidence in animals or humans.

Carcinogen, Select	A chemical listed by the National Toxicology Program (NTP) as "known to be carcinogenic" or by the International Agency for Research on Cancer (IARC) as a Group 1 carcinogen. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP and that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: 1. 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/m3 2. After repeated skin application of less than 300 mg/kg of body weight per week 3. After oral dosages of less than 50 mg/kg of body weight per day.
Chemical Fume Hood	A device constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory.
Chemical Hygiene Officer (CHO)	An employee who is designated by the employer and who is qualified by training and experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.
Chemical Hygiene Plan (CHP)	A written program developed and implemented by the Chemical Hygiene Officer which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting personnel from the health hazards presented by the hazardous chemicals used in that particular workplace.
Chronic exposure	A prolonged exposure occurring over a period of days, weeks, or years.
Combustible	According to the DOT and NFPA, Combustible liquids are those having a flash point at or above 100 °F (37.8 °C), or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances and must be handled with caution. Substances such as wood, paper, etc., are termed "Ordinary Combustibles."
Compressed Gas	Any material or mixture that is a gas at 20°C (68 °F) or less at an absolute pressure of 101 kPa (14.7 psia) and that has a boiling point of 20 °C (68 °F) or less at an absolute pressure of 101 kPa (14.7 psia) and that is liquefied, non-liquefied, or in solution, including those gases that have no other health or physical hazard properties and exerts in the packaging an absolute pressure of 280 kPa (40.6 psia) at 20°C (68 °F)
Concentration	The relative amount of a material in combination with another material. For example, 5 parts (of acetone) per million (parts of air).
Corrosive	A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

Cutaneous/Dermal	Pertaining to or affecting the skin.
Cytotoxin	A substance toxic to cells in culture or to cells in an organism.
Decomposition	The breakdown of a chemical or substance into different parts or simpler compounds. Decomposition can occur due to heat, chemical reaction, decay, etc.
Department of Transportation (DOT)	The United States Department of Transportation is the Federal agency that regulates the labeling and transportation of hazardous materials.
Dermatitis	An inflammation of the skin.
Designated Area	An area which may be used for work with "Particularly Hazardous Substances" such as "select carcinogens," "reproductive toxins," or substances which have a high degree of acute toxicity. This area may be the entire laboratory or an area under a device such as a laboratory hood.
Dilution Ventilation	See GENERAL VENTILATION.
Dyspnea	Shortness of breath; difficult or labored breathing.
EHSO	Environmental Health and Safety Office
Emergency	Any occurrence such as, but not limited to, equipment failure, ruptures of containers, or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.
Employee	An individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of their assignments.
Environmental Protection Agency (EPA)	The Environmental Protection Agency is the governmental agency responsible for administration of laws to control and/or reduce pollution of air, water, and land systems.
EPA Number	The number assigned to chemicals regulated by the Environmental Protection Agency.
Epidemiology	The study of disease in human populations.
Erythema	A reddening of the skin.
Evaporation Rate	The rate at which a material is converted to vapor (evaporates) at a given temperature and pressure when compared to the evaporation rate of a given substance. Health and fire hazard evaluations of materials involve consideration of evaporation rates as one aspect of the evaluation.
Explosive	A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.
Eye Irritant	A substance that can cause reversible changes in the eye within 21 days of contact.

Flammable Gas	A gas that, at an ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or a gas that, at an ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.
Flammable Liquid	According to the DOT and NFPA, a flammable liquid is one that has a flash point below 100 °F (See FLASH POINT).
Flammable Solid	A solid, other than a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily, and when ignited burns so vigorously and persistently it creates a serious hazard.
Flash Point	The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture and burn when a source of ignition (sparks, open flames, etc.) is present. Two tests are used to determine the flash point: open cup and closed cup. The test method is indicated on the SDS after the flash point.
Fume	A solid particle that has condensed from the vapor state.
Gas	Chemical substances that exist in the gaseous state at room temperature.
General Ventilation	Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, or where fire or explosion hazards are generated close to sources of ignition. (See LOCAL EXHAUST VENTILATION)
Grams per Kilogram (g/kg)	This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 grams (of substance) per kilogram of body weight (of the experimental animal).
Hazardous Chemical	A hazardous chemical is defined as any chemical, chemical compound, or mixture of compounds which is a physical and/or health hazard.
Hazardous Chemicals	Any chemical for which there is significant evidence that acute or chronic health effects may occur in exposed personnel. The term "health hazard" includes chemicals that are carcinogens, toxins, irritants, corrosives, heptatoxins, nephrotoxins, agents that act on the hematopoietic systems, sensitizers, and agents that can damage the lungs, skin, eyes, or mucous membranes.
Ignitable	A solid, liquid, or compressed gas waste that has a flash point of less than 140 °F. Ignitable material may be regulated by the EPA as a hazardous waste, as well.
Incompatible	The term applied to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

Ingestion	Taking a substance into the body through the mouth as food, drink, medicine, or unknowingly, as on contaminated hands or cigarettes, etc.
Inhalation	The breathing in of an airborne substance that may be in the form of gas, fumes, mists, vapors, dusts, or aerosols.
Irritant	A substance that produces an irritation effect when it contacts skin, eyes, nose, or the respiratory system.
Laboratory	A facility where relatively small quantities of hazardous materials are used on a nonproduction basis.
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.
Laboratory Use of Hazardous Materials	The handling or use of chemicals in which 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. 4. Protective laboratory practices and equipment are available and in common use to minimize the potential for personnel exposure to hazardous chemicals.
Laminar Air Flow	Air flow in which the entire mass of air within a designated space moves with uniform velocity in a single direction along parallel flow lines with a minimum of mixing.
Lethal Concentration, LC50	The concentration of an air contaminant that will kill 50 percent of the test animals in a group during a single exposure.
Lethal Dose, LD50	The dose of a substance or chemical that will kill 50 percent of the test animals in a group within the first 30 days following exposure.
Local Exhaust Ventilation	A ventilation system that captures and removes air contaminants at the point they are being produced before they escape into the workroom air. The system consists of hoods, ductwork, a fan, and possibly an air cleaning device.
Lower Explosive Limit (LEL)	The lowest concentration of a substance that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn. (See also UEL)
Medical Consultation	A consultation between an employee and a licensed physician for the purpose of determining what medical examination or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.
Melting Point	The temperature at which a solid changes to a liquid. A melting range may be given for mixtures.

Mutagen	Anything that can cause a change (or mutation) in the genetic material of a living cell causing abnormal development.
Narcosis	Stupor or unconsciousness caused by exposure to a chemical.
National Fire Protection Association (NFPA)	The National Fire Protection Association is a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 704, "Identification of the Fire Hazards of Materials." This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.
National Institute for Occupational Safety and Health (NIOSH)	The National Institute for Occupational Safety and Health is a Federal agency that, among its various responsibilities, trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.
Occupational Safety and Health Administration (OSHA)	A Federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.
Odor Threshold	The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.
Oxidation	The process of combining oxygen with some other substance or a chemical change in which an atom loses electrons.
Oxidizer	A substance that gives up oxygen easily to stimulate combustion of organic material.
Oxygen Deficiency	An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% oxygen at sea level.
Particularly Hazardous Substances	Particularly hazardous substances are select carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity.
Permissible Exposure Limit (PEL)	An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short term exposure limit (STEL), or a ceiling (C). The PELs are found in Tables Z-1,Z-2, or Z-3 of OSHA regulations 1910.1000. (See also TLV)
Personal Protective Equipment (PPE)	Any devices or clothing worn by the worker to protect against hazards in the environment. Examples include: respirators, gloves, and chemical splash goggles.
Physical Hazard	A chemical that has scientifically valid evidence proving it to be a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive.

Polymerization	A chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction with an uncontrolled release of energy.
RAD	The unit of absorbed dose equal to 100 ergs per gram or 0.01 joules per kilogram of absorbing material.
Reactivity	A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosion, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on an SDS.
Reproductive Toxins	Chemicals which affect the reproductive capabilities including: adverse effects on sexual function, fertility, chromosomal damage (mutations) and effects on fetuses.
Respirator	A device which is designed to protect the wearer from inhaling harmful contaminants.
Respiratory Hazard	A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some bodily function impairment.
Select Carcinogen	A chemical listed by the National Toxicology Program (NTP) as "known to be carcinogenic" or by the International Agency for Research on Cancer (IARC) as a Group 1 carcinogen. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP and that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: 1. 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/m3 2. After repeated skin application of less than 300 mg/kg of body weight per week 3. After oral dosages of less than 50 mg/kg of body weight per day.
Self-Reactive	A substance that is thermally unstable and can decompose exothermically even without air.
Sensitizer	A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.
Short Term Exposure Limit	Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also, the daily TLV-TWA must not be exceeded.

"Skin"	This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes. Thus, protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.
Skin Irritant	A substance that can cause reversible damage to skin after up to 4 hours of contact.
Systemic	Spread throughout the body; affecting many or all body systems or organs; not localized in one spot or area.
Teratogen	An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.
Threshold Limit Value	Airborne concentrations of substances devised by the ACGIH that represent conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards, that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLVs: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL), and Ceiling (TLV-C). (See also PEL)
Time Weighted Average	The average time over a given work period (e.g. 8-hour workday) of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the time period. Represented as TLV-TWA.
Toxicity	The potential of a substance to exert a harmful effect on humans or animals and a description of the effect and the conditions or concentration under which the effect takes place.
Unstable (Reactive)	A chemical that, in its pure state or as commercially produced, will react vigorously in some hazardous way under shock conditions (i.e., dropping), certain temperatures, or pressures.
Upper Explosive Limit (UEL)	The highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically, above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is 1 ppm and the UEL is 5 ppm, then the explosive range of the chemical is 1 ppm to 5 ppm. (See also LEL).
Vapor	The gaseous state of substances which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with low boiling points will evaporate.
Vapor Pressure	The pressure that a solid or liquid exerts when it is in equilibrium with its vapor at a given temperature.
Water-reactive	A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Appendix A – Industrial Toxicology Overview

Chemical Toxicology

Toxicology is the study of nature and action of chemical poisons. Toxicity is the ability of a chemical molecule or compound to produce injury once it reaches a susceptible site in or on the body.

Toxicity hazard is the probability that injury will occur considering the manner in which the substance is used.

Dose-Response Relationship

The potential toxicity (harmful action) inherent in a substance is exhibited only when that substance comes in contact with a biological system. A chemical normally thought of as "harmless" may evoke a toxic response if added to a biological system in sufficient amount. The toxic potency of a chemical is thus defined by the response that is produced in a biological system.

Routes of Entry into the Body

There are four main routes by which chemicals enter the body:

- Inhalation: Introduction to system through the respiratory tract. Most important in terms of severity.
- Absorption: Skin absorption through mucous membranes.
- Ingestion: Introduction to system through the digestive tract. Can occur through eating or smoking with contaminated hands or in contaminated work areas.
- Injection: Introduction of toxin into bloodstream; can occur by accidental needle stick or puncture of skin with a sharp object.

Exposure Limits as Related to Routes of Entry

Most exposure standards are based on the inhalation route of exposure. They are normally expressed in terms of parts per million (ppm) or milligrams per cubic meter (mg/m) concentration in air.

The Occupational Safety and Health Administration (OSHA) has established Permissible Exposure Limits (PELs) and the American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLVs) for employee exposure limits. In many instances, the PEL and TLV are represented as the same number. In the instances where one is lower than the other, it is a prudent safety practice to maintain exposures at the lowest level achievable.

If a significant route of exposure for a substance is through skin contact, the TLV or PEL will have a "skin" notation. Examples are pesticides, carbon tetrachloride, cyanides, ethylene diamine, and thallium.

Types of Effects

Acute poisoning is characterized by rapid absorption of the substance when the exposure is sudden and severe. Normally, a single large exposure is involved. Examples are carbon monoxide or cyanide poisoning.

Chronic poisoning is characterized by prolonged or repeated exposures of a duration measured in days, months, or years. Symptoms may not be immediately apparent. Examples are lead poisoning, mercury poisoning, or pesticide exposure.

Local refers to the site of action of an agent where the action takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples are strong acids or alkalis.

Systemic refers to the site of action other than the point of contact and presupposes absorption has taken place. For example, an inhaled material may act on the liver. For example, inhaled benzene affects the bone marrow.

Cumulative poisons are characterized by materials that tend to build up in the body as a result of numerous chronic exposures. The effects are not seen until a critical body burden is reached. Examples are heavy metals.

Synergistic effects occur when two or more hazardous materials present at the same time having a resulting action greater than the effect predicted based on the individual substances. For example, workers exposed to benzene may show a direct toxicity in hematopoietic tissue, and therefore may be more susceptible to oxygen-displacing agents such as carbon monoxide.

Other Factors Affecting Toxicity

Rate of Entry and **Route of Exposure** are how fast the toxic dose is delivered and by what means.

Age can affect the capacity to repair damaged tissue.

Previous Exposure can lead to tolerance, increased sensitivity, or make no difference.

State of Health, Medications, Physical Condition, and Lifestyle can affect the toxic response. Pre-existing disease can result in increased sensitivity.

Environmental Factors include temperature and pressure, for example, and can affect exposure.

Host Factors are genetic predispositions and the sex of the exposed individual.

Physical Class Effects on Toxicity

When considering the toxicity of gases and vapors, the **solubility** of the substance is a key factor. Highly soluble materials like ammonia irritate the upper respiratory tract. On the other hand, relatively insoluble materials like nitrogen dioxide penetrate deep into the lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body.

An **aerosol** is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium. The toxic potential of an aerosol is only partially described by its concentration in milligrams per cubic meter (mg/m^3). For a proper assessment of the toxic hazard, the size of the aerosol's particles is important. Particles above 1 micrometer tend to deposit in the upper respiratory tract. Particles less than 1 micrometer in diameter enter the lung. Very small particles (<0.2 µm) are generally not deposited.

Physiological Classifications of Toxic Materials

See Glossary of Terms for definitions of the following classifications:

- Irritants
- Corrosives
- Asphyxiants
- Teratogenic
- Mutagenic

Other specific classifications include:

- A **primary irritant** exerts no systemic toxic action because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. An example is hydrogen chloride.
- A **secondary irritant's** effect on mucous membranes is over-shadowed by a systemic effect resulting from absorption. Examples include hydrogen sulfide and aromatic hydrocarbons. Exposure to a secondary irritant can result in pulmonary edema, hemorrhage, and tissue necrosis.

Primary anesthetics have a depressant effect upon the central nervous system, particularly the brain. Examples include halogenated hydrocarbons and alcohols.

Target organ effects may occur from exposure to hazardous chemicals, including examples of signs and symptoms and chemicals which have been found to cause such effects. The following is a target organ categorization of effects:

Organ Category	Signs & Symptoms	Example Chemicals
Hepatotoxins (Liver)	Jaundice, liver enlargement	Carbon tetrachloride, nitrosamines, chloroform, toluene, perchloroethylene, cresol, dimethylsulfate
Neurotoxins (Nervous System)	Narcosis, behavioral changes, decreased muscle coordination	Mercury, carbon disulfide, benzene, carbon, tetrachloride, lead, mercury, nitrobenzene
Hematopoietic (Blood System)	Cyanosis, loss of consciousness	Carbon monoxide, cyanides, nitrobenzene, aniline, arsenic, benzene, toluene

Organ Category	Signs & Symptoms	Example Chemicals
Pulmonary (Lung)	Cough, tightness in chest, shortness of breath	Silica asbestos, nitrogen dioxide, ozone, hydrogen sulfide, chromium, nickel, alcohol
Reproductive Mutagens & Teratogens	Birth defects, sterility	Lead, 1,2-dibromo-3-chloropropane
Dermal Irritants & Sensitizers (Skin)	Defatting of skin, rashes, irritation	Ketones, chlorinated compounds, alcohols, nickel, phenol, trichloroethylene
Nephrotoxins (Kidney)	Edema, proteinuria	Halogenated hydrocarbons, uranium, chloroform, mercury, dimethyl sulfate
Hazard to Eyes	Conjunctivitis, corneal damage	Organic solvents, acids, cresol, quinone, hydroquinone, benzyl chloride, butyl alcohol, bases

Table 19. Target Organ Categorization of Effects

Appendix B – Hazard Assessment

Hazard Assessment Tool

OSHA requires that SOPs be included in the CHP; these SOPs focus on the major hazard classifications of chemicals. An SOP is a method of hazard assessment. At UNO, individual research laboratories need to develop effective SOPs to work safely with hazardous chemicals. The American Chemical Society (ACS) created a tool to help "identify hazards, assess risk, and select the appropriate control measures to eliminate a hazard or minimize risk…" The ACS Hazard Assessment Tool can be used to facilitate this process, and a variety of methods are available.

Please use the ACS Hazard Assessment Tool as needed.