UCONN
CHEMICAL HYGIENE PLAN

Environmental Health and Safety
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CHEMICAL HYGIENE PLAN- SIGNATURE CONFIRMATION
Chemical Hygiene Plan

I. Purpose

The University of Connecticut seeks to promote and maintain all programs that support the safety, health, and well-being of University employees, students and visitors. To this end, this plan has been developed to protect the health and safety of all personnel working in University laboratories. It incorporates the requirements of the Occupational Health & Safety Administration (OSHA) standard 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*, more commonly referred to as the *OSHA Laboratory Standard*, and serves as the University’s written *Chemical Hygiene Plan*, as required by the standard.

II. Scope and Applicability

The *Chemical Hygiene Plan* (CHP) applies to all laboratories at the University of Connecticut’s main and regional campuses, with the exception of the UConn Health Center, that use, store, or handle hazardous chemicals and to all personnel who work in these facilities. For the purposes of this plan, laboratories are defined as work areas where small quantities of hazardous chemicals are used on a non-production basis. It excludes workplaces whose function is to produce commercial quantities of materials. In laboratories, reactions, transfers, and handling of chemicals are designed to be safely carried out by one person. In addition to the requirements of the CHP, work in laboratories involving biological or radiological materials must comply with UConn’s *Biological Safety Manual* and *Radiation Safety Manual*.

The CHP provides a general overview of standard operating procedures, work practices, controls, and personal protective equipment used to protect personnel from the health and physical hazards present in laboratories. It is the responsibility of all individuals working in laboratories to comply with the guidelines of the CHP. In addition, lab personnel must follow the safety manuals, standard operating procedures, and work practices required by departments, principal investigators, and laboratory/facility managers to address procedures and hazards specific to their laboratories.
III. Enforcement

As stated in the University’s *Health and Safety Policy*, the University of Connecticut is committed to providing a healthful and safe environment for all activities under its jurisdiction and complying with all applicable federal, state, and local safety regulations and standards. Department heads, principal investigators, laboratory/facility managers, lab workers, and other authorized individuals all share the responsibility for minimizing personnel exposure to laboratory hazards and maintaining compliance with the *Chemical Hygiene Plan*. Failure to comply with this plan may result in disciplinary measures in accordance with University Laws and By-Laws, *General Rules of Conduct for All University Employees*, applicable collective bargaining agreements, and the *University of Connecticut Student Code*.

IV. Definitions

- **Active Lab Area**- laboratory areas where chemicals are used or stored.

- **Chemical Hygiene Plan**- a written program developed and implemented by the University which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting lab personnel from the health hazards presented by hazardous chemicals used in that particular workplace.

- **Hazardous chemical**- any chemical which is classified as a physical hazard, a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise classified.

- **Health Hazard**- means a chemical that is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard.

- **Lab Personnel**- department heads, principal investigators, laboratory/facility managers, lab workers, and other individuals assigned by UConn to perform specific duties in laboratories where hazardous chemicals are used or stored. This does not include maintenance, custodial, or other workers not actively engaged in laboratory activities.

- **Permissible Exposure Limit (PEL)**- a regulatory limit set by OSHA based on the amount or concentration of a substance in the air. In some cases, it may also contain
a skin designation. Most PELs are based on an 8-hour time weighted average (TWA) exposure to which it is believed most workers may be exposed to for a working lifetime without developing serious illness. PELs are enforced as a legal standard.

- **Physical Hazard** - a chemical that is classified as posing one of the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self-reactive; pyrophoric (gas, liquid, or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or combustible dust.

- **Threshold Limit Value (TLV)** - the time-weighted average (TWA) concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may be repeatedly exposed, day after day, for a working lifetime without adverse effect. The TLV is a consensus standard issued by the American Conference of Governmental Industrial Hygienists (ACGIH).

V. **Roles and Responsibilities**

Individuals overseeing or working in laboratories where hazardous chemicals are used or stored are responsible for following the guidelines listed in the *Chemical Hygiene Plan*. This plan does not apply to undergraduates or other students enrolled in laboratory courses in teaching labs where hazardous chemicals may be used or stored. The responsibilities of each position are outlined below:

A. **Vice President for Research**

- Provides institutional leadership and assumes ultimate responsibility to ensure compliance with the *Chemical Hygiene Plan*.
- Supplies the *University Chemical Hygiene Officer* with the support necessary to implement and maintain the requirements of the *Chemical Hygiene Plan*.
- Updates the *President of the University* on EHS policies, programs, and relevant issues regarding laboratory safety.

B. **University Chemical Hygiene Officer (CHO)**

*EHS Chemical Safety Manager*

- Reviews and updates the *Chemical Hygiene Plan*.
- Works with departments, principal investigators, laboratory/facility managers, and lab workers to develop and implement chemical hygiene policies, programs, laboratory-specific standard operating procedures, and safe work practices.
• Provides technical assistance to lab personnel regarding adherence to the *Chemical Hygiene Plan.*
• Manages the University laboratory training, inspection, and chemical inventory programs.
• Assists lab personnel in the selection of appropriate engineering controls, administrative controls, and personal protective equipment for hazards encountered in laboratories.
• Works with departments, lab personnel, and the *Chemical Hygiene Committee* to continually improve the chemical hygiene program.
• May appoint a Deputy Chemical Hygiene Officer (DCHO) and delegate duties to the DCHO in accordance with the *Chemical Hygiene Plan.* The DCHO has the authority to independently act on behalf of the CHO to implement the *Chemical Hygiene Plan* and fulfill these roles and responsibilities.

C. **Department Head**

• Directs lab personnel within their department(s) to comply with the guidelines of the *Chemical Hygiene Plan.*
• Instructs lab personnel within their department(s) to receive *Initial Lab Safety & Chemical Waste Management* training and annual retraining through EHS.
• Works to maintain an up-to-date list of lab personnel within their department(s).
• Works with principal investigators or laboratory/facility managers, within their department(s), found to be in violation of the *Chemical Hygiene Plan* or the *Health and Safety Policy* to ensure timely corrective action.
• Reviews accident reports and works with principal investigators, laboratory/facility managers, lab personnel, and EHS to make appropriate changes to laboratory standard operating procedures to prevent future incidents from occurring.

D. **Principal Investigator (PI)**

• Follows the guidelines of the *Chemical Hygiene Plan* and ensures compliance with all EHS policies and programs applicable to their labs.
• Ensures that their lab personnel, including the PI, complete *Initial Lab Safety & Chemical Waste Management* training provided by EHS prior to working in or overseeing work done in the lab. A refresher course must be completed annually by the PI and their lab personnel, either online or in-person.
• Maintains an accurate, up-to-date chemical inventory for each laboratory.
• Reviews and updates the lab’s *Workplace Hazard Assessment Form(s)*, as needed.
- Provides training to lab personnel that addresses the hazards, controls, work practices, personal protective equipment (PPE), and emergency procedures specific to the lab.
- Maintains and makes available lab-specific training documentation for lab personnel, including the contents of training and a list of personnel receiving the training.
- Ensures compliance with the University’s Working Alone Policy.
- Ensures that minors (individuals under 18 years old) will be supervised at all times by qualified laboratory personnel.
- Provides appropriate personal protective equipment to personnel in their lab(s) for the health hazards, physical hazards, and equipment identified in the Workplace Hazard Assessment.
- Reviews and approves protocols and procedures of lab personnel for potential safety and/or technical issues prior to active research.
- Develops and provides training and lab-specific standard operating procedures (LSOPs) for lab personnel engaged in research with the following particularly hazardous chemicals: pyrophorics and hydrofluoric acid.
- Ensures that lab personnel properly collect, label, and manage wastes.
- Minimizes or eliminates actual or potential hazards that could lead to accidents, injuries, or property damage.
- Ensures that lab(s) remain clean, orderly, and in a sanitary condition.
- Ensures safe operation of laboratory equipment through proper installation, inspection, maintenance, and repair.
- Reports all lab-related accidents/emergencies to UCFD (911) and injuries to Human Resources. Serious injuries (i.e., death, in-patient hospitalization, amputation, or loss of an eye) must be reported to EHS immediately to allow for compliance with OSHA reporting time requirements. Near miss incidents (i.e., incidents that did not result in injury, illness, or damage, but had the potential to do so given a slight shift in circumstances) should also be documented and reported to EHS for review.
- Contacts Facilities Operations or EHS when safety showers, eyewash stations, fume hoods, or other safety-related equipment are not working properly.
- Provides oversight of laboratory operations to ensure compliance with the University Chemical Hygiene Plan, Laboratory Chemical Inventory Program, Laboratory Inspection Program, and Chemical Waste Disposal Manual.
- May designate an individual working in their lab(s) to collaborate with the PI to enact laboratory-specific safety policies and procedures. Designation of such an individual does not absolve the PI of the responsibilities listed in this section. The PI is ultimately responsible for ensuring health and safety in the lab(s).
E. Laboratory/Facility Manager

- Oversees a shared laboratory/equipment space.
- Follows the guidelines of the Chemical Hygiene Plan and ensures compliance with all EHS policies and programs applicable to the labs or facilities they oversee.
- Ensures all individuals assigned to the lab/facility, including the Lab/Facility Manager, complete Initial Lab Safety & Chemical Waste Management training provided by EHS prior to working in or overseeing work done in the lab. A refresher course must be completed annually by the Lab/Facility Manager and all lab personnel, either online or in-person.
- Maintains an accurate chemical inventory for each laboratory.
- Informs laboratory users of the actual and potential hazards of chemicals, equipment, and operations of the shared laboratory/equipment space.
- Provides appropriate personal protective equipment to personnel in their lab(s)/facility for the health hazards, physical hazards, and equipment identified in the Workplace Hazard Assessment.
- Ensures wastes are properly collected, labeled, stored, and managed.
- Minimizes or eliminates actual or potential hazards that could lead to accidents, injuries, or property damage.
- Reports all lab-related accidents to UCFD (911) and injuries to Human Resources. Serious injuries (i.e., death, in-patient hospitalization, amputation, or loss of an eye) must be reported to EHS immediately to allow for compliance with OSHA reporting time requirements. Near miss incidents (i.e., incidents that did not result in injury, illness or damage, but had the potential to do so given a slight shift in circumstances) should also be documented and reported to EHS for review.
- Ensures that the lab(s)/facility remains clean, orderly, and in a sanitary condition.
- Manages safe operation of laboratory equipment through proper installation, inspection, maintenance, and repair.
- Ensures authorized lab personnel are properly trained for use of laboratory equipment.
- Contacts Facilities Operations or EHS when safety showers, eyewash stations, fume hoods, or other safety-related equipment are not working properly.

F. Lab Worker

- Reviews and follows policies, procedures, and work practices outlined in the Chemical Hygiene Plan and lab-specific procedures.
Attends Initial Lab Safety & Chemical Waste Management training prior to working in a lab.

Stays current with Lab Safety & Chemical Waste Management training by attending initial or online refresher training annually.

Uses engineering, administrative, and work practice controls to minimize exposure to hazards present in the lab.

Wears appropriate personal protective equipment as specified in the Workplace Hazard Assessment Form, Safety Data Sheets (SDSs), or other applicable documentation.

Receives approval from the principal investigator or laboratory/facility manager prior to conducting research involving hazardous chemicals.

Notifies and consults with the principal investigator or laboratory/facility manager prior to making changes to existing, reviewed procedures.

Properly collects, handles, labels, stores, and manages hazardous chemicals and wastes.

Ensures that lab(s) remain clean, orderly, and in a sanitary condition.

Reports unsafe conditions and near misses to the principal investigator or laboratory/facility manager and EHS.

Adheres to all University, Departmental, and laboratory-specific safety policies, procedures, and directives.

G. Chemical Hygiene Committee

Reviews and provides input for the Chemical Hygiene Plan and standard operating procedures for the use of hazardous chemicals.

Reviews and provides input into the Laboratory Chemical Inventory Program.

Reviews reports of chemical spills and other emergency laboratory situations and provides input on any mechanisms to improve safety and emergency response.

Reviews and provides input regarding the content and scheduling of training programs for laboratory personnel.

H. Environmental Health and Safety

Reviews, edits, and evaluates the Chemical Hygiene Plan annually and as needed.

Establishes chemical hygiene policies and procedures to protect lab personnel and the environment.

Conducts Laboratory Safety & Chemical Waste Management training.
• Provides technical guidance and consultation to the University community regarding work practices, procedures, controls, and personal protective equipment to ensure safe use of hazardous materials in labs.
• Performs fume hood evaluations.
• Inspects laboratories as outlined in the Laboratory Inspection Program.
• Provides services and consultation related to hazardous waste management and disposal.
• Investigates accidents involving hazardous chemicals.
• Conducts exposure monitoring, as necessary.

I. Minors

• Individuals under 18 years old are not allowed in laboratories that contain health or physical hazards unless they are University of Connecticut students or registered participants in a University-sanctioned project or program.
• Individuals under 18 years old must be supervised by lab personnel at all times while working in laboratories.
• Activities involving minors, who are not enrolled or accepted for enrollment in credit-granting courses at the University or who are not employees of the University, must be sponsored by a unit within the University, be registered with the University’s Minor Protection Coordinator, and meet University standards described in the Policy for the Protection of Minors and Reporting of Child Abuse and Neglect. For more information, please visit the Minor Protection website.

VI. Training and Information

The OSHA Laboratory Standard requires that training be provided to all employees working in laboratories at the time of initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The CHP applies this standard to all individuals working in laboratories at UConn, with the exception of undergraduate students attending class in non-research laboratories (See note below). It is the responsibility of all lab personnel to attend and stay current with Laboratory Safety & Chemical Waste Management Training provided by EHS and any job-specific training provided by departments, principal investigators, laboratory/facility managers, or other qualified individuals.
Note: Undergraduate students enrolled in laboratory courses in teaching labs receive training through their instructor which is documented through the Student Administration System.

A. Initial Safety Training

All individuals working in labs, including principal investigators, laboratory/facility managers, lab workers, and other personnel must attend the Initial Laboratory Safety & Chemical Waste Management Training provided by EHS prior to work in laboratories. The training covers:

- The contents and location of the OSHA Laboratory Standard;
- The location and details of the Chemical Hygiene Plan;
- The permissible exposure limits for OSHA regulated substances or recommended exposure limits;
- Signs and symptoms associated with exposures to hazardous chemicals;
- The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals;
- Methods and observations that may be used to detect the presence or release of a hazardous chemical;
- The physical and health hazards of chemicals in the work area; and
- Appropriate work practices, emergency procedures, and personal protective equipment to be used to protect individuals from hazards in laboratories.

B. Annual Refresher Training

Refresher training provided by EHS must be completed every year by principal investigators, laboratory/facility managers, lab workers, and other individuals working in labs. The training is required to ensure that all individuals working in labs are up-to-date with current federal and state regulations and University policies regarding safety. The refresher training course is offered through EHS in both in-person and online formats.

C. Laboratory-Specific Training

In addition to training provided by EHS, laboratory-specific training must be provided by departments, principal investigators, or laboratory/facility managers on the specific hazards of chemicals, equipment, or operations unique to each laboratory. Examples of laboratory-specific training include, but are not limited to:
- Use of cryogenic liquids;
- Safety protocols for use of equipment that present health and/or physical hazards to lab personnel (e.g., impact, cuts/penetration, harmful dusts/vapors, noise, etc.);
- Procedures using highly reactive or explosive chemicals (e.g., pyrophoric, water-reactive, etc.); and
- Emergency procedures.

Laboratory-specific training must take place prior to involvement with the chemical, equipment, or operation. Documentation of the training, including the content, training date, and signatures of both the trainee and trainer, is recommended.

VII. Emergency and First Aid Procedures

Emergencies are incidents that pose an actual or potential threat to people and/or the environment. They include events such as, but not limited to, equipment failure, explosions, fires, spills, rupture of containers, or failure of control equipment that results in an uncontrolled release into the laboratory. The UConn Fire Department (UCFD) is the first responder at the Storrs and Depot campuses and must be contacted immediately after an emergency occurs. Lab personnel working at regional campuses must contact local fire departments (i.e., 911 or 8-911 [Avery Point Campus Landline]). No individual working in a laboratory is allowed to use a fire extinguisher without appropriate training. All emergencies must be reported to the principal investigator or laboratory/facility manager and EHS (860-486-3613). The following procedure must be followed if an emergency occurs:

Table 1. Emergency Procedure

<table>
<thead>
<tr>
<th>Course of Action</th>
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<tr>
<td>1. RELOCATE everyone in the immediate work area to a safe location.</td>
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<tr>
<td>2. ALERT - Dial 911. Follow the directions of the dispatcher. The person that dials 911 must meet UCFD upon arrival to provide further information about the emergency.</td>
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<tr>
<td>3. CONFINE - If it can be done safely, close doors to confine the area where the emergency occurred. Post a “No Entry” sign on the door(s) to prevent reentry by other personnel.</td>
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</tbody>
</table>
4. **EVACUATE** the building through the nearest exit. Do not run. Do not use elevators.

5. **REPORT** to your designated meeting site.

6. **REENTER** once the lab has been cleared by emergency personnel.

*Note:* Additional emergency response procedures for non-chemical threats (e.g., power outages, bomb threats, suspicious packages, shelter-in-place, etc.) are available for review in the *Emergency Hazard Guide* provided by the Office of Emergency Management.

A. Chemical Spills

Chemical spills refer to the release of chemicals, wastes, oils, or other potentially dangerous materials into the air, water, or workplace. Spills may include incidents where a person is impaired, injured, or contaminated. Chemical spills must not be cleaned up without the assistance of emergency personnel (i.e., UCFD, the local Fire Department, or other emergency response vendor). UCFD or the local fire department will assess the risk from a spill and take into account:

- Risk of fire/explosion,
- Potential overexposure to airborne contaminants,
- Onset of dangerous reactions,
- Contact hazards with corrosive and/or toxic chemicals, and
- Threat to the environment.

Lab personnel involved in hazardous chemical spills must follow the emergency procedure outlined above in Table 1.

B. Incidental Releases

Incidental releases are small spills that can be safely dealt with by laboratory personnel. Incidental releases must present little to no risk of exposure to individuals or the environment and can be safely controlled at the time of release. If an incidental release occurs in a laboratory, the following steps must be followed:
Table 2. Procedure for Incidental Releases

<table>
<thead>
<tr>
<th>Course of Action</th>
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<tbody>
<tr>
<td>1. Evacuate everyone in the lab and post a “No Entry” sign on the door(s) to prevent reentry by other lab personnel.</td>
</tr>
<tr>
<td>2. Contact the PI or Laboratory/Facility Manager prior to cleaning up any small spill. Dial 911 if the PI/Facility Manager is not available and follow the procedure in Table 1.</td>
</tr>
<tr>
<td>3. Ensure the risk of exposure is minimal with the PI/Lab Manager. If a danger or risk of exposure exists, follow the emergency procedure in Table 1.</td>
</tr>
<tr>
<td>4. Avoid contact with contaminated areas. If the spill is located in a non-ventilated area, relocate, dial 911, and follow the procedure in Table 1.</td>
</tr>
<tr>
<td>5. If safe, turn off ignition sources and compressed gases. If not, evacuate the lab, call 911, and follow the procedure in Table 1.</td>
</tr>
<tr>
<td>6. Put on appropriate personal protective equipment indicated in the safety data sheet. Work with another person to clean up the spill. Do not clean up a spill alone.</td>
</tr>
<tr>
<td>7. Use the appropriate spill kit to control the source and confine the spill to a small area.</td>
</tr>
<tr>
<td>8. Place spill debris in an appropriate container, tightly seal or close container, and properly label the waste.</td>
</tr>
<tr>
<td>9. Place the waste in the Satellite Accumulation Area and contact EHS for a waste pickup.</td>
</tr>
<tr>
<td>10. Report the spill to EHS.</td>
</tr>
<tr>
<td>11. Restock supplies used to clean up the spill.</td>
</tr>
</tbody>
</table>

C. Safety Showers and Eyewash Stations

Properly-functioning eyewash stations and safety showers are required to be present for immediate emergency use within 10 seconds walking time of labs where corrosive materials are used or stored. The water temperature in both eyewash stations and safety showers must range between 60°F (16°C) and 100°F (38°C). Eyewashes and safety showers must be located on the same level as the hazard and the path of travel.
must be free of obstructions. The ANSI standard Z358.1 should be used as a guideline for the proper design, certification, performance, installation, use, and maintenance of eyewash stations and safety showers. Drench hose units may supplement, but may not be used in place of, dedicated eyewash units and safety showers.

Lab personnel are responsible for identifying locations of eyewash stations, safety showers, and other emergency equipment prior to research. Eyewash stations must be tested weekly to ensure proper function. Safety showers are inspected annually by Facilities Operations. If a safety shower has not been tested within the last year or an eyewash station or shower is not working properly, principal investigators, lab/facility managers, or other lab personnel must initiate a work order with Facilities Operations to assess and/or repair the equipment.

D. First Aid Procedures

Lab personnel are responsible for identifying locations of eyewash stations, safety showers, first aid kits, fire alarms, and other emergency equipment prior to research. The following procedure must be followed when an emergency situation results in an exposure to the eyes with a hazardous chemical.

<table>
<thead>
<tr>
<th>Table 3. Eye Exposure to Hazardous Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Aid Response</strong></td>
</tr>
<tr>
<td>1. Forcibly hold both eyes open under an emergency eyewash to ensure an effective wash behind both eyelids.</td>
</tr>
<tr>
<td>2. If contact lenses are being worn, remove the contacts while flushing.</td>
</tr>
<tr>
<td>3. Dial 911 or have someone else from the lab dial 911.</td>
</tr>
<tr>
<td>4. Continue flushing the eyes underneath the eyewash until emergency personnel arrive.</td>
</tr>
<tr>
<td>5. <strong>Report</strong> the injury to your principal investigator and/or laboratory/facility manager and EHS.</td>
</tr>
</tbody>
</table>

The following procedure must be followed when an emergency situation results in an exposure to the eyes with a nonhazardous solid.

<table>
<thead>
<tr>
<th>Table 4. Eye Exposure to Nonhazardous Solid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Aid Response</strong></td>
</tr>
<tr>
<td>1. If eyes are exposed to glass, metal, wood, or other type of particulate, do <strong>NOT</strong> flush eyes under an emergency eyewash.</td>
</tr>
<tr>
<td>2. Close or cover the eye(s), dial <strong>911</strong>, and have emergency personnel evaluate the eye(s) prior to flushing.</td>
</tr>
</tbody>
</table>
The following procedure must be followed when an emergency situation results in a chemical exposure to the skin.

### Table 5. Skin Exposure

<table>
<thead>
<tr>
<th>First Aid Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wash affected area(s) with tepid water from an emergency safety shower. Take care not to break skin.</td>
</tr>
<tr>
<td>2. Remove or cut off contaminated clothing while rinsing. Do not pull contaminated clothing over the head.</td>
</tr>
<tr>
<td>3. For chemical and thermal burns, flush affected area(s) with water from the safety shower, if indicated in safety data sheet.</td>
</tr>
<tr>
<td>4. For blood, biological, or radiological exposures use soap and water.</td>
</tr>
<tr>
<td>5. Dial 911 or have someone else from the lab dial 911.</td>
</tr>
<tr>
<td>6. Keep flushing affected area(s) underneath the safety shower until emergency personnel arrive.</td>
</tr>
<tr>
<td>7. Report the injury to your principal investigator and/or laboratory/facility manager and EHS.</td>
</tr>
</tbody>
</table>

The following procedure must be followed when an emergency situation results in an exposure through inhalation of chemical vapors, fumes, or smoke.

### Table 6. Inhalation of Chemical Vapors, Fumes or Smoke

<table>
<thead>
<tr>
<th>First Aid Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. If exposed individual is unconscious, do NOT enter the lab if a possibility of oxygen depletion, toxic vapors, or an explosive atmosphere exists. Dial 911.</td>
</tr>
<tr>
<td>2. If exposed individual is conscious, move the person to fresh, uncontaminated air. Dial 911.</td>
</tr>
<tr>
<td>3. Report the injury to your principal investigator and/or laboratory/facility manager and EHS.</td>
</tr>
</tbody>
</table>

The following procedure must be followed when an emergency results in ingestion of a hazardous chemical.

### Table 7. Chemical Ingestion

<table>
<thead>
<tr>
<th>First Aid Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. If safe to do so, move affected individual to an uncontaminated area.</td>
</tr>
</tbody>
</table>
The following procedure must be followed when an emergency results in exposure to a cryogenic liquid.

**Table 8. Exposure to Cryogenic Liquids**

<table>
<thead>
<tr>
<th>First Aid Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. If skin comes into contact with a cryogen, place affected area in a warm water bath (not above 40°C/104°F). Never use hot or cold water or dry heat. Thawing of the affected area(s) must be done gradually.</td>
</tr>
<tr>
<td>2. If a burn from a cryogen occurs, do not rub the burned area. Rubbing can result in further tissue damage.</td>
</tr>
<tr>
<td>3. Dial 911 and seek medical attention as soon as possible for all frostbite injuries.</td>
</tr>
<tr>
<td>4. Report the injury to your principal investigator and/or laboratory/facility manager and EHS.</td>
</tr>
</tbody>
</table>

**VIII. Safety Documentation**

Safety documentation is required in each laboratory to assure compliance with regulations and University policies. Principal investigators or laboratory/facility managers are required to update forms and documentation as changes to laboratory personnel, chemicals, or personal protective equipment occur. The following safety documentation must be present in all laboratories:

**A. Chemical Hygiene Plan (CHP)**

Every laboratory is required to have an up-to-date copy of the CHP in the lab. Access to hard or electronic copies of the document is acceptable. Electronic copies must be kept on a computer that is readily accessible to all researchers. Each individual working in the lab is required to complete a **CHP Signature Confirmation**, confirming adherence to the CHP. In addition to the University CHP, departments, principal investigators, and/or
laboratory/facility managers can develop laboratory-specific safety manuals to inform lab personnel of the hazards and procedures specific to the department or laboratory.

B. Chemical Inventory

1. Lab-Specific Inventory

Every chemical, including compressed gas cylinders, brought into a laboratory must be added to a chemical inventory. The principal investigator and/or laboratory/facility manager is responsible for maintaining an accurate chemical inventory. At a minimum, the chemical inventory must contain:

- Name of the chemical;
- Location of the chemical in the lab (e.g., flammable storage cabinet); and
- Approximate amount of the chemical (i.e., the size of the container).

Chemicals relocated or removed from the lab (e.g., empty, expired, off-specification, etc.) must be deleted from the inventory to ensure accuracy. The chemical inventory can be printed out and stored in the laboratory or maintained on a computer that is accessible to all lab personnel.

2. Laboratory Chemical Inventory Program

The goal of the Laboratory Chemical Inventory Program is to create and maintain an accurate, campus-wide inventory of hazardous chemicals at the Storrs and Depot campuses. This program excludes the Chemistry Department, which maintains its own chemical inventory program. EHS and the Chemistry Department will use the systems to track hazardous chemicals from the point of delivery to final disposal. Principal investigators, laboratory/facility managers, and lab personnel are responsible for:

a. Following the steps for ordering chemicals outlined in each program to ensure chemicals are barcoded by Central Stores or the Chemistry Department prior to use;
b. Verifying that chemicals are delivered to the correct location(s);
c. Contacting EHS or the Chemistry Department if the barcoded materials are relocated to another location; and
d. Providing barcode numbers to EHS or the Chemistry Department (e.g., mail (Unit 4097), FAX (860-486-1106), email (ehs@uconn.edu) or in-person) when containers are empty.

Specific responsibilities and procedures, with the exception of those working in the Chemistry Building, required to be followed by EHS, Central Stores - Chemical Receiving, principal investigators, laboratory/facility managers, lab personnel, and fiscal officers are outlined in the Laboratory Chemical Inventory Program. Lab personnel working at the Storrs and Depot campuses are responsible for compliance with this program.

C. Safety Data Sheets (SDSs)

Safety data sheets (SDSs) are printed or electronic documents that provide health and safety-related information on chemicals. Manufacturers or importers of chemicals are required to obtain or develop an SDS for each hazardous chemical they produce or import. Principal investigators or laboratory/facility managers are responsible for ensuring that SDSs are available for every chemical in the laboratory and readily accessible to lab personnel. Either printed or electronic copies of safety data sheets are acceptable. If safety data sheets will be stored on a computer, they must be on a computer that is accessible to everyone in the lab. The format of SDSs, including section numbers, headings and descriptions, are located in the table below:

<table>
<thead>
<tr>
<th>Section</th>
<th>Section Heading</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identification</td>
<td>Product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use</td>
</tr>
<tr>
<td>2</td>
<td>Hazard(s) identification</td>
<td>All hazards regarding the chemical; required label elements</td>
</tr>
<tr>
<td>3</td>
<td>Composition/ information on ingredients</td>
<td>Information on chemical ingredients; trade secret claims</td>
</tr>
<tr>
<td></td>
<td>First-aid measures</td>
<td>Important symptoms/effects, acute, delayed; required treatment</td>
</tr>
<tr>
<td>---</td>
<td>--------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>5</td>
<td>Fire-fighting measures</td>
<td>Suitable extinguishing techniques, equipment; chemical hazards from fire</td>
</tr>
<tr>
<td>6</td>
<td>Accidental release measures</td>
<td>Emergency procedures; protective equipment; proper methods of containment and cleanup</td>
</tr>
<tr>
<td>7</td>
<td>Handling and storage</td>
<td>Lists precautions for safe handling and storage, including incompatibilities</td>
</tr>
<tr>
<td>8</td>
<td>Exposure controls/personal protection</td>
<td>Includes OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE)</td>
</tr>
<tr>
<td>9</td>
<td>Physical and chemical properties</td>
<td>Lists the chemical's characteristics</td>
</tr>
<tr>
<td>10</td>
<td>Stability and reactivity</td>
<td>Chemical stability and possibility of hazardous reactions</td>
</tr>
<tr>
<td>11</td>
<td>Toxicological information</td>
<td>Routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity</td>
</tr>
<tr>
<td>12</td>
<td>Ecological information</td>
<td>Non-mandatory—Information on the environmental impact of the chemical</td>
</tr>
<tr>
<td>13</td>
<td>Disposal considerations</td>
<td>Non-mandatory—Guidance on proper disposal practices, recycling, or reclamation</td>
</tr>
<tr>
<td>14</td>
<td>Transport information</td>
<td>Non-mandatory—Guidance on classification for shipping and transportation</td>
</tr>
<tr>
<td>15</td>
<td>Regulatory information</td>
<td>Non-mandatory—Identifies any safety, health and environmental regulations not covered elsewhere in the SDS</td>
</tr>
</tbody>
</table>
Lab personnel are responsible for understanding the contents of safety data sheets to ensure proper chemical handling, storage, and disposal. Safety data sheets can be obtained through the website located on the *UConn Laboratory Safety Information Card*, the EHS website, manufacturer’s websites, or other reliable sources.

**D. Workplace Hazard Assessment Form**

Every lab is required to complete a *Workplace Hazard Assessment Form (WHA)*. The WHA form was designed to help UConn supervisory personnel choose appropriate personal protective equipment (PPE) for their workers. A copy of the workplace hazard assessment form must be sent to EHS and another copy must be present in the lab. The form is required to be updated whenever operations in the lab change or warrant the use of new personal protective equipment. Both instructions for completing the form and the form itself can be reviewed and completed on the EHS website.

**E. Safety Information Cards**

Every laboratory is required to complete and post the *UConn Emergency Information Card* on the exterior door of the lab. The card is used by emergency personnel to contact the principal investigator and/or laboratory/facility manager if an accident occurs in the lab. The card must be updated whenever changes to lab personnel occur. A copy of the card is located below:
Every laboratory is also required to complete and post a Laboratory Safety Information Card on the interior door of the lab. This card is used to identify the location(s) of safety-related documentation (e.g., chemical inventory, safety data sheets, workplace hazard assessment form, etc.) required in each lab. A copy of the card is located below:

**Figure 2. Laboratory Safety Information Card**

*The Principal Investigator or Laboratory/Facility Manager is:*

*The Laboratory’s Chemical Hygiene Plan is located:*
http://www.ehs.uconn.edu/Chemical/chemplan.php OR

*The Laboratory’s Safety Data Sheets (SDSs) are located:*
http://www.msds.com/ OR

*The Laboratory’s Chemical Inventory is located:*

*The Laboratory’s Workplace Hazard Assessment is located:*

University of Connecticut
Division of Environmental Health & Safety
860-486-3613
www.ehs.uconn.edu
IX. Chemical Management

The OSHA Laboratory Standard applies to chemicals that exhibit health and physical hazards. Each type of hazardous chemical has been assigned a hazard class(s), pictogram(s) and hazard category(s) by manufacturers or importers based on scientifically-validated methods, tests, and evidence. The health and/or physical hazard class(s) for each chemical is listed in the safety data sheet. Lab personnel are responsible for recognition and control of chemicals that pose health and physical hazards in their research.

Pictograms are required on original container labels and safety data sheets to alert users of the chemical hazards to which they may be exposed. Each pictogram represents a distinct hazard(s) identified by a symbol on a white background framed within a red border. The pictogram(s) is determined by chemical manufacturers and importers. Chemicals can have one or multiple pictograms.

Hazard category refers to the division of criteria within each hazard class (e.g., Flammable Liquids are divided into four hazard categories numbered from Category 1 through Category 4). These categories compare hazard severity within a specific hazard class (e.g., a Category 1 flammable liquid is considered a more severe hazard than a Category 4 based on lower flashpoints and boiling points). Most categories are classified based on a number (e.g., 1, 2, 3, etc.) and in some cases, a subcategory letter (e.g., 1A, 1B, 1C, etc.). Categories are ranked in severity by descending order (i.e., Category 1 or 1A is considered a more severe than Category 2 or 1B). Lab personnel must be familiar with the hazard category for each chemical in use to properly assess the risks involved.

A. Health Hazard Classes

The definitions, pictograms, and categories of each type of health hazard defined by OSHA are listed below:
<table>
<thead>
<tr>
<th>Health Hazard Class Definition</th>
<th>Pictogram(s)</th>
<th>Category Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute toxicity</strong> refers to those adverse effects occurring following oral or dermal administration of a single dose of a substance, multiple doses given within 24 hours, or an inhalation exposure of 4 hours.</td>
<td>![Skull and Crossbones] ![Exclamation Mark]</td>
<td>1,2,3,4</td>
</tr>
<tr>
<td><strong>Aspiration</strong> means the entry of a liquid or solid chemical directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system.</td>
<td>![Person Silhouette with Exclamation Mark]</td>
<td>1</td>
</tr>
<tr>
<td><strong>Carcinogen</strong> means a substance or a mixture of substances that induce cancer or increase its incidence.</td>
<td>![Person Silhouette with Cancer Symbol]</td>
<td>1A,1B,2</td>
</tr>
<tr>
<td><strong>Eye irritation</strong> is the production of changes in the eye following the application of test substance to the anterior surface of the eye that are fully reversible within 21 days of application.</td>
<td>![Exclamation Mark]</td>
<td>2A</td>
</tr>
<tr>
<td><strong>Mutation</strong> is defined as a permanent change in the amount or structure of the genetic material in a cell.</td>
<td>![Person Silhouette with Cancer Symbol]</td>
<td>1A,1B,2</td>
</tr>
<tr>
<td><strong>Reproductive toxicity</strong> includes adverse effects on sexual function and fertility in adult males and/or females, as well as adverse effects on development of the offspring.</td>
<td>![Person Silhouette with Cancer Symbol]</td>
<td>1A,1B,2</td>
</tr>
<tr>
<td><strong>Respiratory sensitizer</strong> means a chemical that will lead to hypersensitivity of the airways following inhalation of the chemical.</td>
<td><img src="image" alt="Chemical" /></td>
<td>1A,1B</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Serious eye damage</strong> is the production of tissue damage in the eye, or serious physical decay of vision, following application of a test substance to the anterior surface of the eye, that is not fully reversible within 21 days of application.</td>
<td><img src="image" alt="Eye" /></td>
<td>1</td>
</tr>
<tr>
<td><strong>Skin corrosion</strong> is the production of irreversible damage to the skin; namely, visible necrosis through the epidermis and into the dermis, following the application of a test substance for up to 4 hours.</td>
<td><img src="image" alt="Eye" /></td>
<td>1A,1B,1C</td>
</tr>
<tr>
<td><strong>Skin irritation</strong> is the production of reversible damage to the skin following the application of a test substance for up to 4 hours.</td>
<td><img src="image" alt="Eye" /></td>
<td>2</td>
</tr>
<tr>
<td><strong>Skin sensitizer</strong> means a chemical that will lead to an allergic response following skin contact.</td>
<td><img src="image" alt="Eye" /></td>
<td>1A,1B</td>
</tr>
<tr>
<td><strong>Specific target organ toxicity- single exposure (STOT-SE)</strong> means specific, nonlethal target organ toxicity arising from a single exposure to a chemical.</td>
<td><img src="image" alt="Eye" /></td>
<td>1,2,3</td>
</tr>
<tr>
<td><strong>Specific target organ toxicity- repeated exposure (STOT-RE)</strong> means specific target organ toxicity arising from repeated exposure to a substance or mixture.</td>
<td><img src="image" alt="Eye" /></td>
<td>1,2</td>
</tr>
</tbody>
</table>

*Table derived from [OSHA 1910.1200 App A](osha.gov).
B. Physical Hazard Classes

The definitions, pictograms, and categories of each type of each physical hazard defined by OSHA are listed below:

Table 11. Physical Hazards

<table>
<thead>
<tr>
<th>Physical Hazard Definition</th>
<th>Pictogram(s)</th>
<th>Category Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemicals that, in contact with water, emit flammable gases</strong> are solid or liquid chemicals that, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.</td>
<td><img src="image1" alt="Pictogram" /></td>
<td>1,2,3</td>
</tr>
<tr>
<td>A chemical that is <strong>corrosive to metals</strong> means a chemical which by chemical action will materially damage, or even destroy, metals.</td>
<td><img src="image2" alt="Pictogram" /></td>
<td>1</td>
</tr>
<tr>
<td><strong>Explosive chemicals</strong> are solid or liquid chemicals that are capable of self-reaction to produce gas at such a temperature, pressure and speed as to cause damage to the surroundings.</td>
<td><img src="image3" alt="Pictogram" /></td>
<td>1,1, 1.2, 1.3, 1.4, 1.5, 1.6</td>
</tr>
<tr>
<td><strong>Flammable gas</strong> means a gas having a flammable range with air at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 psi).</td>
<td><img src="image4" alt="Pictogram" /></td>
<td>1,2</td>
</tr>
<tr>
<td><strong>Flammable liquid</strong> means a liquid having a flash point of not more than 93°C (199.4°F).</td>
<td><img src="image5" alt="Pictogram" /></td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td><strong>Flammable solid</strong> means a solid that is a readily combustible solid, or that may cause or contribute to fire through friction.</td>
<td><img src="image6" alt="Pictogram" /></td>
<td>1,2</td>
</tr>
<tr>
<td><strong>Gases under pressure</strong></td>
<td><strong>Compressed gases, liquefied gases, dissolved gases, refrigerated liquefied gases</strong></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>are gases that are contained in a receptacle at a pressure of 200 kPa (29 psi) (gauge) or more, or that are liquefied or liquefied and refrigerated.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Organic peroxide</strong></th>
<th><strong>A,B,C,D,E,F,G</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>means a liquid or solid organic chemical that contains the bivalent -O-O- structure and as such is considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Oxidizing liquid</strong></th>
<th><strong>1,2,3</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>means a liquid that, while in itself is not necessarily combustible, may cause or contribute to the combustion of other material, generally by yielding oxygen.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Oxidizing solid</strong></th>
<th><strong>1,2,3</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>means a solid that, while in itself is not necessarily combustible, may cause or contribute to the combustion of other material, generally by yielding oxygen.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Pyrophoric liquid</strong></th>
<th><strong>1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>means a liquid that, even in small quantities, is liable to ignite within five minutes after coming into contact with air.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Pyrophoric solid</strong></th>
<th><strong>1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>means a solid that, even in small quantities, is liable to ignite within five minutes after coming into contact with air.</td>
<td></td>
</tr>
</tbody>
</table>
**Self-reactive chemicals** are thermally unstable liquid or solid chemicals liable to undergo a strongly exothermic decomposition even without participation of oxygen (air).

<table>
<thead>
<tr>
<th>Self-heating chemicals</th>
<th>A,B,C,D,E,F,G</th>
</tr>
</thead>
<tbody>
<tr>
<td>are a solid or liquid chemicals, other than a pyrophoric liquid or solid, which, by reaction with air and without energy supply, is liable to self-heat; this chemical differs from a pyrophoric liquid or solid in that it will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).</td>
<td>1,2</td>
</tr>
</tbody>
</table>

*Table derived from [OSHA 1910.1200 App B](https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10350).*

**C. Chemical Labeling**

All chemicals and samples used or created in laboratories must be properly labeled. All new chemicals brought into labs must be labeled with a product identifier, signal word, hazard statement(s), precautionary statement(s), pictogram(s), and the name, address, and telephone number of the chemical manufacturer, importer, or other responsible party. Existing chemicals present in labs prior to December 2015, must be labeled with, at a minimum, a chemical name.

1. **Original Containers**

   Original chemical bottles must have labels that are written in English (other languages may also be included, if necessary), legible, and prominently displayed on the container. Lab personnel are responsible for ensuring that labels on incoming containers of hazardous chemicals are not removed or defaced. Existing chemical labels that have become illegible must be relabeled to identify contents.

2. **Secondary Containers**

   Secondary containers (e.g., beakers, flasks, jars, spray bottles, etc.) holding chemicals or samples must be properly labeled with the chemical name(s) and hazard class(s). The full name(s) of the hazard class(s) (e.g., Flammable, Corrosive, Reproductive toxicant, etc.) can be written out on the secondary container or the
The corresponding OSHA GHS pictogram can be affixed to the container. A list of approved OSHA GHS pictograms for both health and physical hazards is outlined below:

Table 12. Health & Physical Hazard Pictograms

<table>
<thead>
<tr>
<th>HEALTH HAZARDS</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hazard Symbol</strong></td>
<td><strong>Pictogram</strong></td>
</tr>
<tr>
<td>Exclamation Mark</td>
<td><img src="Image" alt="Exclamation Mark" /></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrosion</td>
<td><img src="Image" alt="Corrosion" /></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Skull &amp; Crossbones</td>
<td><img src="Image" alt="Skull &amp; Crossbones" /></td>
</tr>
<tr>
<td>Health Hazard (Silhouette of a person with a starburst on the chest)</td>
<td><img src="Image" alt="Health Hazard" /></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PHYSICAL HAZARDS</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hazard Symbol</strong></td>
<td><strong>Pictogram</strong></td>
</tr>
<tr>
<td>Exploding Bomb</td>
<td><img src="Image" alt="Exploding Bomb" /></td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
D. Chemical Segregation and Storage

Chemicals must be stored according to compatibility and hazard class. Incompatible chemicals stored in the same cabinet can react with other chemicals and degrade labels, containers, and cabinets. Lab personnel are required to review safety data sheets (SDSs) to obtain proper storage, stability, and compatibility guidelines. Incompatible chemicals must not be stored alphabetically or in close proximity of one another. At a minimum, chemicals must be segregated into the following hazard classes:

<table>
<thead>
<tr>
<th>Hazard Class</th>
<th>Recommended Storage Method</th>
<th>Common Chemical Examples</th>
<th>Common Incompatibles (Always Consult SDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosive Acids-</td>
<td>Store in corrosives cabinet, or on protected shelving and in secondary containment. Secondary containment must be used when storing acids on bare metal.</td>
<td>*Hydrochloric acid, Sulfuric acid, Phosphoric acid, *Nitric acid</td>
<td>Flammable liquids, flammable solids, bases and oxidizers, organic acids, cyanides, sulfides</td>
</tr>
<tr>
<td>Inorganic</td>
<td>*Oxidizing acids must be stored in a separate, compatible secondary containment bin.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrosive Acids-</td>
<td>Store in corrosives cabinet, or on protected shelving and in secondary containment away from inorganic acids.</td>
<td>Acetic acid, Trichloroacetic acid, Formic acid</td>
<td>Flammables, bases and oxidizers, inorganic acids, cyanides, sulfides</td>
</tr>
<tr>
<td>Organic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| Flame               | ▪ Flammable ▪ Pyrophoric ▪ Self-heating ▪ Emits flammable gas ▪ Self-reactive ▪ Organic peroxide |                                           |                                           |
| Flame Over Circle   | ▪ Oxidizers                                                                                  |                                           |                                           |
| Gas Cylinder        | ▪ Gases under pressure                                                                       |                                           |                                           |</p>
<table>
<thead>
<tr>
<th>Category</th>
<th>Storage Instructions</th>
<th>Examples</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosive Bases-Inorganic</td>
<td>Secondary containment must be used when storing acids on bare metal.</td>
<td>Ammonium hydroxide, Potassium hydroxide, Sodium hydroxide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*If stored together, organic acids must be separated from flammable chemicals using a secondary containment bin.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrosive Bases-Organic</td>
<td>Store in corrosive cabinet, or on protected shelving away from acids.</td>
<td>Hydroxylamine, Tetramethylenelethylene diamine, Triethylamine</td>
<td>Oxidizers, hypochlorites, inorganic bases</td>
</tr>
<tr>
<td>Explosives</td>
<td>Store in a secure location away from other chemicals, store in areas away from shock or friction.</td>
<td>Trinitrophenol, Picric acid, Diazoisobutyl nitrite</td>
<td>Consult SDS and/or EHS</td>
</tr>
<tr>
<td>General Stock Chemicals</td>
<td>Store on lab benches or shelves with other stock chemicals.</td>
<td>Sodium chloride, Potassium phosphate, agar</td>
<td>Consult SDS and/or EHS</td>
</tr>
<tr>
<td>Flammable Solids</td>
<td>Store in cool dry area away from oxidizers and corrosives.</td>
<td>Carbon, Charcoal, Paraformaldehyde</td>
<td>Acids, bases, oxidizers</td>
</tr>
<tr>
<td>Oxidizers</td>
<td>Store in secondary containment with non-combustibles or inorganic materials.</td>
<td>Perchlorates, Permanganates, Nitrates</td>
<td>Flammables, combustibles, organic materials</td>
</tr>
<tr>
<td>Toxics</td>
<td>Store in a ventilated, dry, cool area, as recommended by the manufacturer.</td>
<td>Cyanides, Heavy metal compounds (e.g., cadmium, mercury)</td>
<td>Flammable liquids, acids, bases, reactives, oxidizers. Consult EHS for assistance.</td>
</tr>
<tr>
<td>Water-Reactive</td>
<td>Store in a cool dry location. Protect from sources of</td>
<td>Sodium, Lithium, Potassium metals, Sodium borohydride</td>
<td>Aqueous solutions,</td>
</tr>
</tbody>
</table>
**Safety data sheets must be consulted for specific manufacturer storage and compatibility guidelines.**

Each hazard class should be stored in a separate cabinet or location in the lab. If separate cabinets are not available, chemicals of different hazard classes, in limited cases, can be segregated by placing them on separate shelves in separate secondary containment bins within individual cabinets.

The following chemical storage requirements must be followed in laboratories:

- Flammable chemicals should be stored in an approved flammable storage cabinet or refrigerator.
- No more than 10 gallons of flammable liquids can be stored outside of a rated flammable storage cabinet.
- Tightly seal containers to minimize the vapor release.
- Corrosive liquids must be stored below eye level (i.e., approximately 5 feet or below).
- Limited quantities of hazardous chemicals should be stored on benches, floors, or in fume hoods.
- If storage of hazardous chemicals on floors must occur, secondary containment is required.
- Secondary containment bins are recommended to retain materials if the primary container breaks or leaks.
- Acutely toxic chemicals must be stored in dedicated cabinets.
- Chemical shelving must be firmly secured to walls.
- Chemicals must not be stored on top of cabinets.
- Chemicals must be stored away from heat and direct sunlight.
- Off-specification, expired, and other chemicals with no useful purpose in the lab should be disposed of through EHS.

**E. Chemical Transport**

Chemicals will be delivered directly to laboratories or central delivery areas. When chemicals must be transported to other locations within or outside of the building,
individuals must ensure that the following measures are taken to protect chemicals during transport.

- Secondary containment must be used during transport.
- The secondary containment must be large enough to contain the contents of the bottle(s) being transported in the event of breakage.
- Secondary containers must be leak and break-resistant.
- Ensure chemicals are tightly sealed prior to transport.
- Chemicals must not be left unattended during transport.
- Sturdy carts with secondary containment must be used for transporting multiple, heavy, or large containers.
- Avoid transporting chemicals on stairs. Use elevators (preferably a freight elevator) when moving chemicals between floors.
- Contact EHS (486-3613) prior to transporting unstable or explosive chemicals.
- Wear appropriate personal protective equipment (PPE).
- Avoid high-traffic areas.
- Prior to moving large quantities of hazardous chemicals (e.g., relocating to another building), contact EHS (486-3613) to ensure compliance with federal, state, and local laws.

**Note:** EHS must be contacted when chemicals are relocated from their original assigned location to another location within or outside of the building to maintain compliance with the *Laboratory Chemical Inventory Program*.

## X. Standard Operating Procedures

All individuals working in UConn laboratories must follow the standard lab procedures listed in the *Chemical Hygiene Plan*. Additional lab-specific policies or work practices required by the PI or Laboratory/Facility Manager must also be followed by lab personnel. Lab-specific policies and practices must be at least as stringent as the guidelines in the CHP.

### A. General Requirements

- Avoid working alone in laboratories. Review the *Working Alone Policy* to understand responsibilities and disciplinary actions for violation of the policy.
- Unauthorized individuals are not allowed in laboratories. Access is limited to University lab personnel and visitors with legitimate reasons for being in such a laboratory. Authorized individuals must be properly trained, made aware of the
hazards present in the lab, and provided appropriate personal protective equipment.

- Pets are not allowed in laboratories, with limited exceptions for police dogs and service animals (e.g., guide dogs) as permitted by the Animals on Campus policy. The only live vertebrate animals allowed in laboratories are those to be used in teaching and research and must be approved prior to entry by the Institutional Animal Care and Use Committee (IACUC).
- Review the safety data sheet(s) for all applicable chemicals prior to use.
- Substitute a hazardous chemical with a safer alternate, or reduce the quantities of hazardous chemicals being used whenever possible.
- Review the CHP and laboratory-specific standard operating procedures.
- Identify and understand how to properly use emergency equipment. No individual working in a laboratory is allowed to use a fire extinguisher without training through UCFD.
- Know procedures for emergencies, including evacuation routes.
- Wear personal protective equipment (PPE) as specified in the Workplace Hazard Assessment Form, safety data sheets, or equipment specifications.
- At a minimum, ANSI-approved safety glasses or goggles, clothing that covers the legs, and closed-toed footwear (e.g., no sandals, flip-flops, etc.) must be worn at all times in active lab areas. Corrective eyeglasses must be used in conjunction with safety eyewear unless the eyeglasses comply with ANSI standard Z87.1.
- Inspect equipment and personal protective equipment (PPE) for damage prior to use. Replace or repair damaged equipment or PPE.
- Use a properly functioning chemical fume hood or other local ventilation when working with hazardous chemicals.
- Label all secondary containers (e.g., a beaker, flask, vial, jar, etc.) containing hazardous chemicals and samples in with the chemical name(s) and hazard class(s).
- Use all chemicals and equipment for their intended purpose.
- A first aid kit should be available for emergency use.
- Use spill trays under equipment to catch accidental spills or overflow of liquids.
- Report accidents, spills, or other emergencies to the principal investigator or laboratory/facility manager and EHS.

B. Personal Hygiene

- Do not eat, drink, smoke, chew gum, or apply cosmetics in active lab areas.
- Do not store food, beverages, tobacco, or cosmetic products in active lab areas.
- Never touch a hazardous chemical without appropriate hand protection.
- Never attempt to smell, inhale, or taste a hazardous chemical.
- Do not reuse disposable gloves.
- Do not use mouth suction to pipet. Use a pipet bulb or similar device.
- Secure loose-fitting jewelry.
- Tie back and secure long hair.
- Lab coats are recommended for all research involving hazardous chemicals. Specific required lab attire must be documented in the WHA form.
- Lab coats, gloves, and other personal protective equipment are not allowed outside of active lab areas.
- Wash hands thoroughly with soap and water before and after handling chemicals, and prior to exiting the lab.
- Wash affected areas promptly whenever a chemical has come in contact with the skin.
- Remove and properly manage contaminated clothing and gloves before leaving the laboratory.
- Contaminated clothing and other reusable personal protective equipment must be laundered by an approved vendor. Contaminated clothing must never be taken home for cleaning.
- All contaminated materials and equipment must be decontaminated prior to reuse or disposal.

C. Housekeeping

- Fire alarms, fire extinguishers, electrical panels, disconnect switches, first aid kits, safety showers, eyewash stations, and other safety-related equipment must remain unobstructed and be appropriately marked.
- Aisles, hallways, and stairs must be kept clear of chemicals and equipment.
- Lab benches, floors, shelving, and equipment must be kept clean and orderly and in a sanitary condition.
- Lab benches must be cleared of additional chemicals, materials, and equipment that are not necessary to perform current research.
- Lab benches and equipment must be cleaned and/or decontaminated at the end of each experiment and each work day.
- Laboratory doors must be kept closed to minimize the spread of chemical vapors, pathogens, or smoke in case of an accident.
- Materials, including chemicals, wastes, equipment, cords, and other objects, must be stored in a manner that does not create a hazard for workers.
- Storage of flammable/combustible materials (e.g., rags, paper, cardboard, etc.) must be limited.
- Order only chemicals in amounts that will be used in the foreseeable future. Excessive storage increases the potential for chemical exposure/accidents.
- Lab equipment must be regularly inspected and maintained, and repaired whenever necessary.
- Floors must remain clean and dry.
- Floors must be free of obstructions that could pose a slip, trip, or fall hazard.
- Vacuum equipment must be trapped or filtered.
- Chemicals must be placed in assigned storage areas at the end of each day.
- Spills must be cleaned up immediately.
- All belts, pulleys, fans, and other moving parts must be appropriately guarded.
- Space heaters are not allowed in laboratories.
- Hazardous waste must be labeled and managed properly.
- Sharps must be disposed of in approved sharps containers provided by EHS.

D. Electrical Safety

1. Electrical Panels
   - Lab personnel should know the location of electrical panels and disconnect switches so that power can be quickly shut down in the event of a fire or electrical accident.
   - Disconnect switches must remain unobstructed.
   - A minimum 3-foot clearance must be maintained in front of electrical panels at all times to permit ready and safe operation and maintenance of such equipment.
   - Electrical boxes with conductors, receptacles, and switches, etc., must have covers in place and show no signs of damage.

2. Electrical Cords
   - Electrical cords must not be frayed, twisted, worn, abraded, corroded, or used with exposed wires or missing ground pins.
   - Electrical cords must be sized in accordance with the load that the cord will carry and the environment they are exposed to.
   - Extension cords are only to be used on a temporary basis.
- Extension cords must not be used as a substitution for fixed receptacle outlets.
- Multi-tap power strips are only allowed for use with computer or electronic equipment that normally does not draw excessive amperage per the ratings on the unit.
- Extension cords and/or power strips must never be linked together (i.e., daisy-chaining).
- Electrical cords must not run through doors, walls or partitions, under rugs, or above drop ceilings. They must not be tied in knots, draped overhead, or attached to building structures.
- Electrical cords should be grounded (do not remove ground prongs).
- Electrical circuits must never be overloaded.

3. Electrical Equipment

- Electrical equipment must be kept away from wet or damp locations, unless specifically rated for use under such conditions.
- Live parts must be effectively insulated or physically guarded.
- Enclose all power supplies to prevent contact with power circuits.
- Use a ground fault circuit interrupter when using electrical devices in, or in close proximity to, wet environments. In some cases, it may be necessary to install ground fault circuit interrupting devices in the circuits being utilized.
- Keep flammable and corrosive materials away from electrical equipment, unless the equipment is rated for such environments by the manufacturer.
- Minimize condensation that may enter electrical equipment placed in cold rooms or refrigerators.
- Repairs and maintenance of electrical equipment must be conducted by a qualified person as defined in the UConn Electrical Safety Program.

E. Research Approval

Laboratory personnel must obtain approval from their principal investigator prior to:

- Performing new or unfamiliar procedures.
- Using highly reactive or toxic chemicals (e.g., pyrophoric chemicals, hydrofluoric acid, etc.).
- Performing highly hazardous procedures (e.g., potential for violent reaction, generation of a toxic gas, etc.).
- Working alone in an immediately hazardous environment.
Laboratory personnel must obtain further approval to proceed with existing laboratory procedures from their principal investigator when:

- A change in quantity and/or volume or substitution of the chemicals in the procedure is planned. Principal investigators must determine the quantity/volume for which further approval is required.
- A change in the agreed-upon experimental set-up is planned.
- Signs of a failure in safety design or equipment are observed.
- Signs or symptoms of a chemical exposure are observed.
- Unexpected and/or potentially dangerous experimental results occur (e.g., fire, uncontrolled buildup of heat and/or pressure, etc.).

The principal investigator and EHS are available to assist laboratory personnel in reviewing hazards associated with any procedure, equipment, or chemical to be used in the laboratory to ensure that appropriate safety procedures and safeguards are established.

F. Laboratory Inspections

EHS conducts laboratory safety inspections to ensure compliance with federal and state laws and regulations, along with University policies and standards. Priority will be given to laboratories using highly reactive, toxic, or potentially explosive substances. Standards to achieve laboratory compliance are outlined in the Laboratory Inspection Program. The EHS inspection procedure is outlined below:

1. EHS will contact the principal investigator or laboratory/facility manager of each laboratory in advance of the inspection.

2. EHS will inspect the laboratory.

3. A copy of the inspection report will be sent to the principal investigator and/or laboratory/facility manager within 7 business days.

4. The principal investigator and/or laboratory/facility manager must take corrective action and respond to EHS within 21 days of receipt of the inspection report.

5. Laboratories identified with unsafe conditions will be re-inspected by EHS. Re-inspections may be either announced or unannounced. If progress is unsatisfactory,
a second inspection report will be sent to the principal investigator and/or laboratory/facility manager and the department head.

In addition to EHS inspections, self-inspections should be carried out regularly by laboratory personnel to confirm compliance and identify safety related issues. An inspection checklist is available in the Laboratory Inspection Program to help facilitate the inspection process.

G. Laboratory Security

Lab personnel must take measures to ensure labs remain secure to prevent theft, sabotage, or vandalism. The following measures must be taken to ensure labs remain secure:

- Keep laboratory doors closed at all times and locked when unoccupied.
- Ensure doors to cold rooms, dark rooms, common areas, and storage rooms with hazardous chemicals remain locked when unoccupied.
- Keep an accurate inventory for all chemicals in each lab.
- Provide additional security, such as a locked cabinet, for highly toxic or reactive chemicals.
- Dispose of hazardous chemicals no longer being used through EHS.
- Do not allow unauthorized individuals to enter labs.
- Report thefts, vandalism or other suspicious activities to UCPD immediately.

In addition to the general precautions listed above, applicable labs must also comply with the specific security requirements involving biological select agents and toxins, radioactive isotopes, research animals, and controlled substances.

H. Exposure Monitoring

Personal and/or environmental exposure monitoring may be necessary when lab personnel exhibit signs or symptoms of a chemical exposure or perform experiments using hazardous chemicals without adequate ventilation. Principal investigators, laboratory/facility managers, and laboratory personnel are responsible for contacting EHS when laboratory activities have or could lead to an actual or potential overexposure. In such cases, EHS will perform an exposure assessment and may conduct specific quantitative exposure monitoring. Monitoring results will be sent to the PI and all affected individuals. The results of the monitoring will be kept on file at EHS.
XI. Controlling Workplace Hazards

Efforts must be made to control hazardous or potentially hazardous conditions in laboratories. The hierarchy of controls is a system that lists hazard controls in descending order from the most effective to the least. The hierarchy of controls is listed below:

**Hierarchy of Control for Workplace Hazards**

![Hierarchy of Control Diagram]

Procedures must be followed in laboratories to both control the hazard and control worker exposure to the hazard. The primary methods for controlling exposure to respiratory hazards in the workplace must be through elimination, substitution with less toxic materials, or through engineering controls such as ventilation or enclosure of an operation. If such controls are not feasible or cannot alone reduce exposures to acceptable levels, appropriate administrative controls and/or personal protective equipment must be used, preferably in conjunction with engineering controls, to minimize worker exposure to hazards.

A. Engineering Controls

Engineering controls seek to control hazards at their source by designing the work environment or the job itself to eliminate or reduce exposure to hazards. Examples of engineering controls include:
- Purchasing equipment that provides a barrier between the hazard(s) and the individual(s);
- Redesigning existing equipment to reduce hazards;
- Change of a process to minimize contaminant release;
- Use of barriers, shields, or enclosures to isolate a hazard or a person; and
- Use of local exhaust ventilation.

1. **Fume Hoods**

Fume hoods are the most important engineering control used in labs to protect workers from exposure to hazardous chemicals. All procedures or operations that generate irritating and/or hazardous air contaminants should be conducted inside a fume hood. EHS inspects all constant velocity and variable air volume fume hoods to ensure proper flow rates. The parameters used to assess proper flow rates are listed in the table below.

<table>
<thead>
<tr>
<th>Hood Sticker</th>
<th>Flow Rate (linear feet per minute)</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>80-120</td>
<td>SAFE TO USE</td>
</tr>
<tr>
<td>Yellow</td>
<td>60-79 or 121-150</td>
<td>USE CAUTION</td>
</tr>
<tr>
<td>Red</td>
<td>&lt;60 or &gt;150</td>
<td>DO NOT USE</td>
</tr>
</tbody>
</table>

EHS initiates work orders through Facilities Operations for all fume hoods that receive yellow or red stickers. Facilities Operations will contact EHS to recheck the hoods once repairs have been completed. Lab personnel must not use red-tagged fume hoods until EHS re-inspects and assures proper function. Yellow-tagged fume hoods may be used under certain conditions, as indicated by the principal investigator, laboratory/facility manager, and/or EHS.

The following work practices, at a minimum, must be followed while working in fume hoods:
Table 15. Fume Hood Work Practices

<table>
<thead>
<tr>
<th>Work Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Keep all apparatus and chemicals at least <strong>6 inches</strong> back from the front face of the hood.</td>
</tr>
<tr>
<td>2. Do not store chemicals or apparatus in the hood. Keep only those chemicals and materials necessary for the current procedure.</td>
</tr>
<tr>
<td>3. Keep the hood sash lowered as much as possible. <strong>Never exceed 18 inches.</strong> For hoods with horizontal sash panels, at least one panel should be positioned between the user’s body and the work in the hood (i.e., arms wrapped around the sliding horizontal panel).</td>
</tr>
<tr>
<td>4. Do not use the hood to volatilize chemicals or wastes (i.e., allow chemicals to evaporate).</td>
</tr>
<tr>
<td>5. Keep the slots in the hood baffles free of obstruction.</td>
</tr>
<tr>
<td>6. Never use electrical outlets inside the hood. Run all equipment cords to outlets outside of the hood.</td>
</tr>
<tr>
<td>7. Elevate large equipment (e.g., a centrifuge) at least two inches off the base of the hood interior.</td>
</tr>
<tr>
<td>8. Fume hoods must remain working at all times when chemicals are present in the hood.</td>
</tr>
<tr>
<td>9. Keep the hood sash closed when not in use.</td>
</tr>
<tr>
<td>10. Lab personnel must be aware of the lab-specific procedures to follow in the event of a fume hood failure.</td>
</tr>
<tr>
<td>11. Never work in a fume hood that is not running properly. Remove chemicals from hood, close the sash, and contact EHS (486-3613) to retest the hood and initiate a work order.</td>
</tr>
</tbody>
</table>

**Caution:** Using perchloric acid in a standard fume hood can lead to accumulation of explosive perchlorate salts in the ductwork. Prior to using heated or concentrated perchloric acid in a chemical fume hood, contact EHS at 860-486-3613 for approval.

2. Gloveboxes

Gloveboxes are enclosed compartments with tight-closing doors or air locks and armholes with impervious gloves sealed into the box. They can be under either positive or negative pressure and are designed to provide a separate atmosphere for hazardous materials that are sensitive to air, water vapor, or other air contaminants. Depending on the material in use, exposure to air contaminants can lead to rapid degradation or a violent reaction. The following work practices must be followed while working in gloveboxes:
• The principal investigator or laboratory/facility manager must ensure that all personnel are trained prior to working in the glovebox. Training should be documented.
• The principal investigator or laboratory/facility manager is responsible for ensuring the glovebox, vacuum pump and associated cords, lines, gauges, solvent scrubbers, and/or other associated equipment have been installed and are used as specified by the manufacturer.
• Inspect the gloves, windows, vacuum pump, lines, and connections for signs of damage or deterioration (e.g., holes, discoloration, etc.) prior to each use.
• Maintain the glovebox as specified by the manufacturer, including routine maintenance and service contracts.
• Wear nitrile gloves inside the glovebox gloves to extend the life of the glovebox gloves and avoid cross-contamination.
• Ensure back-up procedures are in place for a loss of power or an absence of required compressed gases.

3. Other Sources of Ventilation

In addition to fume hoods and gloveboxes, other forms of ventilation including biosafety cabinets, canopy hoods, clean benches, downdraft tables, ductless fume hoods, elephant trunks, slot hoods, toxic gas cabinets, and other devices may be present in labs. Local exhaust ventilation (LEV) refers to systems designed to enclose or capture and remove contaminated air at the source. Other sources of ventilation are only designed to protect samples or products from contamination. Types and descriptions of other sources of ventilation are indicated in the table below:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biosafety Cabinets</td>
<td>Biosafety cabinets use one or more HEPA filters to deliver clean, nearly particulate free, air to a work surface. Biosafety cabinets (BSC) are designed to protect the product, the worker and the environment from contamination. BSCs must be certified annually to ensure the unit's ability to perform its intended function.</td>
</tr>
<tr>
<td>Canopy Hoods</td>
<td>Canopy hoods are one or two-sided overhead hoods primarily used to capture heated air or vapor from ovens or autoclaves. Canopy hoods must not be used to capture hazardous chemicals since most are positioned too high to effectively capture hazardous vapors and draw contaminants through workers' breathing zones.</td>
</tr>
<tr>
<td>Clean Benches</td>
<td>A clean bench is a device that draws air from the lab through a HEPA filter and vents the filtered air downwards onto a work surface.</td>
</tr>
<tr>
<td><strong>Surface to keep the materials nearly free from particulate contamination. Clean benches only protect the product from contamination. These devices are not to be used with hazardous materials as they provide no personal protection.</strong></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>Downdraft Tables</strong></td>
<td>Downdraft hoods or necropsy tables are specially-designed work areas with ventilation slots on the sides of the work area. They are used primarily for animal perfusions and dissections. Downdraft hoods are designed to be used with chemicals with vapor densities that are heavier than air.</td>
</tr>
<tr>
<td><strong>Ductless Fume Hoods</strong></td>
<td>Ductless fume hoods use a fan to draw air into a chamber, through one or more filters, and back into the laboratory. <strong>EHS DOES NOT RECOMMEND THE USE OF DUCTLESS FUME HOODS IN LABS</strong> due to unpredictable filter change-out schedules and low face velocities, which increase turbulence and the risk of recirculating hazardous materials back into the laboratory.</td>
</tr>
<tr>
<td><strong>Elephant Trunks</strong></td>
<td>An elephant trunk, or snorkel, is a piece of flexible duct or hose that is connected to an exhaust duct. They are primarily used to capture discharges from gas chromatographs, pipe nipples, and pieces of tubing. To capture contaminants effectively, the trunk must be positioned very close to the point source (e.g., typically one-half a diameter of the hood from the end of the hose), or it will be susceptible to inefficient capture.</td>
</tr>
<tr>
<td><strong>Slot Hoods</strong></td>
<td>Slot hoods are local exhaust ventilation hoods specially designed to capture contaminants generated according to a specific rate, distance from the hood, and release velocity for specific ambient airflow. They are application-specific (e.g., dark rooms) and must be designed by a qualified engineer to ensure proper function and capture velocity.</td>
</tr>
<tr>
<td><strong>Toxic Gas Cabinets</strong></td>
<td>Gas cabinets are fully enclosed, noncombustible cabinets connected to an exhaust system that are used to provide an isolated environment for highly toxic compressed gas cylinders in storage or in use. Highly toxic or odorous gases should be used and stored in gas cabinets to prevent contamination of the laboratory, in the event of a leak or rupture.</td>
</tr>
</tbody>
</table>

The following guidelines must be adhered to while working with biosafety cabinets, canopy hoods, clean benches, downdraft tables, ductless fume hoods, elephant trunks, slot hoods, toxic gas cabinets, and other sources of ventilation.

- The department, principal investigator, and/or laboratory/facility manager is/are responsible for ensuring that the local exhaust and/or other ventilated devices have been installed as specified by the manufacturer.
- All lab personnel working with the ventilated device must have appropriate training. Training should be documented.
- Inspect the equipment prior to each use.
- Maintain the equipment as indicated by the manufacturer, including routine maintenance and service contracts.
- Wear appropriate personal protective equipment as indicated in the workplace hazard assessment form, safety data sheets, and/or manufacturer equipment specifications.
- Ensure proper backup measures are in place for a loss of power or other equipment failure.

B. Administrative Controls

Administrative controls are policies, work practices, and procedures designed to limit personnel exposure to workplace hazards. Administrative controls are often used in conjunction with engineering controls and personal protective equipment. Examples of administrative controls include:

- Training and education;
- Policies to limit risk of exposure;
- Standard operating procedures;
- Housekeeping;
- Routine maintenance of equipment; and
- Signs and labels.

In addition to the guidelines in the Chemical Hygiene Plan, the principal investigator and/or laboratory/facility manager may implement administrative controls specific to their labs. Lab-specific training and other lab-specific policies and procedures must be conveyed to lab personnel prior to research in the labs.

1. Working Alone in Labs

The Working Alone Policy applies to undergraduates, graduate students, and post-doctoral scholars performing academic or research related work. The policy was developed to minimize the risk of serious injury while working alone with materials, equipment, or in areas that could result in serious injury or an immediate life-threatening hazard. Department heads, principal investigators, laboratory/facility managers, lab workers, and others responsible for assigning work to students must not permit them to work alone in an immediately hazardous environment, as defined in the policy.
2. **Lab-Specific Standard Operating Procedures (LSOPs)**

Lab-specific standard operating procedures (LSOPs) are detailed documents that describe the steps and appropriate safety controls that must be followed prior to performing a given experimental procedure. While the *Chemical Hygiene Plan* provides a general overview of safe work practices with regards to laboratory safety, principal investigators, laboratory/facility managers, and other lab personnel are responsible for developing LSOPs for procedures involving hazardous chemicals and/or processes that fall outside the guidelines of the CHP. LSOPs must provide enough detail so that individuals with limited experience can safely carry out the procedure or process. Specific attention must be paid to chemicals with high degrees of acute toxicity, reactivity (e.g., explosives, pyrophorics, etc.) and other chemicals which can cause severe harm upon single or repeated exposure. Each LSOP must include, at a minimum, the following elements:

**Table 17. Lab-Specific Standard Operating Procedure Format**

<table>
<thead>
<tr>
<th>Section</th>
<th>Section Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Chemical or List of Chemicals</td>
</tr>
<tr>
<td>2.</td>
<td>Administrative Controls</td>
</tr>
<tr>
<td>3.</td>
<td>Engineering Controls</td>
</tr>
<tr>
<td>4.</td>
<td>Work Practices</td>
</tr>
<tr>
<td>5.</td>
<td>Personal Protective Equipment</td>
</tr>
<tr>
<td>6.</td>
<td>Storage</td>
</tr>
<tr>
<td>7.</td>
<td>Spills and Accident Procedures</td>
</tr>
<tr>
<td>8.</td>
<td>First Aid Procedures</td>
</tr>
<tr>
<td>9.</td>
<td>Waste Management</td>
</tr>
<tr>
<td>10.</td>
<td>Decontamination Procedures</td>
</tr>
<tr>
<td>11.</td>
<td>Specific Protocols</td>
</tr>
<tr>
<td>12.</td>
<td>Approval</td>
</tr>
</tbody>
</table>

EHS has developed LSOPs for [hydrofluoric acid](https://en.wikipedia.org/wiki/Hydrofluoric_acid) (HF) and [pyrophoric chemicals](https://en.wikipedia.org/wiki/Pyrophoricity). Principal investigators whose labs use HF or pyrophoric chemicals are responsible for completing the LSOP, signing a copy, ensuring that lab personnel review and sign the LSOP, and modifying the LSOP if procedures change. Every individual working with hydrofluoric acid and pyrophoric chemicals is required to review, follow, and sign a copy of the LSOP. LSOPs for HF and pyrophoric chemicals must be readily available in the lab.
Note: Principal investigators or laboratory/facility managers must develop lab-specific procedures for other chemicals, processes, or operations not covered by the standard operating procedures in the CHP. A blank LSOP template is available for this purpose. LSOPs developed without using this template, must include all the elements noted in the template.

C. Personal Protective Equipment

When engineering or administrative controls are not feasible or do not provide sufficient protection from hazards, principal investigators and/or laboratory/facility managers are responsible for providing appropriate personal protective equipment (PPE) to lab personnel and ensuring its proper maintenance and use. PPE for the eyes, face, hands, head, body, and feet must be of safe design and construction for the work to be performed and be used and maintained in a sanitary and reliable condition. A Workplace Hazard Assessment must be performed to determine the appropriate PPE to be worn in each lab or for specific work activities.

Personal protective equipment must provide a level of protection greater than the minimum required to protect individuals from the hazards identified in the lab. Careful consideration must be given to fit and comfort. PPE that fits poorly will not provide adequate protection. PPE that fits well and is comfortable to wear will encourage further use. Multiple sizes and/or types of PPE may need to be purchased to accommodate all lab personnel. If several different types of PPE are worn together they must be compatible.

PPE must conform to the American National Standards Institute (ANSI)/International Safety Equipment Association (ISEA) or American Society for Testing and Materials (ASTM) requirements that have been incorporated into the OSHA regulations, as follows:

<table>
<thead>
<tr>
<th>PPE</th>
<th>OSHA Standard</th>
<th>ANSI/ASTM Standard</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye &amp; Face Protection</td>
<td>29 CFR 1910.133</td>
<td>ANSI/ISEA Z87.1</td>
<td>Safety glasses/Impact goggles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Surgical masks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Filter lenses</td>
</tr>
</tbody>
</table>

Table 18. Personal Protective Equipment Standards
| Head Protection | 29 CFR 1910.135 | ANSI/ISEA Z89.1 | ▪ Hard hats  
▪ Helmets  
▪ Bump caps |
|-----------------|-----------------|-----------------|-----------------|
| Hand Protection | 29 CFR 1910.138 | ANSI/ISEA 105 | ▪ Abrasion, cut, or puncture-resistant gloves  
▪ Chemical-resistant gloves  
▪ Heat-resistant gloves  
▪ Cold-resistant gloves for working with cryogens |
| Foot Protection | 29 CFR 1910.136 | ASTM F2413 | ▪ Closed-toed footwear  
▪ Puncture-resistant safety shoes  
▪ Slip-resistant footwear  
▪ Foot covers and guards |
| Body Protection | 29 CFR 1910.132 | Not Applicable | ▪ Coveralls  
▪ Lab coats  
▪ Aprons, vests or sleeves  
▪ Heat-resistant clothing |

The minimum personal protective equipment that must be worn in labs where hazardous chemicals are used or stored are **ANSI-approved goggles or safety glasses, clothing that covers the legs, and closed-toed footwear** (i.e., sandals, flip-flops, clogs, or other footwear that expose the front, top, side or back of the feet are not allowed). Lab coats are recommended for all work involving hazardous chemicals. Chemical splash goggles are recommended when handling:

- Chemicals known to cause damage or injury to the eyes;
- Chemicals whose ability to cause damage or injury to the eyes is unknown;
- Liquids over 60°C (140°F); and
- Cryogenic liquids.

Principal investigators or laboratory/facility managers must determine, through the **Workplace Hazard Assessment**, when face shields that protect the chin, neck, and ears must be worn by lab personnel (e.g., increased risk of splashing, flying particles, etc.). Face shields must be used in conjunction with safety goggles or glasses. Additional PPE, as indicated on the lab **Workplace Hazard Assessment Form**, must also be worn by lab personnel.
1. **Glove Selection**

Prior to engaging in work with hazardous chemicals, principal investigators, laboratory/facility managers, and lab personnel must ensure that the gloves being worn are compatible with the substances being handled. The hazards of the chemical, duration of use, temperature, pH, and other properties of the chemical as well as the permeation rate, breakthrough time, and degradation rate of the glove must all be taken into account. No single type of glove will provide adequate protection against all chemicals. **Safety data sheets (SDSs) and the manufacturer's chemical-resistance glove guide must be consulted to ensure proper selection.** Laboratory personnel may consult with EHS for assistance in determining which gloves provide the best protection against specific hazards. The following glove guide gives a general overview of the most common types of chemical-resistant gloves and the types of hazards they can guard against:

<table>
<thead>
<tr>
<th>Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Use Against</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl Rubber</td>
<td>Extended contact time possible</td>
<td>Poor vs. hydrocarbons, chlorinated solvents</td>
<td>Use against polar organics (e.g., glycol ethers, ketones, esters)</td>
</tr>
<tr>
<td>Natural rubber/latex</td>
<td>Good physical properties, dexterity</td>
<td>Incidental contact only, poor vs. oils, organics, hard to detect puncture holes, can trigger latex allergies</td>
<td>Bases, alcohols, dilute water solutions, fair vs. aldehydes, ketones.</td>
</tr>
<tr>
<td>Neoprene</td>
<td>Extended contact time possible, medium chemical resistance, medium physical properties</td>
<td>Poor for halogenated and aromatic hydrocarbons</td>
<td>Good for acids, bases, alcohols, fuels, peroxides, hydrocarbons, and phenols</td>
</tr>
<tr>
<td>Nitrile</td>
<td>Excellent physical properties, dexterity</td>
<td>Incidental contact only, poor vs. benzene, methylene chloride, trichloroethylene, many ketones</td>
<td>Oils, greases, petroleum products and some acids and bases, fair vs. toluene</td>
</tr>
<tr>
<td>Polyvinyl alcohol (PVA)</td>
<td>Resists a very broad range of organics, good physical properties, specific-use glove</td>
<td>Cannot be used with water or water-based solutions, poor vs. light alcohols (e.g., methanol, ethanol)</td>
<td>Aliphatics, aromatics, chlorinated solvents, ketones (except acetone), esters, ethers</td>
</tr>
</tbody>
</table>
### Polyvinyl chloride (PVC)
- Good abrasion resistance, medium chemical resistance, specific-use glove
- Plasticizers can be stripped making gloves rigid, poor for most organic solvents
- Acids, fats and petroleum hydrocarbons

### Fluoroelastomer (Viton)
- Extended contact possible, organic solvents, good resistance to cuts and abrasions
- Poor physical properties, poor vs. some ketones, esters, amines
- Aromatics, chlorinated solvents, also aliphatics and alcohols

### Norfoil
- Extended contact possible, excellent chemical resistance
- Poor fit, easily punctures, poor grip, stiff
- Good for most hazardous chemicals

---

2. **Respirators**

The primary method for controlling exposure to respiratory hazards in the workplace must be through engineering controls such as ventilation, enclosure of an operation, or substitution with less toxic materials. However, when lab personnel may be exposed above recognized exposure limits, respirators must be used if:

- Engineering controls are not feasible;
- Engineering controls alone cannot reduce exposures to acceptable levels; or
- Respirators are used as an interim measure while engineering controls are in the process of being implemented.

Principal investigators, laboratory/facility managers, and lab personnel planning to wear respirators must comply with all requirements outlined in the **UConn Respirator Program**.

**a. Required Use of Respirators**

Lab personnel required to use respirators, including filtering facepiece respirators (e.g., dust masks), must be trained in their proper use, inspection, and maintenance, and must receive a medical evaluation and fit test prior to use.

The principal investigator and/or laboratory/facility manager must ensure that lab personnel receive training through EHS as follows:

1) Initially - prior to being assigned a respirator;
2) Annually; and
3) Whenever retraining appears necessary because:
   a) Changes in the workplace or the type of respirator render the...
previous training obsolete.

b) Inadequacies in an individual’s knowledge or use of the respirator indicate that the individual has not retained the necessary understanding or skill.

c) Any other situation arises in which retraining appears necessary to ensure safe respirator use.

b. Voluntary Use of Dust Masks

On occasion individuals may desire to use dust masks voluntarily in labs, though conditions do not exist that mandate their use. In such cases, medical evaluations and fit testing are not required and the employer may provide dust masks at the request of the individual or permit them to use their own if:

1) The use of the dust mask is not required by the principal investigator and/or laboratory/facility manager;

2) The dust mask is used for comfort purposes only and not to protect the health of the worker;

3) The principal investigator and/or laboratory/facility manager determines that such dust mask use will not in itself create a hazard; and

4) Selection, maintenance, and training requirements are met.

When dust masks will be used voluntarily, principal investigators and/or laboratory/facility managers must ensure that:

a) Lab personnel receive Respiratory Protection - Voluntary Use of Dust Masks (HuskyCT) training, and

b) The respirator maintenance and care provisions of the UConn Respirator Program are followed.

If other types of respirators will be used voluntarily, principal investigators and/or laboratory/facility managers must ensure that lab personnel are medically evaluated, trained, and fit-tested annually. Principal investigators, laboratory/facility managers, and lab personnel planning to wear respirators must comply with all requirements outlined in the UConn Respirator Program.
XII. Waste Management

A. Hazardous Waste

Hazardous wastes include discarded solids, liquids, or gases with properties that are dangerous or potentially harmful to human health or the environment. Hazardous wastes include those chemicals that are listed as a hazardous waste or exhibit characteristics (i.e., ignitability, corrosivity, reactivity, or toxicity) of a hazardous waste as defined by the Environmental Protection Agency (EPA). All listed and characteristic hazardous wastes are identified by waste codes. The waste list and descriptions of each type are listed in the table below:

<table>
<thead>
<tr>
<th>Hazardous Waste List</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F-list</strong> <em>(Non-specific source wastes)</em></td>
<td>The F-list consists of 28 different wastes, including certain spent solvents, metal finishing wastes, dioxin-containing wastes, chemical manufacturing wastes, wood preserving wastes, petroleum refinery wastewater treatment sludges, and hazardous waste landfill leachate.</td>
</tr>
<tr>
<td><strong>K-list</strong> <em>(Source-specific wastes)</em></td>
<td>The K-list consists of over 100 wastes from specific industrial processes (e.g., wood preserving, petroleum refining, primary and secondary metals manufacturing; and the manufacturing of industrial chemicals, inks, pigments, pesticides, explosives, and veterinary pharmaceuticals).</td>
</tr>
<tr>
<td><strong>P-list</strong> <em>(Discarded commercial chemical products-acute)</em></td>
<td>This P-list consists of about 200 different commercial chemical products that are defined as acutely hazardous and toxic. Wastes that fall under this listing include only those products that contain the listed constituent as the sole active ingredient. These wastes include virgin materials that are being discarded, as well as container residues and spill residues.</td>
</tr>
<tr>
<td><strong>U-list</strong> <em>(Discarded commercial chemical products- non-acute)</em></td>
<td>The U-list consists of several hundred different commercial chemical products. Wastes that fall under this listing include only those products that contain the listed constituent as the sole active ingredient. These wastes include old or off-specification virgin materials that are being discarded, as well as container residues and spill residues of these materials.</td>
</tr>
</tbody>
</table>

*Table derived from 40 CFR Part 261 Subpart D.*
Hazardous wastes not identified on the F, K, P or U-lists must still be managed in labs as hazardous waste if they exhibit any of the four characteristics listed below:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignitability (D001)</td>
<td>A waste is <strong>ignitable</strong> if: (1) it is liquid and has a flash point below 140° Fahrenheit; (2) it is a flammable solid; (3) it is an ignitable compressed gas; or (4) it is classified by the U.S. Department of Transportation as an oxidizer.</td>
</tr>
<tr>
<td>Corrosivity (D002)</td>
<td>A waste is <strong>corrosive</strong> if: (1) it is aqueous (i.e., water-based) and has a pH of 2.0 or lower (i.e., a strong acid) or 12.5 or more (i.e., a strong alkali/base); or (2) it can corrode steel at a rate of greater than 0.250 inch per year.</td>
</tr>
<tr>
<td>Reactivity (D003)</td>
<td><strong>Reactive wastes</strong> include wastes that are unstable, react with water or form hazardous mixtures with water, are capable of releasing toxic cyanide or sulfide gases under certain conditions, are explosive, or are capable of detonating under normal conditions or when heated.</td>
</tr>
<tr>
<td>Toxicity (D004-D043)</td>
<td>A waste is <strong>toxic</strong> if it contains any of 40 different hazardous constituents at a concentration equal to or greater than a certain threshold amount. These 40 constituents include 8 metals, 6 pesticides, 2 herbicides, 10 volatile organic compounds (VOCs), and 14 semi-volatile organic compounds (SVOCs).</td>
</tr>
</tbody>
</table>

Table derived from [40 CFR Part 261 Subpart C](https://www.epa.gov/). No listed (i.e., F, K, P, or U-listed wastes) or characteristic hazardous wastes are allowed to be disposed of down drains, treated to render them non-hazardous, or volatilized into the air. In addition, abandoned chemicals, **unknown chemicals**, or chemicals in deteriorating containers must also be managed as hazardous waste. The principal investigator and/or laboratory/facility manager is responsible for assuring that the procedures outlined in the [University Chemical Waste Disposal Manual](https://) are followed by their lab workers.

1. **Hazardous Waste Management in the Laboratory**
   a. Package all hazardous waste in a sturdy container compatible with the type of waste to be stored in it. EHS provides 20 liter containers upon request. Empty household or food grade containers must not be used to store hazardous waste.
b. All waste containers must be marked with the words “Hazardous Waste” and full chemical names (i.e., **DO NOT USE CHEMICAL FORMULAS OR ABBREVIATIONS**) from the moment waste is added. EHS provides “Hazardous Waste” stickers and tags upon request. Examples of compliant hazardous waste labels are pictured below:

c. Containers must remain closed with a tight-fitting cap or lid (e.g., no corks, rubber stoppers or open funnels), unless waste is being directly added to the container.

d. Containers that continually generate hazardous wastes (e.g., HPLC wastes) must be placed in secondary containment, and all tubes and hoses must be closed as much as possible to minimize potential release.

e. Incompatible materials must not be mixed in the same container.

f. Incompatible materials must not be stored in the same secondary containment bin.

h. All hazardous waste must be stored at or near a green “Satellite Accumulation Area” (SAA) sign. EHS provides SAA signs upon request.

h. SAA areas must not exceed **55 gallons of non-acute waste** per waste stream or **1 quart of acutely hazardous waste**.
2. Hazardous Waste Disposal Procedures

   a. Ensure “Hazardous Waste” tags or stickers, full chemical names, and percentages are legible and prominently displayed on each container.
   
   b. EHS will NOT remove hazardous wastes that have chemical abbreviations or symbols, illegible names, or fail to use “Hazardous Waste” stickers or tags.
   
   c. When waste containers are almost full, a Chemical Waste Pickup/Supply Delivery Request Form must be submitted through the EHS website.
   
   d. A confirmation email will be sent to the email address listed on the form to verify submission of the pick-up/delivery request.

B. Ethidium Bromide Waste

Ethidium bromide is a toxin capable of causing harm and genetic defects upon exposure. Although ethidium bromide is not regulated by the EPA as a hazardous waste, specific work practices must be followed to ensure proper disposal through EHS. The management and disposal practices for ethidium bromide waste are listed below:

<table>
<thead>
<tr>
<th>Table 22. Management of Ethidium Bromide Solids &amp; Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethidium Bromide Solid Waste Management</strong></td>
</tr>
<tr>
<td>1. Place ethidium bromide gels or contaminated debris in an “Open Head 5 Gallon Pail for Solids” available through EHS.</td>
</tr>
<tr>
<td>2. Place a green “Connecticut Regulated Waste” sticker on the pail and label the sticker with the words “Ethidium Bromide.”</td>
</tr>
<tr>
<td>3. Close the container when not directly adding waste to the container.</td>
</tr>
<tr>
<td>4. Submit an EHS Chemical Waste Pickup/Supply Delivery Request Form when the container is almost full.</td>
</tr>
<tr>
<td>5. EHS will remove the waste during the next regularly scheduled pick-up.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Ethidium Bromide Liquid Waste Management</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Place ethidium bromide liquids in a sturdy, non-leaking container.</td>
</tr>
<tr>
<td>2. Place a green “Connecticut Regulated Waste” sticker on the container and label the sticker “Ethidium Bromide.”</td>
</tr>
<tr>
<td>3. Submit an EHS Chemical Waste Pickup/Supply Delivery Request Form when the container is almost full.</td>
</tr>
<tr>
<td>4. EHS will remove the waste during the next regularly scheduled pick-up.</td>
</tr>
</tbody>
</table>
Do not use biohazard or autoclave bags to store ethidium bromide wastes. All ethidium bromide wastes must be managed, collected, and disposed of through EHS as chemical waste.

C. Universal Waste Management & Disposal

Universal wastes refer to common items such as thermometers, batteries, and fluorescent lamps that contain mercury and/or other toxic metals. These wastes are generated in a wide variety of settings, including laboratories. In Connecticut, the following materials must be managed as Universal Wastes by lab personnel:

<table>
<thead>
<tr>
<th>Table 23. Universal Wastes &amp; Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
</tr>
<tr>
<td>Mercury Containing Lamps (e.g., Linear</td>
</tr>
<tr>
<td>Fluorescent, HID/HPS, U &amp; Circines,</td>
</tr>
<tr>
<td>Biax &amp; Compact/PL’s, etc.)</td>
</tr>
<tr>
<td>Batteries, Automotive (Lead-acid vehicle</td>
</tr>
<tr>
<td>batteries)</td>
</tr>
<tr>
<td>Batteries, Non-Automotive (e.g., lead-</td>
</tr>
<tr>
<td>acid, nickel-cadmium, silver oxide,</td>
</tr>
<tr>
<td>lithium, mercury, magnesium, etc.)</td>
</tr>
<tr>
<td>Mercury Thermostats</td>
</tr>
<tr>
<td>Used Electronic Equipment (e.g.,</td>
</tr>
<tr>
<td>Computers, Monitors, Radios, Copiers,</td>
</tr>
<tr>
<td>etc.)</td>
</tr>
</tbody>
</table>
D. Other Waste Management

In addition to hazardous chemical wastes, other materials generated in labs must also be properly managed. Lab personnel are required to follow all applicable guidelines in the Chemical Waste Disposal Manual.

1. Empty Chemical Container Management

Empty chemical containers must be managed based on the chemical(s) originally present in the container and be removed from the lab-specific and/or Laboratory Chemical Inventory Program.

a. Acutely Hazardous Chemicals

Empty containers of P-listed chemicals must be properly labeled as hazardous waste and be discarded through EHS. Wastes that fall on the P-List include only those products that contain the listed constituent as the sole active ingredient. P-listed chemicals commonly found in labs include osmium tetroxide, sodium azide, potassium cyanide, 2,4-dinitrophenol, and arsenic trioxide. Prior to disposal of any empty container, principal investigators, laboratory/facility managers, and lab personnel must determine if the empty container is listed on the EPA’s P-List.

b. Non-Acutely Hazardous Chemicals

All empty containers, not identified on the P-List, must meet the following four criteria prior to disposal in the regular trash:

1) All waste has been removed using the practices commonly employed to remove materials from that type of container, e.g., pouring, pumping, and aspirating;

2) No more than 2.5 centimeters (one inch) of residue remain on the bottom of the container or inner liner;

3) No more than 3% by weight of the total capacity of the container remains in the container or inner liner; and
4) The empty container does not have a residual, highly noxious odor.

If all four criteria are met, the caps on the empty containers must be removed and the chemical name(s) must be crossed out/defaced before the containers can be disposed of in the regular trash, lab glass, or other suitable waste receptacle.

If one or more of the four criteria cannot be met the container must be managed as hazardous waste and be disposed of through EHS.

2. Glass Waste

- A labeled, puncture-resistant container must be used for glass waste. EHS provides open-top, 5-gallon pails for glass waste upon request.
- Glass waste must not be disposed of in the regular trash.
- No solids or liquids are allowed in glass waste containers.
- Glass waste is removed by custodial staff or other Facilities Operations personnel depending on the building. EHS does not remove glass waste from labs.

3. Sharps Waste

The Environmental Protection Agency (EPA) and Connecticut Department of Energy & Environmental Protection (DEEP) require sharps waste (e.g., needles, scalpel blades, hypodermic needles, syringes (with or without attached needles) and needles with attached tubing, regardless of contact with infectious agents, to be managed as “Regulated Medical Waste.”

Other sharps that can puncture or tear autoclave bags including Pasteur pipettes, disposable pipettes, razor blades, blood vials, test tubes, pipette tips, broken plastic culture dishes, glass culture dishes, and other types of broken and unbroken glass waste (e.g., microscope slides and cover slips) that may have been in contact with infectious material must also be managed as sharps.

All sharps generated in labs must be disposed of in approved sharps containers provided by EHS. Sharps containers are available through submission of a Biological Pick-Up/Supply Delivery Request Form.

**Caution:** Sharps derived from injections with P-Listed chemicals (e.g., epinephrine) must be disposed of in black sharps containers provided by EHS upon request.
4. **Gas Cylinder Returns/Disposal**

EHS does not manage the return or disposal of compressed gas cylinders. Lab personnel using cylinders must return empty and/or unused compressed gas cylinders to the supplier. EHS recommends checking with the supplier, prior to purchase, to ensure acceptance of empty or partially-used cylinders. If the supplier will not accept the cylinders, lab personnel must try to find a supplier that will remove the cylinders, in accordance with all applicable regulations, from the lab. Check with the Purchasing Department for a current list of approved vendors for compressed gases at UConn.

5. **Biological Waste**

Procedures for the treatment and disposal of biological and regulated medical waste at all University of Connecticut campuses (excluding the UConn Health Center) are outlined in the Biological Waste Guide. Principal investigators, laboratory/facility managers, lab personnel, and others generating biological and/or regulated medical waste in UConn labs are responsible for compliance with the federal and state regulations and University procedures indicated in the guide.

The mixing of biological and hazardous chemical wastes should be avoided. If biological waste is mixed with hazardous chemicals, the entire mixture must be managed as hazardous waste.

6. **Radiological Waste**

Prior authorization must be obtained from the Radiation Safety Committee to use radioactive material. Procedures for authorized, proper disposal of radioactive waste generated in UConn labs must be carried out as indicated in the Radiation Safety Manual. Principal investigators, laboratory/facility managers, and lab personnel generating radioactive wastes in UConn labs are responsible for compliance with the federal and state regulations and University procedures indicated in the manual.

Mixed wastes that contain both hazardous waste and radioactive material are regulated by the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). No mixed waste (i.e., regulated hazardous waste contaminated with radioactive material) shall be generated unless prior authorization is obtained through the Radiation Safety Committee in an approved radioactive materials usage...
permit. Principal investigators, laboratory/facility managers, and lab personnel are responsible for contacting EHS prior to the generation of mixed waste containing hazardous chemicals and radioactive materials.

XIII. Chemical-Specific Procedures

A. Toxic Chemicals

Chemicals used in laboratories have a wide range of physical, chemical, and toxicological properties that lead to adverse health effects in humans. The risks associated with their use are dependent on both the level of exposure and the inherent toxicity of the chemical. The most important factor that determines whether a substance is toxic to an individual is the relationship between the amount of the chemical reaching the target organ and the toxic effect it produces. In some cases, a single (acute) exposure may bring about negative health effects whereas other toxic effects may be revealed after repeated, long-term (chronic) exposures. Many toxic effects from chemicals are reversible (i.e., causing no permanent damage) whereas other exposures can lead to permanent damage and even death at a sufficient dose, duration, and/or frequency.

Exposure to chemicals in the laboratory occurs by four routes:

1. Inhalation into the respiratory tract,
2. Absorption through the skin via dermal contact,
3. Ingestion into the digestive tract, and
4. Injection directly into the bloodstream.

PIs, laboratory/facility managers, and other lab personnel are responsible for using engineering controls, administrative controls, work practices, and personal protective equipment to eliminate or minimize exposure to toxic chemicals in labs.

1. Exposure Limits

Exposure to toxic chemicals in laboratories can lead to negative health effects in susceptible individuals. As a result, the Occupational Safety & Health Administration (OSHA), American Conference of Governmental Industrial Hygienists (ACGIH) and National Institute for Occupational Safety and Health (NIOSH) have established exposure limits for chemicals to protect individuals from workplace hazards. OSHA’s
action levels and permissible exposure limits (PELs) are enforceable by law. Descriptions of exposure limits located in safety data sheets are listed below:

Table 24. Exposure Limits

<table>
<thead>
<tr>
<th>Exposure Limit</th>
<th>Description</th>
<th>Regulatory Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action level</strong></td>
<td><em>Action level</em> means a concentration designated for a specific substance, calculated as an 8-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.</td>
<td>OSHA</td>
</tr>
<tr>
<td><strong>Immediately Dangerous To Life or Health (IDLH)</strong></td>
<td>An IDLH condition is defined as a situation that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment.</td>
<td>NIOSH</td>
</tr>
<tr>
<td><strong>Permissible Exposure Limits (PELs)</strong></td>
<td><em>PELs</em> are regulatory limits based on the amount or concentration of a substance in the air. In some cases, they may also contain a skin designation. Most <em>PELs</em> are based on an 8-hour time weighted average (TWA) exposure to which it is believed most workers may be exposed to for a working lifetime without developing serious illness.</td>
<td>OSHA</td>
</tr>
<tr>
<td><strong>Recommended Exposure Limits (RELs)</strong></td>
<td><em>RELs</em> are time-weighted average (TWA) concentrations for up to a 10-hour workday during a 40-hour workweek.</td>
<td>NIOSH</td>
</tr>
<tr>
<td><strong>Threshold Limit Values (TLVs)</strong></td>
<td><em>Threshold Limit Values (TLVs)</em> are based on the TWA concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may be repeatedly exposed, day after day, for a working lifetime without adverse effect.</td>
<td>ACGIH</td>
</tr>
<tr>
<td><strong>Threshold Limit Value-Ceiling (TLV–C)</strong></td>
<td>TLV–C is the concentration that should not be exceeded during any part of the working exposure. If instantaneous measurements are not available, sampling should be conducted for the minimum period of time sufficient to detect exposures at or above the ceiling value.</td>
<td>ACGIH</td>
</tr>
<tr>
<td><strong>Short-Term Exposure Limit</strong></td>
<td><em>Short-Term Exposure Limit (STEL)</em> is a 15-minute TWA exposure that should not be exceeded at any time during</td>
<td>ACGIH</td>
</tr>
</tbody>
</table>
(STEL) a workday, even if the 8-hour TWA is within the TLV–TWA. The STEL is the concentration to which it is believed that workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, 3) dose-rate-dependent toxic effects, or 4) narcosis of sufficient degree to increase the likelihood of accidental injury, impaired self-rescue, or materially reduced work efficiency.

OSHA requires that safety data sheets list not only the relevant OSHA PEL but also the TLV and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet. Since only approximately 500 PELs have been established, many chemicals used in laboratories do not have recognized exposure limits. In such cases, comparison of the chemical lacking an exposure limit to other chemicals with similar structures (e.g., hydrocarbons) or physical properties (e.g., volatile organic compounds) may be necessary. Lab workers must contact the principal investigator, laboratory/facility manager, or EHS (486-3613) with questions or concerns regarding exposure limits for specific chemicals used in the lab.

2. Factors Affecting Toxicity

Toxicology is based on the relationship between a toxic reaction (the response) and the amount of toxicant received (the dose). The dose-response relationship is the basic concept for determining the relative level of harmfulness of a chemical. In a sufficient amount, even chemicals normally considered "harmless" can evoke a toxic response. Exposure to toxic chemicals is dependent on a number of factors listed in the table below:

<table>
<thead>
<tr>
<th>Table 25. Factors that Influence Chemical Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Route of Entry</strong></td>
</tr>
<tr>
<td>Physical Condition</td>
</tr>
<tr>
<td>Dose</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Ability to be absorbed</td>
</tr>
<tr>
<td>Metabolism</td>
</tr>
<tr>
<td>Distribution within body</td>
</tr>
</tbody>
</table>

Lab personnel are responsible for using engineering controls (e.g., fume hoods, gloveboxes, etc.), following University and lab-specific standard operating
procedures and wearing appropriate personal protective equipment to prevent exposure to toxic chemicals.

3. Signs and Symptoms of Chemical Exposures

Signs and symptoms of chemical exposures can occur after single or repeated exposures. Some individuals develop a sensitivity (i.e., an allergic reaction) in normal tissue after repeated exposure to certain chemicals (e.g., chromium, nickel, formaldehyde, isocyanates, etc.). The following table is a list of common signs and symptoms associated with chemical exposures:

<table>
<thead>
<tr>
<th>Category</th>
<th>System Affected</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dermatological</td>
<td>Skin, Eyes</td>
<td>Abnormally dark or light skin, burning sensation, itching, rashes, redness, swelling</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Stomach, Intestines</td>
<td>Diarrhea, nausea, vomiting</td>
</tr>
<tr>
<td>Hematological</td>
<td>Blood</td>
<td>Anemia (fatigue, weakness)</td>
</tr>
<tr>
<td>Neurological</td>
<td>Brain, Spinal Cord</td>
<td>Confusion, coma, convulsions, coordination difficulty, depression, dizziness, headache, sweating</td>
</tr>
<tr>
<td>Renal</td>
<td>Kidney</td>
<td>Back pain, frequent or infrequent urination</td>
</tr>
<tr>
<td>Reproductive</td>
<td>Ovaries, Testes, Fetus</td>
<td>Infertility, miscarriage</td>
</tr>
<tr>
<td>Respiratory</td>
<td>Nose, Trachea, Lungs</td>
<td>Irritation, choking, coughing, runny nose, sneezing, tight chest</td>
</tr>
</tbody>
</table>

Lab personnel experiencing any signs or symptoms of chemical exposures must contact their principal investigator, laboratory/facility manager, or EHS prior to conducting further research.
B. Flammable Liquids

The Occupational Safety & Health Administration (OSHA) defines a flammable liquid as having a flash point of not more than 93°C (199.4°F). OSHA defines flash point as “the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.” In most cases, the relative hazard of a flammable liquid increases as the flashpoint decreases. Many common solvents (e.g., acetone, diethyl ether, toluene, etc.) have flash points well below room temperature, making proper use, storage and disposal even more critical. Flammable liquids and mixtures containing flammable liquids are assigned to one of four hazard categories, as indicated in safety data sheets (SDSs), based on their flash points and boiling points (See table below).

## Table 27. Flammable Liquid Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Hazard Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flash point &lt; 23°C and initial boiling point ≤ 35°C (95°F)</td>
<td>Extremely flammable liquid and vapor</td>
</tr>
<tr>
<td>2</td>
<td>Flash point &lt; 23°C and initial boiling point &gt; 35°C (95°F)</td>
<td>Highly flammable liquid and vapor</td>
</tr>
<tr>
<td>3</td>
<td>Flash point ≥ 23°C and ≤ 60°C (140°F)</td>
<td>Flammable liquid and vapor</td>
</tr>
<tr>
<td>4</td>
<td>Flash point ≥ 60°C (140°F) and ≤ 93°C (200°F)</td>
<td>Combustible liquid</td>
</tr>
</tbody>
</table>

Table derived from [OSHA 1910.1200 Appendix B](https://www.osha.gov/dts/osta/osep/index.html).

For a flammable liquid to ignite, three conditions must exist simultaneously: (1) the concentration of the vapor must be between the upper and lower flammable limits of the substance; (2) an oxidizer (usually the oxygen in air) must be present; and (3) a source of ignition must be present. Taking measures to remove any of these conditions will prevent the start of a fire. Additional information on flammable liquids can be found at the fact sheet titled *Flammable Liquids- Safe Work Practices*.

1. Work Practices

   - Work with flammable liquids in a properly functioning chemical fume hood, glovebox or other source of local ventilation.
Keep flammable liquid containers closed when not in use.
Control all ignition sources in areas where flammable liquids are used.
Never heat flammable substances using an open flame. Use oil baths, steam baths, water baths, heating mantles, or hot air baths.
Do not distill flammable substances under reduced pressure.
Make sure that metal surfaces or containers where flammable substances are being used are properly grounded, discharging static electricity.
Identify the locations of fire alarms, pull stations, safety showers, and other emergency equipment.

2. Storage

Flammable liquids should be stored in rated flammable storage or explosion-proof cabinets when not in use.
Venting of flammable storage cabinets is not required for fire protection purposes and should be avoided. Vent openings shall be sealed with bungs.
Storage cabinets of flammable material must be labeled with, at a minimum, the word “Flammable."
Paper, cardboard, or other combustible material must not be stored in flammable storage cabinets.
Flammable liquid storage areas must be free of ignition sources (e.g., electrical outlets, open flames, hot surfaces, static electricity, etc.).
No more than 10 gallons of flammable liquids can be stored outside of a rated flammable storage cabinet in the laboratory.
Storage of flammable liquids or other hazardous chemicals on floors should be avoided.
Safety cans must be approved by a nationally recognized testing laboratory, have a flash-arresting screen, spring-closing lid, spout cover, and be designed to safely relieve internal pressure when subjected to fire exposure.
Flammable liquid quantities in laboratories must comply with UConn Fire Department standards.
Any refrigerator that is used to store multiple flammable liquids must be designed for flammable or explosive storage (i.e., contain no ignition sources such as exposed electrical contacts) and be properly labeled.
Flammable liquids must be stored separately from strong oxidizers, corrosives, and other incompatible materials.
Storage of flammable liquids must not block any route of egress.
C. Corrosive Chemicals

Corrosive chemicals can cause immediate damage to the skin, eyes, tissues, and other parts of the body upon contact. Some chemicals may be corrosive to metals. Both acidic (pH < 4) and alkaline (pH >10) solutions are capable of causing chemical burns. Severity is dependent primarily upon the concentration of the chemical and the duration of contact. Exposure to corrosive chemicals can produce ulcers, bleeding, bloody scabs, skin discoloration, alopecia, scars, and other serious conditions. Below is a table of common corrosive hazard classes, storage methods, and examples of each class:

Table 28. Corrosive Liquid Classes and Storage Guidelines

<table>
<thead>
<tr>
<th>Corrosive Classes</th>
<th>Storage</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic Acids</td>
<td>• Store in corrosives cabinet or on protected shelving and in secondary containment away from organic acids and bases. • Avoid storage on metal shelving.</td>
<td>Hydrochloric acid, Hydrofluoric acid, Phosphoric acid, and Sulfuric acid</td>
</tr>
<tr>
<td>Inorganic Bases</td>
<td>Store in corrosives cabinet away from acids.</td>
<td>Ammonium hydroxide, Potassium hydroxide, and Sodium hydroxide</td>
</tr>
<tr>
<td>Organic Acids</td>
<td>▪ Store in corrosives cabinet, on protected shelving, or in secondary containment away from inorganic acids and bases. ▪ Avoid storage on metal shelving.</td>
<td>Acetic acid, Trichloroacetic acid, and Formic acid</td>
</tr>
<tr>
<td>Organic Bases</td>
<td>Store in corrosive cabinet away from acids and inorganic bases.</td>
<td>Hydroxylamine, Tetramethylethylene diamine, and Triethylamine</td>
</tr>
<tr>
<td>Oxidizing Acids</td>
<td>Store alone or in a separate secondary containment bin with compatible, inorganic acids.</td>
<td>Perchloric acid, Nitric acid, and Chromic acid</td>
</tr>
</tbody>
</table>
1. **Work Practices**

   - Work with corrosive chemicals in a functional chemical fume hood, glovebox or other source of local ventilation.
   - Properly label secondary containers with the appropriate chemical name and hazard class.
   - Work within **10 seconds** of a properly-functioning eyewash station and safety shower.
   - Keep the corrosive chemical containers closed when not in use.
   - Add acid in small quantities to the water to prevent spattering. Never add water to an acid.
   - EHS recommends tight-fitting safety goggles, chemical-appropriate gloves, lab coats, and long pants for all work with corrosive liquids.
   - Research with hydrofluoric acid requires calcium gluconate gels or benzalkonium chloride in the immediate work area for emergency use. Expired calcium gluconate gels and/or benzalkonium chloride solutions must be replaced prior to research with hydrofluoric acid.

2. **Storage**

   - Segregate inorganic acids from organic acids in separate cabinets or in separate secondary containment bins within the same cabinet.
   - Store acids and bases in separate cabinets.
   - Segregate acids from reactive metals (e.g., sodium, potassium, etc.), azides, and cyanides.
   - Oxidizing acids, such as concentrated perchloric and nitric acids, must be stored in a separate cabinet or secondary containment bin, away from organic materials and other incompatible chemicals.

C. **Particularly Hazardous Substances (PHSs)**

   The OSHA Laboratory Standard requires that employees take additional safety precautions while working with particularly hazardous substances (i.e., carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity). These provisions include:

   1. Establishment of a designated area,
2. Use of containment devices such as fume hoods or gloveboxes,
3. Procedures for safe removal of contaminated waste, and
4. Decontamination procedures.

Lab personnel using carcinogens, reproductive toxins, and acutely toxic chemicals are responsible for complying with the OSHA Lab Standard. Principal investigators and/or laboratory/facility managers are responsible for training, providing appropriate personal protective equipment (PPE), and approval of procedures using particularly hazardous substances in their labs.

1. Identification of Particularly Hazardous Substances

   a. Carcinogens are substances or a mixture of substances which cause cancer or increase its incidence. Carcinogenic chemicals are classified into one of three categories based on the strength of evidence in experimental studies. The categories are listed below:

      - Category 1A- Known Human Carcinogens
      - Category 1B- Presumed Human Carcinogens
      - Category 2- Suspected Human Carcinogens

      The category of carcinogenic substance can be identified through safety data sheets (SDSs). Carcinogenic chemicals listed as Category 1A, Category 1B, or Category 2 must be managed as a particularly hazardous substances.

      Carcinogenic chemicals listed in the following groups by OSHA, the National Toxicology Program, and International Agency for Research on Cancer Monographs can be used to identify carcinogenic chemicals to be managed as PHSs:

      - Occupational Safety & Health Administration (OSHA)
      - National Toxicology Program (NTP)– Groups “Known To Be Human Carcinogens” and “Reasonably Anticipated To Be Human Carcinogens”
      - International Agency for Research on Cancer Monographs (IARC)– Groups 1, 2A, and 2B

   b. Reproductive Toxins are substances or a mixture of substances that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and/or females, as well as adverse effects on the development of the offspring. Reproductive toxins are divided into three categories:
• Category 1A- Known human reproductive toxicant,
• Category 1B- Presumed human reproductive toxicant, and
• Category 2- Suspected human reproductive toxicant.

**Category 1A, Category 1B, and Category 2** reproductive toxicants as well as reproductive toxins known to have effects on or via lactation, as indicated in safety data sheets (SDSs), must be managed as a particularly hazardous substances.

c. **Acute toxicity** refers to substances producing adverse health effects following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours. OSHA currently characterizes acutely toxic substances into four categories based on toxicity by the oral, dermal, or inhalation routes. The categories are listed in the table below:

<table>
<thead>
<tr>
<th>Exposure Route</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral (mg/kg bodyweight)</td>
<td>≤ 5</td>
<td>&gt;5 and ≤ 50</td>
<td>&gt;50 and ≤ 300</td>
<td>&gt;300 and ≤ 2000</td>
</tr>
<tr>
<td>Dermal (mg/kg bodyweight)</td>
<td>≤ 50</td>
<td>&gt;50 and ≤ 200</td>
<td>&gt;200 and ≤ 1000</td>
<td>&gt;1000 and ≤ 2000</td>
</tr>
<tr>
<td>Inhalation - Gases (ppmV)</td>
<td>≤ 100</td>
<td>&gt;100 and ≤ 500</td>
<td>&gt;500 and ≤ 2500</td>
<td>&gt;2500 and ≤ 20000</td>
</tr>
<tr>
<td>Inhalation - Vapors (mg/l)</td>
<td>≤ 0.5</td>
<td>&gt;0.5 and ≤ 2.0</td>
<td>&gt;2.0 and ≤ 10.0</td>
<td>&gt;10.0 and ≤ 20.0</td>
</tr>
<tr>
<td>Inhalation - Dusts/Mists (mg/l)</td>
<td>≤ 0.05</td>
<td>&gt;0.05 and ≤ 0.5</td>
<td>&gt;0.5 and ≤ 1.0</td>
<td>&gt;1.0 and ≤ 5.0</td>
</tr>
</tbody>
</table>

*Table derived from OSHA 1910.1200 App A.*

Individuals can identify the category of an acutely toxic substance through the safety data sheet (SDS). Acutely toxic chemicals listed as **Category 1** or **Category 2** must be managed as particularly hazardous substances. Procedures
for **Category 3** and **Category 4** acutely toxic substances must be evaluated by the principal investigator.

2. **Management of Particularly Hazardous Substances**

   In addition to the University **standard operating procedures** required for research with hazardous chemicals as outlined in the CHP, researchers working with PHSs also must follow the additional procedures listed below.

   a. **Establishment of a Designated Area in the Lab**

      1) Particularly hazardous substances must only be used and stored in designated areas.

      2) The designated area may be a fume hood, glovebox, an entire laboratory, or other suitable area recognized by authorized personnel working in the lab.

      3) Signs must be posted in designated areas where particularly hazardous substances are used. The sign(s) for individual or multiple hazards must state:

      ![Signs](image)

      "**The design of the sign(s) can be modified to suit the needs of the lab**"

      4) The designated area may be used for other research purposes as long as laboratory personnel comply with University standard operating procedures, training requirements, and emergency procedures.

   b. **Use of Containment Devices Such as Fume Hoods or Gloveboxes**

      1) Most research using particularly hazardous substances (PHSs) should take place in a fume hood, glovebox, or other suitable containment device. If use of a suitable containment device is not feasible, EHS must be contacted to discuss alternative containment and/or safety protocols.

      2) **Fume hoods** being used for research with PHSs should be running between 80-120 linear feet per minute, have a green sticker, and have been
inspected by EHS within the last year. If the fume hood has a yellow or red sticker or has not been tested in the last year, contact EHS at 486-3613.

3) Gloveboxes can be used when protection from atmospheric moisture or oxygen is necessary, or when a fume hood does not provide adequate protection from exposure. Gloveboxes must be installed and maintained per manufacturer specifications to ensure proper function.

c. Procedures for Safe Removal of Contaminated Waste

1) All waste generated using particularly hazardous substances must be managed as hazardous waste. Each waste container must:

   ▪ Be labeled with “Hazardous Waste” stickers or tags provided by EHS;
   ▪ Use full chemical names to describe the waste (i.e., no chemical abbreviations or symbols);
   ▪ List chemical contents as a percentage of the total volume;
   ▪ Be stored alone or with other compatible chemicals;
   ▪ Be stored in containers with tight-fitting caps or lids (i.e., containers must remain closed unless directly adding waste to the container); and
   ▪ Be stored at or near a green Satellite Accumulation Area sign.

2) Disposable personal protective equipment (e.g., gloves) and materials contaminated with PHSs must be managed as hazardous waste.

3) Chemical Waste Pick-Up Request Forms must be submitted to EHS to ensure proper disposal of PHSs from labs.

4) Review the UConn Chemical Waste Disposal Manual to ensure compliance with empty container management and other requirements that may be specific to PHS waste.

d. Decontamination Procedures

1) All equipment, glassware, and materials used for research with particularly hazardous substances must be properly decontaminated.

2) Procedures must outline methods of decontamination for all equipment that comes into contact with particularly hazardous substances.

3) Manufacturer’s instructions and specifications must be used to identify proper methods to decontaminate equipment.

4) Decontamination of equipment should take place in fume hoods, if feasible.
5) All work surfaces must be decontaminated at the end of the procedure or work day.
6) Equipment contaminated with PHSs must never be removed from the lab without complete decontamination.
7) After decontamination procedures are completed, trained laboratory personnel must properly wash hands and any other body areas that have potentially contacted PHSs.

D. Highly Reactive and Explosive Chemicals

Some hazardous chemicals in laboratories may become highly reactive or explosive when exposed to certain environmental conditions (e.g., heat, fire, water, air, etc.). Others become explosive when they contact incompatible materials, are allowed to dry out, decompose, or encounter sources of friction or mechanical shock. Due to the high hazards associated with such compounds, appropriate procedures, control measures, personal protective equipment, and training are required. Failure to comply with safety measures can lead to explosions, fires, property damage, or serious injuries.

1. Classes of Highly Reactive and Explosive Chemicals

Many chemicals are classified as highly reactive or potentially explosive. A table of the hazard classes, pictograms, and examples of each class is listed below.

<table>
<thead>
<tr>
<th>Hazard Class</th>
<th>Pictogram</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals that produce flammable gases when in contact with water</td>
<td>![Flammable Gas Pictogram]</td>
<td>Alkali metals, Calcium carbide, Metal alkyls, Grignard reagents, Sodium hydride, and Zinc powders</td>
</tr>
<tr>
<td>Explosives</td>
<td>![Explosive Pictogram]</td>
<td>Benzoyl peroxide, Dinitrophenol, Lead azide, Nitroglycerin, and Nitrocellulose Picric acid</td>
</tr>
<tr>
<td>Organic peroxides</td>
<td>Acetaldehyde, Diethyl ether, Isopropyl ether, Potassium metal, and Tetrahydrofuran</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Pyrophoric liquids</td>
<td>t-Butyllithium, Diethylzinc, Grignard reagents, Tributylphosphate, and Trimethyl aluminum</td>
<td></td>
</tr>
<tr>
<td>Pyrophoric solids</td>
<td>Alkali metals, Finely divided metals, Metal hydrides, and White Phosphorus</td>
<td></td>
</tr>
<tr>
<td>Self-Heating</td>
<td>Carbon, Activated potassium sulphide, Anhydrous thiourea dioxide, and Titanium disulphide</td>
<td></td>
</tr>
<tr>
<td>Self-Reactive</td>
<td>2,2'Azobisisobutyronitrile</td>
<td></td>
</tr>
</tbody>
</table>

2. Procedures for Highly Reactive and Explosive Chemicals

Due to the inherent risks involved with the use of highly reactive or explosive chemicals, measures must be taken to assess the risks and control hazards prior to engaging in active experimentation. Conducting “dry runs” of high hazard experiments is recommended to reinforce proper techniques, safety measures, and emergency procedures. The guidelines listed below must be followed when handling high hazard chemicals.

a. Administrative Controls

- Safety training must be provided by the principal investigator or other qualified personnel to all researchers working with highly reactive or potentially explosive chemicals. Documentation of the contents of the training, date of training and signatures of the trainer and trainee are required.
- Use the minimum amount of chemical(s) needed to achieve the desired outcome.
- Avoid working alone with highly reactive or explosive chemicals.
- NEVER deviate from standard operating procedures unless previously discussed and agreed upon with the principal investigator.
- Alert other individuals working in the lab on what experiment is being conducted, the potential hazards, and when the experiment will be run.
- Restrict access to areas where high-scale reactions are taking place.

b. Engineering Controls

- Research involving highly reactive or explosive chemicals must be performed in a properly-functioning fume hood, glovebox, or with another form of ventilation approved by the principal investigator or laboratory/facility manager.
- The principal investigator or laboratory/facility manager must determine whether properly-rated safety shields, barricades, and guards are necessary to protect lab personnel and equipment from injury or damage. The barrier should surround the hazardous area, if feasible.
- If more than one hazardous reaction is carried out simultaneously, the reactions must be shielded from each other and separated as far apart as possible.
- Adequate grounding must be implemented to prevent static sparks from acting as ignition sources.

c. Work Practices

- All containers holding highly reactive or potentially explosive materials must be clearly labelled.
- Do not use metal or wooden devices when stirring, cutting, or scraping potentially explosive compounds. Non-sparking devices must be used.
- Ensure safety devices (e.g., high temperature controls, water overflow devices, etc.) are used to minimize potential incidents.
- Chemicals known to become explosive when dry must be regularly inspected and wetted if necessary (e.g., picric acid).
- Chemicals known to become explosive after a period of time (e.g., peroxide-forming chemicals) must be labeled with the date the bottle was delivered to the lab and the date the bottle was first opened, and they must be tested or disposed of after the expiration date is exceeded.
- Keep all sources of ignition away from reactive or explosive materials.
- When highly reactive materials are in use, a safety shower, eyewash station, and other safety equipment specific for the hazards involved, must be present in the laboratory.

d. Personal Protective Equipment

- Wear personal protective equipment as indicated in safety data sheets (SDSs) and the lab’s *Workplace Hazard Assessment Form*.
- At a minimum, lab coats, appropriate gloves, clothing that covers the legs, closed-toed footwear, and chemical splash goggles or safety glasses that meet American National Standards Institute (ANSI) standard Z-87.1 must be worn when working with highly reactive or explosive chemicals.
- Lab coats must be appropriately sized, buttoned, and fit properly to cover as much skin as possible. Principal investigators or laboratory/facility managers must determine if flame-resistant lab coats are required.
- Closed-toed footwear must cover the entire foot.
- Principal investigators or laboratory/facility managers must determine when full-length shields that protect the entire face and throat are required.
- Leather and/or other suitable gloves (e.g., Nomex) should be worn if researchers must reach behind a shielded area while a hazardous experiment is in progress or when handling high hazard chemicals.
- Additional personal protective equipment required by the PI or laboratory/facility manager must be worn by lab personnel based on the chemicals in use and the risks involved.

e. Storage

- Store in a designated storage area or cabinet with limited access.
- Additional storage precautions (e.g., a refrigerator, a flammable liquid storage cabinet, or a fume hood) may be required for certain compounds based upon chemical properties.
- Store away from incompatible materials.
- Keep away from ignition sources such as open flames, hot surfaces, spark sources, and direct sunlight.
- Storage in chemically compatible secondary containment bins is recommended to contain highly reactive or explosive chemicals in the event of a leak or spill.
- Never store unlabeled chemicals.
E. Compressed Gas Cylinders

Compressed gases can pose serious hazards when mishandled. Damage to the valve or integrity of a cylinder can result in a large release of potential energy, transforming the cylinder into a potential rocket or fragmentation bomb. Safe management of cylinders requires both an understanding of the chemical hazards associated with each gas (e.g., toxic, flammable, corrosive, explosive, oxidizing, inert, or a combination of hazards) as well as an awareness of the other physical hazards resulting from the high pressures contained in each cylinder (e.g., asphyxiation, decompression, etc.). Safety data sheets (SDSs) must be reviewed prior to the handling, storage, or transport of any pressurized gas. In addition, training must be provided by principal investigators, laboratory/facility managers, or a qualified vendor when new gases, or new equipment that uses compressed gases, are brought into laboratories.

1. Types of Gases under Pressure

The Occupational Safety & Health Administration (29 CFR 1910.1200- Appendix B) classifies gases under pressure based on pressure, temperature, and physical state. The four categories and criteria for gases under pressure are listed in the table below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed gas</td>
<td>A gas which when under pressure is entirely gaseous at -50°C (-58°F), including all gases with a critical temperature ≤ -50°C (-58°F) (e.g., Helium, Nitrogen, Oxygen, and Argon).</td>
</tr>
<tr>
<td>Liquefied gas</td>
<td>A gas which, when under pressure, is partially liquid at temperatures above -50°C (-58°F) (e.g., Ammonia, Carbon dioxide, Propane). A distinction is made between:</td>
</tr>
<tr>
<td></td>
<td>a) High pressure liquefied gas: a gas with a critical temperature between -50°C (-58°F) and +65°C (149°F); and</td>
</tr>
<tr>
<td></td>
<td>b) Low pressure liquefied gas: a gas with a critical temperature above +65°C (149°F).</td>
</tr>
<tr>
<td>Refrigerated liquefied gas</td>
<td>A gas which is made partially liquid because of its low temperature (e.g., Liquid Nitrogen).</td>
</tr>
</tbody>
</table>
Dissolved gas | A gas which when under pressure is dissolved in a liquid phase solvent (e.g., Acetylene).

*Table derived from OSHA 1910.1200 Appendix B.*

2. **Work Practices**

- The contents of each cylinder must be clearly labeled. Do not accept cylinders from manufacturers without appropriate labels.
- Never write on cylinder labels. Labels are required to be free of markings for proper identification and safe transport.
- A cylinder cap or regulator valve must be in place at all times.
- Each cylinder must be secured with a chain, strap, or cable to a wall or lab bench that can support the weight of the cylinder.
- Cylinders restraints (e.g., chain, strap, etc.) must be secured at least halfway up the body of the cylinder.
- Cylinder restraints must be kept tight to restrict cylinder movement.
- Cylinders must be secured individually (i.e., one restraint per cylinder), unless cages, racks, or stands are designed to support multiple cylinders.
- Obtain gas cylinders in returnable canisters whenever feasible. Fees associated with the proper disposal of non-returnable canisters (e.g., lecture bottles) may be charged to the PI/department.
- Order bottles with the lowest cylinder pressure possible for its intended purpose.
- Bond and ground all cylinders, lines, and equipment used with flammable compressed gases.
- Electrical equipment used with flammable compressed gases (e.g., hydrogen) must be approved for use with flammable gases by the manufacturer and PI or laboratory/facility manager.
- Never drag, roll, or slide cylinders.
- The regulator and cylinder must be accessible at all times.
- Do not place cylinders where they may become part of an electric circuit.
- When discharging gas into a liquid, a trap or suitable check valve must be used to prevent liquid from returning back to the cylinder or regulator.
- Appropriate personal protective equipment must be provided to lab personnel for the specific gases being used.

3. **Regulators, Piping & Fittings**

- Use only the regulator designed for the specific gas being used.
- Regulator valves must be kept closed when equipment is not in use.
- Regulators, valves, hoses, and distribution lines must be free of oil or grease and examined for leaks or other damage before each use.
- Valves, piping, and fittings must be rated for the pressures, temperatures, and gases being used.
- Do not force threads that do not fit.
- Avoid mixing different brands and types of tube fittings. Construction of parts is brand-specific they are usually not interchangeable.
- Never use parts with damaged or partly stripped threads.
- Never use oil or lubricants on equipment used with oxygen, unless specifically approved for the application (e.g., Krytox).
- Never use silver or copper piping for acetylene or ammonia.
- Never use cast iron piping for chlorine or hydrogen.
- If a cylinder valve cannot be opened by hand, do not use tools to open the valve. Contact the UConn contract vendor or manufacturer and have cylinder replaced.

4. Tubing & Hoses

- Label all gas lines with the chemical name leading from a compressed gas supply.
- Instrument connective tubing and hoses must be rated and compatible for the gases being used.
- Inspect tubing frequently and replace when necessary.
- Tygon® and plastic tubing are not appropriate for most pressure work. These materials can fail under pressure or thermal stress.
- Never use Teflon™ tape on CGA (Compressed Gas Association) fittings (i.e., straight thread) where the seal is made by a metal-to-metal contact. Use of Teflon™ tape causes the threads to spread and weaken, increasing the likelihood of leaks.
- Tubing/hoses connected to compressed gas cylinders must not be laid across floors or aisles where they could create a trip or fall hazard.
- Avoid sharp bends of copper tubing. Copper tubing can crack with repeated bending.
- Brass, copper, or other tubing material incompatible with ammonia shall not be used.
- Do not mix different brands and types of tubing. Parts are usually not interchangeable.
- Consult the gas manufacturer if you are unsure about the particular connection for your cylinders.
5. Pressure-Relief Devices

- Pressure-relief devices and associated fittings (tubing, connectors, etc.) must be properly sized and configured to provide a sufficient rate of pressure relief while preventing over-pressurization.
- Pressure-relief devices that may discharge toxic, corrosive, flammable, or otherwise hazardous or noxious materials must be properly vented.
- Do not install valves or other shutoff devices between pressure-relief devices and the equipment they are to protect.
- Do not install shutoff valves downstream of the relief device.
- Ensure that the relief vent is not blocked or restricted.
- Tubing and piping downstream of pressure relief devices must be at least the same diameter as the fitting on the vent side of the relief device.
- Only qualified persons can perform maintenance work on pressure-relief devices.

6. Storage & Disposal

- All cylinders must be stored upright.
- Store in cool, well-ventilated areas (e.g., no cold rooms) away from direct sunlight and sources of heat and ignition.
- Do not expose cylinders to temperatures exceeding 125°F.
- Do not artificially heat cylinder in an attempt to raise internal pressure.
- All cylinders must be stored based on hazard class.
- Keep the number of cylinders to a minimum.
- Do not store cylinders where heavy-moving objects may strike or fall on them.
- Compressed gas cylinders must be stored away from exits.
- Cylinder storage areas must be protected from access by unauthorized personnel.
- Do not store corrosives near gas cylinders. Corrosive vapors from mineral acids can deface markings and damage valves.
- Oxidizing gases must be stored at least 20 feet away from flammable chemicals (e.g., hydrogen) or the storage area must be separated by a firewall at least 5 feet high and have a fire resistance rating of 30 minutes.
- Cylinders containing corrosive and toxic gases (e.g., arsine, ammonia, carbon monoxide, chlorine, ethylene oxide, fluorine, hydrogen sulfide, hydrogen cyanide, phosgene, silane, etc.) must be stored in locations with suitable exhaust (e.g., ventilated gas cabinet, fume hood, etc.).
- Separate and secure full and empty cylinders.
- When returning an empty cylinder, close the valve, secure the cylinder cap, label the cylinder “EMPTY” and contact the UConn contract vendor or manufacturer to remove the cylinder from the lab.

7. Transport

- At a minimum, protective eyewear must be worn during transport of gas cylinders.
- Cylinder caps must be in place (i.e., never transport a cylinder with a regulator in place).
- Transport one cylinder at a time.
- Cylinders must be moved on an approved cart and secured with a strap or chain.
- Cylinders must never be rolled on their sides or dragged.
- Contact the UConn contract vendor to transport cylinders between buildings, or as needed.

F. Cryogenic Liquids

A cryogenic liquid is defined as a liquid with a boiling point below -90°C (-130°F) at 101.3 kPa (14.7 psi) absolute. Commonly used cryogenic liquids include liquid nitrogen, helium, and oxygen. Solid carbon dioxide (i.e., dry ice) is not a cryogen but can still be hazardous when not handled properly. Most cryogenic liquids are odorless, colorless, and tasteless when vaporized. When cryogenic liquids are exposed to the atmosphere, the cold boil-off gases condense the moisture in the air, creating a highly visible fog. Hazards associated with cryogenic liquids are listed in the table below:

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesion</td>
<td>Contact with tanks, piping, or equipment containing cryogenic liquids can cause skin to stick to the surface, tearing the skin during removal.</td>
</tr>
<tr>
<td>Asphyxiation</td>
<td>Cryogenic liquids can displace oxygen in the atmosphere due to large liquid-to-gas volume displacement ratios, typically about 700:1.</td>
</tr>
<tr>
<td>Explosion due to rapid expansion</td>
<td>Large liquid-to-gas ratios can lead to rapid pressure changes as cryogenic liquids vaporize. All cryogens can condense sufficient moisture from the air leading to freezing and blockage of the openings to storage vessels. Explosions can result from the build-up of trapped gases in the container.</td>
</tr>
<tr>
<td>Extreme cold and frostbite</td>
<td>Cryogenic liquids can freeze human tissue upon contact resulting in cold burns and frostbite.</td>
</tr>
</tbody>
</table>
Liquid hydrogen has a wide flammability range, 4% to 74% in air, and requires a small amount of energy for ignition. To prevent formation of explosive mixtures in air, no ignition sources are allowed where liquid hydrogen is stored or handled. **Any planned use of liquid hydrogen or other flammable cryogenic liquid must be reviewed by UCFD.**

Vaporization of liquid oxygen in an enclosed area can cause oxygen enrichment, which may cause or intensify a fire. Although oxygen does not burn, it will support combustion. Combustible materials (e.g., oil, grease, etc.) will become more likely to ignite, burn more vigorously, and may explode when exposed to oxygen-enriched materials. **Any planned use of liquid oxygen must be reviewed by UCFD.**

1. **Work Practices**
   - Read the safety data sheet for each cryogenic liquid prior to use.
   - Avoid eye or skin contact.
   - Work in a well-ventilated location. Avoid closets, cold rooms, and other locations with little or no ventilation. A leak in such an area could cause an oxygen-deficient atmosphere.
   - Consider ventilation monitors or oxygen deficient sensors and alarms. Check the monitors and alarms before and during cryogen use.
   - Examine containers and pressure relief valves for signs of defects prior to each use. Never use a container that has defects. Contact a cryogenic vendor for assistance.
   - Do not allow liquid oxygen or oxygen-enriched air to come in contact with organic materials.
   - Never touch uninsulated pipes or vessels containing cryogenic liquids.
   - Carefully select working materials and equipment used with cryogenic liquids. Cryogenic liquids may alter the physical characteristics of many materials, making them brittle and leading to failure.
   - Use non-metallic tongs or tongs with insulated handles to add or remove materials from cryogenic liquids.
   - Verify there is pressure relief for any place where a pressure build-up could occur.
   - Push, do not pull, Dewars with wheels if they need to be moved, unless otherwise instructed by the manufacturer. Pulling Dewars on wheels increases the risk of tipping.
   - Do not ride on elevators when cryogenic liquids are being delivered by outside vendors.
- Schedule large Dewar fills during normal business hours, when staff are available to assist. If after-hours access is needed, it is recommended that other lab personnel be nearby to assist.
- If Dewars must be moved, clear all obstacles from the pathway before transport. Contact the UConn contract vendor or manufacturer for assistance with moving cylinders if necessary.
- If a Dewar pressure relief valve fails and causes improper or frequent venting, leave the lab, post a warning sign on the door(s) to the lab to prevent access and dial 911.

2. Personal Protective Equipment (PPE)

- Wear safety goggles when working with cryogenic liquids. Safety glasses do not provide sufficient protection.
- Wear a face shield together with safety goggles when filling Dewars or transferring cryogenic liquids from one container to another.
- Wear appropriate gloves designed for cryogenic liquids; do not leave skin exposed. Gloves must be loose-fitting to allow for quick removal if a cryogen leaks or is spilled into them.
- Most cryogenic gloves are designed for splash protection only. They are not designed for immersion into cryogenic liquids.
- Do not wear metal jewelry or watches.
- Closed-toed footwear is required when handling cryogenic liquids. Leather will shed the spilled liquid better than canvas or other absorbent materials.
- An apron made of leather or other non-absorbent material should be used when working with liquid cryogens. Most clothing material will absorb spilled liquid cryogens, increasing the risk of skin exposure.
- Review the Workplace Hazard Assessment to identify the specific PPE required by the principal investigator or laboratory/facility manager.

3. Storage

- Store cryogens in well-ventilated areas to prevent oxygen deficiency.
- Use only approved storage vessels that have pressure relief valves.
- Never adjust, block, or plug a pressure relief valve.
- Avoid contact with moisture during storage to prevent ice plugs in relief devices.
- Never store a cryogen in a sealed, airtight container at a temperature above the boiling point of the cryogen; the pressure resulting from the production of gaseous carbon dioxide or nitrogen may lead to an explosion.
- Periodically check container necks for ice plugs; core out ice plugs if present.
- Keep heat sources away from cryogenic liquids.
- Do not use cryogens or dry ice in cold rooms due to risk of asphyxiation.

G. Peroxide-Forming Chemicals

Peroxide-forming compounds can become extremely hazardous if not managed properly. Several commonly used solvents (e.g., diethyl ether, tetrahydrofuran, dioxane, etc.) can form explosive peroxides through a relatively slow oxidation process in the presence of heat, light, moisture, oxygen, or impurities. Since most peroxide-forming chemicals are packaged in atmospheres containing air, even unopened bottles can produce peroxides. Refrigeration does not eliminate peroxide formation and stabilizers only slow down formation.

Peroxide formation becomes evident when crystalline solids are observed in the liquid itself or around the bottle’s cap. Some peroxide-forming chemicals produce solutions that appear cloudy. Once peroxides have formed, they can detonate when combined with other compounds or when disturbed by unusual heat, mechanical shock, impact, or friction. Visual inspection is the safest way to determine peroxide formation. If you suspect the presence of peroxides, contact Environmental Health and Safety at 860-486-3613.

The following table lists common peroxide-forming chemicals present in laboratories. The lists of chemicals in the table below are not comprehensive. Safety data sheets (SDSs) must be reviewed to indicate whether chemicals being utilized in the laboratory can form explosive peroxides.

<table>
<thead>
<tr>
<th>CLASS 1.- Severe Peroxide Hazard Without Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Chemicals will form explosive levels of peroxides without becoming concentrated. A severe peroxide hazard will occur after prolonged storage, especially after exposure to air.</td>
</tr>
<tr>
<td><strong>Management:</strong> Label these items with a date of receipt and date of opening. Test for peroxides monthly and discard after 3 months (even if unopened).</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
</tr>
<tr>
<td>Butadiene (liquid monomer)</td>
</tr>
<tr>
<td>Chemicals</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Chloroprene (liquid monomer)</td>
</tr>
<tr>
<td>Divinyl acetylene</td>
</tr>
</tbody>
</table>

**CLASS 2.- Peroxide Hazard Due to Concentration**

- **Description:** These chemicals become a peroxide hazard when they are concentrated through distillation or evaporation and can pose a serious explosion hazard.

- **Management:** Label these items with a date of receipt and date of opening. Test for peroxides 6 months after opening (if uninhibited) and dispose of within 12 months, unless peroxide testing confirms no peroxides are present.

**Examples**

<table>
<thead>
<tr>
<th>Acetal</th>
<th>Diacetylene</th>
<th>2-Hexanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaldehyde</td>
<td>Dicyclopentadiene</td>
<td>Methylacetylene</td>
</tr>
<tr>
<td>Benzyl alcohol</td>
<td>Diethylene glycol dimethyl ether (diglyme)</td>
<td>Methyl cyclopentane</td>
</tr>
<tr>
<td>2-Butanol</td>
<td>Diethyl ether</td>
<td>Methyl-isobutyl ketone</td>
</tr>
<tr>
<td>Cumene</td>
<td>Diethylene glycol</td>
<td>2-Pentanol</td>
</tr>
<tr>
<td>2-Cyclohexen-1-ol</td>
<td>Dimethyl ether</td>
<td>1-Phenylethanol</td>
</tr>
<tr>
<td>Cyclohexene</td>
<td>Dioxanes</td>
<td>Tetrahydrofuran</td>
</tr>
<tr>
<td>Cyclooctene</td>
<td>Ethylene glycol dimethyl ether (glyme)</td>
<td>Tetrahydronaphthalene</td>
</tr>
<tr>
<td>Cyclopentene</td>
<td>4-Heptanol</td>
<td>Vinyl ethers</td>
</tr>
</tbody>
</table>

**CATEGORY 3.- Autopolymerize as a Result of Peroxide Accumulation**

- **Description:** These chemicals may explode when relatively small quantities of peroxides form. These chemicals normally have an inhibitor added by the manufacturer to prevent peroxide formation. Do not store inhibited chemicals in an inert atmosphere.

- **Management:** Label these items with a date of receipt and date of opening. Dispose of inhibited chemicals after 12 months and uninhibited items within 24 hours of use.

**Examples**

<table>
<thead>
<tr>
<th>Acrylic acid</th>
<th>Chlorotrifluoroethylene</th>
<th>Vinylacetylene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile</td>
<td>Methyl methacrylate</td>
<td>Vinyl chloride</td>
</tr>
<tr>
<td>Butadiene</td>
<td>Styrene</td>
<td>Vinyl pyridine</td>
</tr>
</tbody>
</table>
### CATEGORY 4.- May Form Peroxides

**Description:** These chemicals are normally stable but have the ability to form peroxides under certain conditions.

**Management:** Review the safety data sheet to determine under which conditions peroxide formation is expected and manage accordingly. Consult EHS if crystals are present.

<table>
<thead>
<tr>
<th>Chloroprene</th>
<th>Vinyl acetate</th>
<th>Tetrafluoroethylene</th>
</tr>
</thead>
</table>

| Acrolein | 2-Ethylbutanol | 1-Pentene |
| Benzyl ethyl ether | Ethyl vinyl ether | Phenoxyacetyl chloride |
| Benzyl methyl ether | n-Hexyl ether | Phenyl-o-propyl ether |
| Cyclooctene | Isoamyl ether | n-Propyl ether |
| p-Dibenzyloxybenzene | Isobutyl vinyl ether | Tetrahydroxypropylene |
| Diethyl fumarate | b-Isopropoxypropionitrile | Triethylene glycol diacetaet |
| Diethyl acetal | 2-Methoxycethanol | 1,3,3-Trimehoxypropene |
| Dimethoxymethane | 3-Methoxyethyl acetate | 1,1,2,3-Tetrachloro-1,3-butadiene |
| Di(1-propyl) ether | b-Methoxypropionitrile | 4-Vinyl cyclohexene |
| 2-Ethoxyethyl acetate | 1-Octene | Vinylene carbonate |

### 1. Administrative Controls

- Identify chemicals that form peroxides through safety data sheets.
- Solvents containing low levels of free radical scavengers such as butylated hydroxytoluene (BHT) should be used whenever the presence of the stabilizing species does not interfere with the intended application.
- Order only the quantities needed. Many uninhibited peroxide-forming chemicals (e.g., diethyl ether, tetrahydrofuran, etc.) used in labs must be tested or discarded after 12 months.
- Use old bottles before opening or ordering new ones.
- Store in tightly-sealed, opaque containers when not in use. Protect peroxide-forming chemicals from air, heat, moisture, light, or impurities.
- Do not store liquid peroxides or solutions of peroxides at a temperature below the point where the peroxide freezes or precipitates. Peroxides in this form are extremely shock and heat-sensitive.
- Store away from incompatible materials such as strong oxidizing and reducing agents.
- If materials must be refrigerated, store in an explosion-proof refrigerator.
Test for peroxides or discard bottles that have exceeded the manufacturer’s expiration date. If the chemical has been tested, the test date must be written on the side of the bottle.

2. Work Practices

- Visually check for crystalline solids before each use.
- Label each bottle with the date received and the date the bottle was first opened.
- Never distill peroxide-forming solvents unless they have been tested and known to be free of peroxides. Peroxides concentrated in the residue can pose a serious explosion hazard.
- Peroxide test strips must be used to test for the presence of peroxides. Testing must NOT be conducted on peroxide-forming chemicals that are of unknown age or origin, if crystals or discolored solids are present, or if the liquid appears cloudy. Contact EHS (860-486-3613) for evaluation and disposal.
- Conduct procedures inside a chemical fume hood. The principal investigator must determine whether work behind a protective shield is also required.
- Reduce the sensitivity of peroxides to heat and shock by dilution with inert solvents.
- Avoid using solutions of peroxides in volatile solvents. Solvent evaporation must be controlled to avoid dangerous concentration of the peroxide.
- Do not allow peroxides to contact iron; compounds of iron, cobalt, or copper; metal oxide salts; acids, bases; or acetone.
- Do not handle peroxides with metal spatulas or magnetic stirring bars that could leach iron. Teflon™, ceramic, or wooden spatulas and stirring blades are recommended.
- Do not allow open flames, other sources of heat or sparks, friction, grinding, or forms of impact near peroxides.
- Do not return unused peroxide-forming chemicals to the original container.

H. Nanomaterials

Nanotechnology involves the engineering, manipulation, and control of particles with lengths in two or three dimensions from 1 to 100 nanometers (1 nanometer is 1 billionth of a meter). In this size range, particles begin to exhibit unique characteristics that influence chemical, physical, and biological behaviors. Research on a nanometer scale involves the production, design, and examination of materials with specific properties related to shape, size, surface area, porosity, and chemistry. Though current
and future applications involving nanomaterials hold considerable potential, the health effects associated with exposure are not yet clearly understood.

Exposure to nanomaterials can occur through inhalation, absorption, injection, or ingestion. Toxicity will depend on the route of exposure and physical and chemical properties of the nanomaterial. Nanomaterials with known hazardous properties (e.g., carcinogens, mutagens, reproductive toxicants, sensitizers, reactive metals, etc.) as well as those that are photo-reactive, have highly-charged surfaces, are highly acidic/basic, soluble, fibrous (i.e., possess a high aspect ratio), and/or have other hazardous properties require further assessment and control measures.

The table below provides a general overview of nanomaterial activities, exposure sources, and engineering controls. Principal investigators or laboratory/facility managers must determine the appropriate engineering controls, work practices, and personal protective equipment necessary for the operations and nanomaterials specific to their labs.

Table 34. Nanomaterial-Related Activities in Labs and Controls

<table>
<thead>
<tr>
<th>State of the Nanomaterial</th>
<th>Activity</th>
<th>Potential Exposure Source</th>
<th>Recommended Engineering Controls</th>
</tr>
</thead>
</table>
| Bound or fixed nanostructures (polymer matrix) | Mechanical grinding, alloying, etching, lithography, erosion, mechanical abrasion, grinding, sanding, drilling, heating, or cooling | Nanomaterials may be released during grinding, drilling, and sanding. Heating or cooling may damage the matrix, allowing release of nanomaterial. | • Local exhaust ventilation  
• Laboratory chemical hood (with HEPA-filtered exhaust)  
• HEPA-filtered exhausted enclosure (glovebox)  
• Biological safety cabinet class II type A1, A2, vented via thimble connection, or B1 or B2 |
| Liquid suspension, liquid dispersion | ▪ Synthesis methods: chemical precipitation, chemical deposition, colloidal, electrodeposition crystallization, laser ablation (in liquid)  
▪ Pouring and mixing of liquid containing nanomaterials  
▪ Sonication  
▪ Spraying/Spray drying | Exposures may result from aerosols of nanoparticles during sonication or spraying, equipment cleaning and maintenance, spills, or product recovery (dry powders). | • Laboratory chemical hood (with HEPA-filtered exhaust)  
• HEPA-filtered exhausted enclosure (glovebox)  
• Biological safety cabinet class II type A1, A2, vented via thimble connection, or B1 or B2 |
| Dry dispersible nanomaterials and agglomerates | Collection of material (after synthesis), material transfers, weighing of dry powders, mixing of dry powders | Exposures may occur during any dry powder handling activity or product recovery. | ▪ Laboratory chemical hood with HEPA-filtered exhaust
▪ HEPA-filtered exhausted enclosure (glovebox)
▪ Biological safety cabinet class II, B1 or B2 |

| Nanoaerosols and gas phase synthesis (on substrate) | Vapor deposition, vapor condensation, rapid solidification, aerosol techniques, gas phase agglomeration, inert gas condensation (flame pyrolysis, high temperature evaporation), or spraying | Exposures may occur with direct leakage from the reactor, product recovery, processing and packaging of dry powder, equipment cleaning, and maintenance. | ▪ Glovebox or other sealed enclosure with HEPA-filtered exhaust
▪ Appropriate equipment for monitoring toxic gas (e.g., CO) |

*Table derived from DHHS (NIOSH) Publication Number 2012-147.*

Prior to research, principal investigators or laboratory/facility managers must evaluate and take measures to control:

- The procedure or operation,
- The ability of the material to become airborne,
- The frequency, duration and quantity of the nanomaterials being used,
- Cleaning and maintenance procedures,
- Storage,
- Emergency response procedures, and
- Waste management.

1. **Engineering Controls**

- All research involving nanomaterials should take place in a properly-functioning fume hood, glove box, ventilated enclosure or other form of local exhaust, unless a risk assessment by the principal investigator determines ventilation is not required and the nanomaterials in use pose no risk to lab personnel.
- Positive pressure laminar flow hoods are not recommended for protection from nanomaterials.
- High-efficiency particulate air (HEPA) filters should be used for removal and/or cleaning of areas contaminated by nanomaterials.
2. Work Practices

- Lab personnel working with engineered nanomaterials must receive training on the associated hazards and risks. Documentation of training is recommended.
- Review the safety data sheet(s) prior to use.
- Avoid manipulating nanomaterials in open systems or in a free particle state (e.g., handling dry nanopowders on a bench top).
- Whenever possible, handle nanomaterials attached to substrates or in solutions to minimize airborne release.
- Avoid creating large, highly concentrated aerosols of combustible nanomaterials.
- Store liquid and solid nanomaterials in unbreakable, tightly sealed containers.
- Label secondary containers with a chemical name and hazard class(es), if applicable. Use the word “Nano” to differentiate from other containers.
- Close or cover all containers when not in use.
- Work in an isolated area of the lab, preferably in a fume hood or approved ventilated enclosure. Post appropriate warnings to notify other lab personnel of the risks.
- Clean all working surfaces potentially contaminated with nanomaterials at the end of each experiment and the end of each day with a HEPA vacuum and/or wet wiping. Do not dry sweep or use compressed air.
- Clean contaminated clothing (e.g., lab coats) through an approved vendor.

3. Personal Protective Equipment

- Wear all personal protective equipment (PPE) specified in the safety data sheet(s) and Workplace Hazard Assessment Form.
- At a minimum, ANSI-approved chemical safety goggles or glasses with side shields must be worn while working with nanomaterials.
- Wear gloves impervious to the materials and/or chemicals being used.
- Wear long sleeve shirts, lab coats, and clothing that covers the legs (without cuffs).
- Gloves should be removed inside the fume hood or under local ventilation and placed in sealed bags to prevent nanoparticles from becoming airborne.
- Principal investigators or laboratory/facility managers must determine when respiratory and face protection in conjunction with safety goggles/glasses are required based on the hazards and quantities of the material(s) handled, the availability of appropriate controls, and the exposure risks.
- Lab personnel required to wear respirators must comply with all requirements of the UConn Respirator Program.
- Wear closed-toed footwear. Disposable, over-the-shoe booties may be necessary to prevent tracking nanomaterials from the lab.

I. Thorium and Uranium Compounds

Thorium and uranium compounds (e.g., thorium acetate, thorium nitrate, uranyl acetate, uranyl nitrate, etc.) are regulated as radioactive source material by the Nuclear Regulatory Commission (NRC). Lab personnel purchasing thorium and uranium compounds must report the quantities and location(s) to Radiation Safety. Radiation Safety is required to include the amounts of thorium and uranium in the overall University inventory. Failure to contact Radiation Safety prior to ordering may result in UConn exceeding regulatory limits. In order to minimize total quantities, Radiation Safety requires:

- Contacting Radiation Safety with the name and gram weight of the compound prior to ordering,
- Purchasing the smallest quantity for the desired application, and
- Sharing stocks from other researchers (Radiation Safety can provide a list of researchers possessing thorium and uranium compounds upon request).

Barcodes on empty chemical bottles previously containing thorium and uranium compounds must be sent to EHS prior to disposal for compliance with the Laboratory Chemical Inventory Program. Unwanted thorium and uranium compounds or waste containing thorium and uranium must be disposed of through Radiation Safety.

XIV. Laboratory Equipment

Departments, principal investigators, laboratory/facility managers, lab personnel, and other individuals working in labs are responsible for proper use and maintenance of equipment used in laboratories. All repair and calibration work on laboratory equipment must be carried out by properly trained and qualified personnel. Equipment used in labs must be installed and maintained as specified by the manufacturer. Prior to purchasing or relocating equipment, principal investigators or laboratory/facility managers must complete an Equipment Form to ensure the spatial, mechanical, electrical, ventilation, and other requirements of the equipment can be accommodated.

In addition to the general work practices for lab equipment listed below, lab personnel must also follow the manufacturer’s guidelines for equipment specific to their labs.
A. Centrifuges

- Follow the manufacturer’s instructions for safe operation.
- Ensure tubes or containers are balanced, hung properly, and not overfilled.
- Inspect tubes or containers for cracks or flaws before using them.
- Ensure that the lid is closed before starting the centrifuge.
- The disconnect switch should automatically shut off the centrifuge when the top is opened.
- Do not exceed a rotor’s maximum rated speed.
- Do not overload a rotor beyond its maximum mass without reducing the rated rotor speed.
- Check O-rings and grease the seals per manufacturer specifications.
- Clean the rotors as specified by the manufacturer.
- Use only the rotor(s) specified by the manufacturer. Change old rotors as advised by manufacturer.
- Use local exhaust ventilation for samples containing flammable and/or hazardous materials.
- Inspect the components of the centrifuge each time it is used. Replace parts if signs of corrosion or cracks on the rotors, cone area, and/or tube cavity are evident.

B. Heating Equipment

- Follow the manufacturer’s instructions for safe operation.
- Never use laboratory ovens to prepare food for human consumption.
- Do not use ovens to dry volatile chemical samples.
- Do not dry glassware that has been rinsed with an organic solvent in an oven.
- Ovens must be exhausted as required by manufacturer’s specifications.
- Bimetallic strip thermometers are preferred for monitoring oven temperatures. Mercury thermometers are not recommended.
- Use only hot plates with fully enclosed heating elements.
- Do not store flammable materials near hot plates.
- Use only heating mantles with a variable autotransformer to control the input voltage. Never plug them directly into a 110-V line.
- Never exceed the input voltage recommended by the mantle manufacturer.
- Avoid using water or other volatile substances near oil, salt, or sand baths.
- Monitor oil baths using a thermometer or other thermal sensing device to ensure temperatures do not exceed the flash point of the oil being used.
• Use thermal-sensing devices that turn off electric power to prevent overheating if an oil bath must be left unattended.
• Thermocouples used by controlling devices must be clamped securely in place to maintain contact with the medium or object being heated at all times.
• Mount oil baths on a stable horizontal support such as laboratory jacks. Avoid use of iron rings.
• Metal pans or heavy-walled porcelain dishes are preferred over Pyrex glassware for containing oil baths.
• Do not heat sealed containers or metal-containing objects in a microwave.
• Never operate microwave ovens with the doors open.
• Never use heat guns in areas with flammable liquids or vapors.

C. Pressure and Vacuum Systems

• Follow the manufacturer’s instructions for safe operation.
• Procedures involving high pressure vacuum systems should be carried out in a properly functioning chemical fume hood.
• Principal investigators or laboratory/facility managers must determine if shielding of the operation is required.
• Ensure glass vessels are designed for the intended operation.
• Inspect glass vessels for cracks, scratches, or etching marks before each use.
• Do not allow water, solvents, and/or corrosive gases to be drawn into vacuum systems.
• Distillation or similar operations requiring a vacuum must use a trapping device.
• Traps must be appropriate for the materials (e.g., particulates, solvents, highly reactive, corrosive, or toxic gases).
• Vacuum pumps must be vented to a suitable exhaust system.
• Vacuum pump oil must be drained and replaced when it becomes contaminated. Contaminated pump oil must be disposed of as hazardous waste.
• Belt-driven mechanical pumps must have protective guards.
• Drip pans are required to minimize spills and must be cleaned regularly.

D. Refrigerators and Freezers

• Follow the manufacturer’s instructions for safe operation.
• Flammable chemicals must be stored in an approved explosion-proof or flammable storage refrigerator or freezer.
• Chemicals stored in refrigerators or freezers must be compatible. Limited quantities of incompatible hazard classes that require refrigeration must be segregated in separate secondary containment bins with tight-fitting caps or lids.
• Do not plug refrigerators or freezers into extension cords or power strips.
• Never store uncapped or partially opened containers (e.g., chemicals covered with aluminum foil, glass stoppers, wooden corks, etc.) of chemicals in a refrigerator.
• Samples and chemicals stored in refrigerators must be appropriately labeled.

E. Solvent Stills

• Follow the manufacturer’s instructions for safe operation.
• Operate stills in a properly functioning chemical hood.
• Run stills during normal business hours if feasible.
• Use Plexiglas® shields around the stills to protect lab personnel.
• Never use air to deactivate a still. Use argon, nitrogen, or another inert gas agreed upon by PI or laboratory/facility manager.
• Never add solvents, indicators, or drying agents while the still is hot.
• Quench the still at the end of each procedure. Do not allow residual material to accumulate. Residual waste liquids/reactive metals must be disposed of as hazardous waste through EHS.

F. Miscellaneous Equipment

• All equipment not referred to in the CHP must be operated in accordance with the manufacturer’s specifications.
• Equipment with moving or rotating parts must be appropriately guarded or enclosed.
• Equipment that generates strong magnetic fields, such as a nuclear magnetic resonance (NMR) system, must exclude ferromagnetic objects from the immediate vicinity of the magnet.
• Laboratories using three-dimensional (3D) printers must comply with EHS guidelines for safe use.
• Equipment that exposes lab personnel to significant noise levels (e.g., ultrasonicators) must be evaluated by EHS. Individuals exposed to noise sources of 85 decibels or greater for an 8-hour average duration must be entered into the Hearing Conservation Program.
- Equipment that exposes lab personnel to radioactive isotopes or sources (e.g., electron capture detectors in gas chromatographs, liquid scintillation counters, etc.) must be in full compliance with *Radiation Safety Manual*.
- Equipment that exposes lab personnel to X-rays must remain in compliance with the *Analytical X-Ray Safety Program*.
- Labs that use Class 3B and 4 lasers must remain in compliance with the *Laser Safety Manual*.

**XV. Medical Consultation and Medical Examinations**

Principal investigators, laboratory/facility managers, and lab personnel working in laboratories at the University must be afforded medical attention, including follow-up examinations, deemed necessary by the examining physician, under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical exposure;
- Where exposure monitoring reveals an exposure level 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;
- Whenever an accident such as a spill, leak, fire, explosion, or other occurrence results in the likelihood of a hazardous exposure; or
- At the request of the University Chemical Hygiene Officer.

All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician. Medical exams/consultations must be conducted within a reasonable timeframe from the date the incident occurred and shall be provided without cost or loss of pay to the employee.

**XVI. Records and Recordkeeping**

The University of Connecticut is required to maintain an accurate record of any exposure monitoring results required to assess employee exposures to toxic or harmful chemicals in the course of employment in accordance with *29 CFR 1910.1020, Access to employee exposure and medical records*. Environmental Health and Safety maintains records of the following information:

- Exposure monitoring results,
- Training,
- Fume hood inspections, and
- Laboratory inspections.

Exposure monitoring results shall be preserved and maintained for at least 30 years. EHS also maintains separate databases regarding employee training, fume hood inspections, and laboratory inspections.
XVII. References and Additional Resources


XVIII. Chemical Hygiene Plan- Signature Confirmation

Click to Access CHP Signature Confirmation