Section 1 - Chemical Hygiene Plan Responsibilities

Contents

A. PURPOSE

The Cleveland State University Office of Environmental Health & Safety is committed to create, maintain, and enhance a safe and healthful environment for all individuals associated with the institution, including students, faculty, staff, and visitors.

A major part of demonstrating this commitment in chemical laboratories is documenting the safety program in the laboratory's chemical hygiene plan.

1. Chemical Hygiene Plan (CHP)

Ohio Revised Code (ORC) 4101.11 requires that Cleveland State University offers a work environment free of recognized hazards. CSU Laboratories must document their safety procedures in a "Chemical Hygiene Plan" or CHP. For CSU laboratories, the laboratory's chemical hygiene plan is created by combining laboratory-specific information and safety requirements with the CSU Laboratory Safety Manual.

Your lab's CHP can be completely electronic, completely paper, or a mixture. It must always be accessible to all personnel who work in areas containing hazardous chemicals.

If the CHP is all electronic, personnel must know where the files are located and how to access them. They must have access to a computer and the files while working. For ease of electronic use, the CSU Laboratory Safety Manual may be "bookmarked" in its entirety as a "PDF" file. Separate sections, templates, etc. can also be bookmarked from the EHS website. A caution with electronic information is that it must be obvious which files and documents are the current ones that must be used.

If an all paper CHP is to be used, the lab-specific information can be filed in the front of the manual, behind the "My Lab" tab following the Quick Start page. The CHP must be accessible to all workers while at work; it cannot be locked in a supervisor's office. Laboratory-specific information such as chemical, standard operating procedures, or safety data sheets (SDS) and other reference materials may be kept elsewhere if necessary.

A mixed paper/electronic version of the CHP may work best in your lab. A master index of where the parts of the complete CHP are located, identifying the current revision number or date for each part, should always be easily available to all personnel.

If some individuals want to keep personal copies of the CSU Laboratory Safety Manual or the lab's standard operating procedures, all people must be aware of where the master CHP is located. Some information not directly associated with safety procedures and which might be troublesome to replace if lost, such as certifications that individuals completed safety training, may be kept separately in locked cabinets. That location should be identified in the laboratory- specific information section.

2. Regulations Pertaining to the Chemical Hygiene Plan

a. Occupational Exposure to Hazardous Chemicals in Laboratories

The Occupational Safety and Health Administration (OSHA) standards set forth in 29 CFR 1910.1450 directly address laboratory safety and the use of hazardous chemicals. The State of Ohio has adopted these standards through the Public Employment Risk Reduction Act Ohio Revised Code (ORC) 4167.07.

b. Chemical Waste Management

The Ohio Administrative Code (OAC) 3745-51-03 provides the definition of

Hazardous Waste. Information in Section 3 of the manual outlines the specifics of these requirements and describes how to safely accumulate and dispose of chemicals.

c. US Department of Homeland Security Regulations

The United States Department of Homeland Security has developed Chemical Facility Anti-Terrorism Standards (CFATS) to implement the Federal Regulations in 6 CFR Part 27. These standards require the University to track and control specific chemicals of interest. The University's chemical inventory system as described in later sections of this manual is an important component in complying with the regulations.

3. Chemical Hygiene Plan Accessibility

The Chemical Hygiene Plan must always be accessible to laboratory employees and students when the laboratory is occupied. If multiple rooms are included in the laboratory, the plan must be available without having to get a key from another person. It must also be available on request to CSU Environmental Health and Safety (EHS) staff and Ohio Bureau of Workers Compensation representatives.

4. Other Plans and References

This Chemical Hygiene Plan/Laboratory Safety Manual is a part of a complete safety program. Other University documents impacting laboratory operations may include the Department or College Health and Safety Plan, the Emergency Evacuation and Operations Plan for the building, the Radiation Safety Manual, and the Biosafety Manual. External to the University, agencies providing grants may require additional plans and certifications.

5. Applicability to Students

CSU health and safety policy 3344-27-01 includes students. Students in laboratories, while not legally covered under these procedures, are afforded the same level of protection as University employees. (Students who are not employees are not covered by Workers' Compensation in the event of an injury.)

B. SCOPE AND APPLICATION

In general, the policies and procedures in the Laboratory Safety Manual apply at all locations that serve as assigned workplaces and educational settings for Cleveland State University faculty, staff, and students. This includes the Cleveland Campus, and other University-owned property, University-leased space, and temporary field locations that are under the control of CSU personnel.

Any laboratory which meets the definition of a chemical laboratory must complete a Chemical Hygiene Plan for the laboratory by adding laboratory-specific information to this manual. Laboratories which do not meet the definition of a chemical laboratory may refer to this manual for general safety information but must comply with general industry regulations concerning chemical management.

1. Chemical Laboratory

A chemical laboratory is defined as an area (which can be a single room, a group of rooms, or a part of a room identified as a researcher's laboratory), where chemical manipulations are done for research, educational, or clinical purposes. The manipulations must involve mixing different hazardous chemicals in a variety of formulations, done on a small scale

(one person can easily handle the volume of the chemical in use). According to Ohio Revised Code 4101.11, a chemical laboratory must also utilize safety practices or safety equipment to reduce the risks of the hazardous chemicals. In addition, the chemical laboratory may not be a production type facility where one process is performed repeatedly to produce a product for others.

2. Chemical and Non-Chemical Hazards

Hazardous chemicals are those which present either a health hazard (such as an acute skin burn from a corrosive acid or a disease from a chronic, long term exposure) or could cause a physical hazard from a chemical action (such as a fire or explosion). Hazardous chemicals can often be identified from their labels, which could state "Danger," "Warning," or "Caution" or words to that effect, or the label could have some symbol which indicates a hazard. The chemical's Safety Data Sheet (SDS) may also indicate that the chemical has dangerous properties, could cause some disease or injury, or that personal protective equipment such as gloves are recommended when handling the chemical.

In addition to chemical hazards, this Laboratory Safety Manual provides information about general hazards (e.g., electrical safety, high noise, etc.) which may be present in the laboratory environment. Appendix B is a glossary of useful terminology applicable to this manual related to both chemical and non-chemical hazards.

It would be impossible for one manual to provide complete information about all potential hazards and controls, so use of other references is encouraged, such as *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (National Research Council Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories)*. This document can be found at the Michael Schwartz Library as an electronic document.

The EHS website contains information about environmental, health and safety policies and procedures for all CSU work areas, not just laboratories. Specific policies and procedures are also addressed concerning the control of biological hazards in the Biosafety in Microbiological and Biomedical Laboratories (BMBL).

For the control of radioactive hazards, please refer to the CSU Radiation Safety Program.

C. RESPONSIBILITIES

1. Responsible Party

Each chemical laboratory must have a designated Principal Investigator (PI) who is knowledgeable about the laboratory's procedures, is actively involved or observant of those procedures being performed and has the authority to enforce correct procedures.

If the PI has other commitments that prevent knowledge of the laboratory's day-to-day activities and assigns another person to be the laboratory's supervisor, the PI is still considered the responsible party for the laboratory. In non-research laboratories, the responsible party may assign a laboratory supervisor, manager, or other senior-level person with authority familiar with activities within the laboratory to be the lab supervisor. The lab supervisor must be identified by name in the laboratory-specific section of the laboratory's CHP.

The PI or Lab Manager must ensure that laboratory-specific information is documented in the CHP and ensure that activities conducted within the laboratory are consistent with the CHP. To aid in compiling laboratory-specific information, a template and guides for noting laboratory-specific information are available in Appendix C of this manual and an electronic copy of the template is available on the EHS website. This template also makes it easier to identify the PI/Lab Manager by name and to remember when the annual review of the CHP should be accomplished.

The laboratory's responsible party must ensure the following is accomplished:

a. Develop the CHP

A chemical laboratory must have a CHP. It consists of the CSU Laboratory Safety Manual plus laboratory-specific information. Major areas of the laboratory-specific information portion include:

- The safety requirements, either as laboratory rules or Standard Operating Procedures (SOPs) which include Personal Protective Equipment (PPE) requirements;
- Laboratory-specific topics covered in the laboratory's training program; and,
- Additional details specific to the laboratory and generally described on the laboratory-specific information template in Appendix C of the Laboratory Safety Manual.

b. Create a List of Chemicals Stored in the Laboratory

An accurate list of chemicals must be entered into the chemical inventory management system and the list updated at least annually. Attach SDS's to the chemical inventory when received in the laboratory. Chemical inventory procedures are described in Section 2.B of the CSU Laboratory Safety Manual.

c. Identify and Assess Hazards

The laboratory's responsible party must ensure all laboratory staff understand that new and changed procedures must be assessed for hazards. The laboratory's PI, CHO or another person familiar with the laboratory's procedures must assess those procedures and determine controls to adequately minimize risks. Any laboratory member can identify hazardous conditions that could result in personal injury or property damage. Once identified, the hazardous conditions must be assessed.

If there are several processes to be assessed, they can be initially prioritized for assessment by knowing past accidents and whether any staff have troubles with a particular procedure, the processes in the laboratory which may be most easily compromised, procedures frequently performed or using large quantities of chemicals, and procedures involving particularly hazardous substances. Steps in the assessment include:

1) Researching chemicals and processes to be used;
2) Identifying and evaluating all types of hazards involved (some questions to consider: what are the hazards/what is the worst that can happen/what can be done to prevent that/what can be done to minimize each risk/what should be done if something goes wrong?);
3) Considering if additional hazards may be present when scaling up;
4) Selecting controls to adequately lower the perceived risks using the hierarchy of controls (starting with the most effective):
    - Eliminate hazardous substances and hazardous steps in the process if possible;
    - Substitute with less hazardous chemicals, smaller quantities, and safer processes if possible;
    - Implement engineering controls such as local ventilation or remote controls;
    - Implement administrative controls such as a "two-person" policy during exceptionally hazardous processes; and,

- Assess PPE requirements as a “last line of defense.”

5) Ensuring emergency response situations have been addressed.

If the assessment results in there being requirements for controls, the requirements must be documented as described in the following paragraph. For best practices, it is recommended that the assessment be documented whether or not controls are required.

d. Document and Enforce Appropriate Safety Practices

Safe work practices and rules required within the laboratory must be documented. Requirements can be documented as general rules conspicuously posted in the laboratory or included in SOPs. Examples of general rules are in Section 2 of this manual and SOPs are described in Section 6. If an individual fails to follow the requirements, the laboratory’s responsible party must initiate enforcement actions and document those actions.

e. Ensure Signage/Labels in Place

Appropriate signage must be posted and hazardous material containers (including hazardous waste containers) must be labeled. Laboratory signage is described in Sections 2.A.7 and 4.C; labeling is described in Section 2.E of this manual.

f. Assess, Provide and Document Training

The laboratory’s responsible party must ensure that training requirements for the individuals are determined depending on their duties. Employees, volunteers, visiting scientists, and students working in the laboratory must receive general and laboratory- specific training, including the hazards of the chemicals present, and the required safety procedures including selection and use of PPE. The department or others may provide information about the CSU’s general requirements such as emergency response procedures. Laboratory staff are responsible for training requirements concerning the materials and the processes conducted within the laboratory. The assessment and training must be documented.

g. Ensure Staff Have Access to Safety Information

All those who work in areas with hazardous chemicals must have access to essential safety information while they are at work, including the CHP and Safety Data Sheets. This information should be available in the laboratory space where work is being done, or easily accessible in electronic format.

h. Ensure Visitor Safety

1) Before starting their chemical use, visiting scientists performing procedures within the laboratory must receive equivalent training as other employees on the hazards and safety precautions including requirements for use of PPE.

2) Other visitors such as maintenance staff, transportation services staff, and “open house” visitors must be protected from the hazards within the laboratory. For example, surfaces and equipment must be decontaminated and cleaned prior to allowing visitors to contact such surfaces and equipment. (Information about preparing equipment for servicing by maintenance personnel is in Section 4.G of this manual. Information about decontaminating equipment and facilities for disposal or lab relocation is in Section 4.H.

i. Enforce Restrictions on Children

The laboratory must not be used as a childcare area, in accordance with Cleveland State University Policy 3344-94-01.

Minors ages 14-17 working in the laboratory as volunteer workers or as employees must not be exposed to agents that pose higher health risks as described in **OAC 1301:7-7-50** These risks include such materials as human body fluids, radioactive, and hazardous substances, or jobs requiring PPE other than gloves, boots, eye protection or hard hats.

j. Enforce Restrictions on Pets

Refer to CSU Policy regarding animals on campus 3344-79-01.

k. Perform Annual Reviews and Update Documents

Annually, someone in the laboratory must check that changed information has been integrated into the CHP and should review that conditions have not drifted from a safety perspective by:

- Checking after September each year for any revisions to the Laboratory Safety Manual;
- Checking that actual laboratory procedures and conditions remain consistent with SOPs and other laboratory-specific information;
- Verifying your chemical inventory is current including SDS's and the names of responsible parties and contacts. Verify that a build-up of old chemical stock does not seem to be occurring in inventory; and,
- Reviewing internal inspection results and the condition of equipment used by laboratory staff to identify possible safety deficiencies, such as dirty or worn equipment, out-of-date fire extinguisher, or emergency shower inspections.

It is recommended that laboratory staff make any changes necessary and note the annual review and maintain the documentation in the laboratory-specific information section of the CHP. If there are major changes during the year, it is recommended that laboratory staff update the laboratory-specific information as conditions or procedures change.

l. Perform Accident Follow-up

All accidents and incidents must be investigated. Any accidents / incidents resulting in injury to personnel to the extent that they need medical attention, and accidents / incidents involving unplanned fires and explosions must be reported to the laboratory's responsible party and to EHS. It is recommended that incidents that do not result in significant injury or damage but do result in learning experiences (often called "near-misses"), also be reported to the laboratory's responsible party and to EHS.

Details for accident follow-up are provided in Section 9.B of this manual, including reporting requirements described in Section 9.B.1.b. If it is recognized that an SOP could be improved, update it prior to performing the procedure again.

m. Perform Inspections and Assist External Inspections

It is recommended that laboratory staff perform periodic self-inspections of the laboratory. Formal self-inspections using a checklist or informal/walk-through self-inspections should be performed semi- annually. If only a few problems are identified, the schedule may be changed to an annual basis (especially if laboratory personnel

and procedures remain constant and few new pieces of equipment are obtained). It is recommended that all inspections have some type of documentation and that different people perform them to spread knowledge and to get different viewpoints.

If deficiencies are identified, they must be addressed. Documentation of the inspections and follow-up should be maintained for three years.

When notified of third-party inspections (i.e., OEPA, ODH), the responsible party should be responsive in scheduling and in providing laboratory- specific information as requested. Survey findings should be addressed in a timely manner. All laboratory staff should support the inspection as much as possible.

Inspection checklists are available here.
https://www.csuohio.edu/ehs/research-safety

2. Dean, Department Chair and Director

The Dean, Department Chair and Director are responsible for the following.

a. Ensure Safety of Occupants

Provide a safe and healthy workplace free from recognized hazards. This can be accomplished by being aware of the University's Accident Prevention Program, being familiar with Office of Environmental Health and Safety's programs and the activities generally being conducted, being aware of the general requirements in this manual and other safety and health requirements.

b. Enforce Laboratory Control Methods

Ensure that SOP's concerning use of particularly hazardous substances identify authorization requirements. For more information, SOP development is described in Section 6.

c. Maintain Records

Ensure that safety records are maintained as described in Section 8 (Record Keeping) of this manual.

d. Review Accidents

Have procedures in place to become aware of accidents affecting laboratory operations within your department, and ensure corrective actions were taken as necessary to prevent accident recurrence.

e. Review and Follow Up on Inspection Findings

Ensure that corrective actions are completed for safety deficiencies.

f. Ensure Appropriate Laboratory Closures/Moves

Ensure that laboratory closures or moves are done responsibly, as described in Section 10.

3. Employees/Students

Employees and students have a responsibility to:

a. Comply with Guidelines and Policies

Know and comply with safety guidelines and policies required for all assigned tasks.

b. Report Unsafe Conditions

Report unsafe conditions to your laboratory's PI, a faculty member, your immediate supervisor, the Departmental Safety Officer, or to EHS (216-687-2500). If you identify a procedure or assigned task as being exceptionally risky, you can perform it only after you believe the risk has been reduced to an acceptable level.

c. Report Accidents

Report accidents and incidents to your supervisor, and to the university using the on-line accident reporting form here:

https://www.csuohio.edu/ehs/report-occupational-injuryillness

d. Use Personal Protective Equipment

Select, maintain, and use PPE appropriately, consistent with your training. Students may be required to provide your own PPE for use in academic laboratories and classrooms.

4. Environmental Health and Safety Department

EHS is responsible for the following:

a. Develop the Laboratory Safety Manual

Produce and update the Laboratory Safety Manual, which provides the generic information for each laboratory's Chemical Hygiene Plan. Make the manual available through the EHS website. Announce updates on the EHS website.

Assist laboratories, as needed, with the development of the laboratory-specific information required to complete their Chemical Hygiene Plan.

b. Liaise with Regulatory Agencies

Act as the liaison between the University and the regulatory agencies enforcing environmental, health, and safety regulations.

c. Advise Concerning Laboratory Safety

Act as a resource regarding laboratory safety issues.

d. Perform Laboratory Surveys/Audits

Conduct laboratory surveys and assist in implementation of self-auditing procedures.

e. Maintain an SDS Database

Maintain an online Safety Data Sheet Safety Data Sheet (SDS) database that is available to the campus community. The database system also contains the ability to document chemical inventories, Follow the attached link to the website:

http://www.csuohio.edu/ehs/chemwatch

f. Conduct General Training

Develop and provide general training courses in laboratory safety.

Section 2 - Chemical Management

Contents

Tables

Figures

A. BASIC LABORATORY SAFETY PRACTICES

1. Working Alone

Do not work alone in the laboratory if the procedures being conducted involve highly hazardous substances or processes (such as are described in section G later in this section). If you are working alone with lesser hazard chemicals, get approval from your PI before operations start. let personnel in other laboratories know of your presence and develop an accountability system with your supervisor and associated lab personnel.

2. Prevent Chemical Exposure

Prevent skin contact with chemicals. For example, use appropriate Personal Protective Equipment (PPE) (goggles, gloves, lab coat, etc. per Lab Safety Manual Section 5.B) but consider it as “the last line of defense” and use other precautions such as using appropriate containment equipment and regularly checking that connections are tight. Clean up spills as soon as possible and minimize clutter to avoid inadvertent spills.

Prevent inhalation of chemicals. For example, use a fume hood whenever handling volatile or aerosolized chemicals, even if they are of relatively low toxicity. Cap chemicals as soon as is convenient. Limit the smelling of chemicals to the minimum amount necessary; only smell a chemical if no other method of identifying a chemical is available and just waft the air at the container opening towards your nose.

Prevent ingestion of chemicals. For example, do not taste chemicals. Mouth suction must not be used to pipet chemicals or to start a siphon; instead, a pipet bulb or an aspirator must be used to provide a vacuum.

Prevent injection of chemicals. For example, cap needles as soon as the injection is complete. Use needles with inherent safety devices that prevent inadvertent needle sticks. Dispose of sharps into appropriate waste containers. If operating a high-pressure system, never check for a pressure leak using your hands.

3. Washing Hands

Wash hands well with soap and water after removing gloves and before leaving the laboratory area. Never wash with organic solvents. (See Section 5.B Personal Protective Equipment and Appendix G Gloves for more information.)

4. Food and Drink

Food and drink increase the chance of exposure to chemicals and are prohibited from being prepared or consumed in laboratories using chemicals.

a. Glassware/Utensils

Glassware or utensils that have been used for laboratory operations must never be used to prepare or consume food or beverages.

b. Storage of Food/Beverages

Laboratory refrigerators, ice chests, and cold rooms must not be used for food or beverage storage.

5. Vacuum

Use extra care when evacuating air from glassware. Shield or wrap the glassware to contain chemicals and glass fragments should implosion occur. When possible use thick wall vacuum glassware.

6. Access to Emergency Exits and Equipment

Storage, even temporary storage, and equipment must not block doorways, corridors, aisles, stairways, to assure unobstructed access to exits in the event of an emergency. Likewise, emergency equipment, such as eyewashes, deluge showers, fire extinguishers, and fire alarm pull stations, must be directly accessible.

7. Laboratory Signs

Laboratory signs must be posted as described in Section 4.C. These signs may provide information (*e.g.*, emergency numbers), prohibit unsafe behavior or require protective measures, or designate locations of various supplies and equipment.

Magnetic or framed signs that can be easily moved may be used to designate a temporary hazard. Warning signs must be removed when the hazard no longer exists, such as a sign indicating the presence of a chemical that is no longer kept in a laboratory.

8. Housekeeping

Laboratory bench tops and other work surfaces must be organized and provide enough space to safely carry out procedures. Aisles and egress routes must be clear to allow for prompt evacuation in the event of a spill, fire or other emergency. Always maintain the following in the laboratory:

- Flammable materials are kept away from ignition sources
- Incompatible materials are separated from each other
- Emergency equipment and supplies (e.g., eyewash, spill kits) are accessible
- Fume hoods are kept uncluttered

Shelves, cabinetry, refrigerators and other storage equipment must be orderly and all chemicals and chemical waste properly labelled. Label information should be visible. Storage on the floor must be limited, temporary in nature, and in accordance with this safety manual.

Surfaces must be promptly cleaned if contaminated with hazardous materials and periodically cleaned as needed. Refuse, recyclables and surplus equipment and materials must be removed regularly.

Pneumatic and gas tubing, power, control and data wiring, must be routed so they are protected from physical damage, do not create a tripping hazard, and are adequately secured to appropriate infrastructure.

B. CHEMICAL INVENTORY AND SDSs

Laboratories must maintain chemical inventories in Microsoft Excel, this is intended for emergency planning efforts and helps laboratories comply with federal, state, and local regulations. Chemical inventories, location contacts, and chemical specific hazard summaries are provided to emergency personnel so they know what chemicals may be involved in an accident and who to contact in the event of an emergency. Laboratories use chemical inventories to keep track of chemicals and to avoid unnecessary purchases.

Laboratory staff are required to maintain their chemical inventories.

1. Access to Chemwatch

For access to SDSs, go to (http://www.csuohio.edu/ehs/chemwatch)

You may also phone EHS at 216-687-2500.

2. Conducting your Chemical Inventory

Personnel must inventory all chemicals including CFATS chemicals of Interest (COI), located in the laboratory and specify the maximum amount normally found at this location. Dilutions and reagents prepared in the lab for further work do not need to be added to the inventory but must have a container label applied unless the preparation will be all used or disposed that day. Review and update inventories annually and whenever there are significant changes in your chemical inventory, a change in COI quantity, or when you are moving a laboratory or starting a new project.

While conducting your inventory, examine containers for deterioration and integrity. Chemicals that are expired, in bad shape or no longer needed must be managed as hazardous chemical waste. For more information about chemical waste management, see Section 3 of this manual.

After completing the inventory, submit your inventory to EHS, print two copies of the inventory: one copy for the lab and one for home in case of an after-hours emergency in the laboratory.

3. Safety Data Sheet (SDS)

Safety Data Sheets (SDSs) are documents that describe the physical and health hazards of chemicals. Manufacturers of chemicals must provide SDSs for chemicals that they sell. Recent changes in the regulation require the manufacturers to begin replacing MSDS with the new SDS format. Although many SDSs have limited application in laboratories due to their orientation towards industrial use of large quantities of a chemical, they provide basic information that all persons using that chemical need to know.

Chemwatch is the centralized SDS database for chemicals used by University personnel (see Section B.1, above).

Laboratory staff and students must have ready access to SDSs for all chemicals used in the laboratory. The department or laboratory may choose whether to maintain the SDSs in either electronic or paper format. The source of the SDS is less important than the requirement that all personnel using chemicals or working around the chemicals must be able to demonstrate that they can retrieve the SDS for a chemical within a short period (such as within five minutes). Chemwatch allows researchers to link to electronic SDSs directly, so is a suitable tool for fulfilling this requirement.

EHS recommends laboratories maintain paper copies of SDSs for the hazardous chemicals most likely to spill and/or cause injury to someone. Having an SDS immediately available when someone has been exposed to a hazardous chemical helps emergency personnel decide how to respond and treat that person.

Call EHS at 216-687-2500 to request assistance locating or accessing SDSs during business hours. If the SDS is online in the Chemwatch system, they can be printed out from a local printer. Chemicals that do not have an SDS in the system will take longer to research and obtain.

If an SDS is received with a chemical shipment, please maintain a copy in the lab and send a copy to EHS for addition to the Chemwatch database.

C. CHEMICAL PROCUREMENT

Most chemical products can be purchased without restriction from suppliers through MagnusMart or through CSU Purchasing Services. However, the following rules and guidelines apply to all chemicals.

1. Hazardous Chemicals

Order only the amount of chemicals needed. Many manufacturers will supply smaller quantities or containers if requested by the purchaser. Do not stockpile chemicals.

Chemicals that are expired and/or appear to be no longer useful are considered hazardous waste.

Purchase hazardous chemicals in plastic coated bottles (when available) instead of uncoated glass bottles.

If possible, hazardous chemicals should be received directly by the laboratory. If it is received in an office, there should be a safe location such as a designated table with adequate open space reserved for temporary storage of the package.

When you open a shipment, you should verify that the proper chemical was sent, that the container is intact, and that the label is legible. The date of receipt should be written on the container's label.

2. Pharmaceuticals

The purchasing of certain pharmaceuticals may require you to obtain a valid State of Ohio Board of Pharmacy License. For more information, follow the link below:

https://www.pharmacy.ohio.gov/Documents/Licensing%20Information.pdf

3. DEA Controlled Substances

DEA registrants can obtain controlled substances from a drug company, wholesaler or CSU Health and Wellness Services. If you wish to order a controlled substance through CSU Health and Wellness Services, a current Controlled Substances Registration Certificate must be faxed or mailed to CSU Health and Wellness Services before an order can be filled. Controlled substances must be stored in a locked cabinet with limited access. A perpetual inventory must be maintained, and the inventory forms used must meet DEA and State regulations. Expired or waste (undesired) drug must be kept secure in a locked cabinet in a separate container properly labeled for content and inventoried until disposal. Drug Services or EHS will provide the contact information of DEA-licensed reverse distributors who must be used for disposal.

4. Non-Denatured Ethyl Alcohol

Instructions for obtaining approval and purchasing non-denatured ethyl alcohol are detailed in the Chemical Procurement Program and list of buildings where it is authorized for use.

5. Radioactive Materials

The Ohio Department of Health and Bureau of Radiation Protection licenses radioactive materials use. Using radioactive materials requires the prior approval of the Radiation Safety Officer (RSO). Call 216-687-2500 if you need assistance. Orders for radioactive materials must be authorized before the purchase through MagnusMart.

6. Highly Dangerous Materials

Materials that are extremely hazardous to property, health or the environment (explosives, pyrophoric materials, highly water reactive chemicals, and highly toxic gases, for example) must not be procured until the necessary permits and administrative, engineering and environmental controls are in place. Hazardous materials must be stored and used in accordance with numerous regulations including, but not limited to, the State Fire Code and local amendments. See Section G: Special Chemical Hazards, below, for examples. Contact EHS at 216-687-2500 for more information.

7. Compressed Gas Cylinder Procurement

Whenever possible, gas cylinders should be purchased through a local supplier that offers a cylinder return authorization program.

If a different vendor must be used to provide a specialty gas, the purchaser must get a written return agreement from the distributor or manufacturer prior to purchasing the gas. It is important that the return agreement include a statement requiring the manufacturer to take back both the cylinder and any unused gas. The purchaser should retain this agreement until the manufacturer has accepted the returned cylinder.

D. CHEMICAL STORAGE

1. Segregate Incompatibles

To avoid dangerous interactions among incompatible chemicals, they should be stored separately. You can contact EHS at 216-687-2500 for additional information about chemical hazard classes and compatible storage.

Consideration should also be given to using compatible materials for containers, tubing, and reaction vessels. Several compatibility guides are available on the web, such as at http://www.graco.com/content/dam/graco/ipd/literature/misc/chemical-compatibility-guide/Graco_ChemCompGuideEN-B.pdf.

2. General Chemical Storage Guidelines

Follow good storage practices no matter wherever the chemicals are stored (i.e. cabinets, refrigerators, or shelves). Some general, good practices are described in Table 2-1, Chemical Storage Recommendations below.

Table 2-1 Chemical Storage Recommendations

Flammables.	Store in approved safety cans or cabinets. Keep away from any source of ignition: heat, sparks, or open flames. Also see section D.3 below.
Light Sensitive Chemicals	Store in amber bottles in a cool, dry, dark place.
Nitrated compounds	Nitrated compounds can be considered explosive; special care and handling may be required. Also see section G.2.a below.
Oxidizers	Store in a cool dry place.
Peroxidizable Chemicals	Store in airtight containers in a dark and cool place. Most peroxidizable compounds are flammable and should be stored in a flammable liquid storage cabinet or room. Label containers with receiving, and opening dates. Periodically test for the presence of peroxides. Discard before exceeding expiration date. Also see section G.2.b below.
Pyrophoric Substances	(Materials that will react with the air to ignite when exposed, e.g., tert-butyl lithium.) Store in a cool dry place, making provisions for an airtight seal. Also see section G.1.d below.
Toxic Chemicals	Store according to the nature of the chemical, using appropriate security where necessary. Also see section G.1.a below.
Water Reactive Chemicals	Store in a cool dry place away from any water source. Have a Class D fire extinguisher available in case of fire. Also see section G.1.e below.

a. Good Storage Practices

1) Cabinets - Whenever practical, chemicals should be stored in approved cabinets.

2) Shelves - All shelves should be securely anchored to walls and fitted with 2-inch lipped edges or enclosed in cabinets with latched doors.

3) Heavy Objects - Heavy objects should be stored on lower shelves.

4) Corrosives – Corrosives should be stored only below eye level.

5) Secondary Containment - Use secondary containment to prevent incompatible chemicals from mixing and reacting with each other if they must be stored together. This can be done by placing and storing chemical containers inside plastic bins.

   Secondary containment or spill control (such as placing the container on an absorbent pad) is generally required for containers on the floor.

6) Consistent Chemical Storage Locations - Particularly hazardous substances (highly dangerous or toxic chemicals, select carcinogens, mutagens, and teratogens) should be stored together if compatible. Signs should be posted indicating their location and unique hazards.

7) High Degree of Toxicity - Chemicals with a high degree of toxicity (*e.g.* venoms, mycotoxins, and select agents) should be doubly contained and stored in a locked area accessible only by authorized personnel. Use containers that are chemically resistant and non-breakable.

8) Chemical Waste - Store chemical wastes following the same guidelines as above. Original container labels must be obliterated and the containers must be labeled with a completed Hazardous Waste Inventory Sheet http://www.csuohio.edu/sites/default/files/hazardous_waste_inventory.pdf, Secondary containment is required if chemical waste is stored near a floor drain or other drain to sanitary sewer. Avoid mixing incompatible waste materials. Serious laboratory accidents have occurred when people have mixed incompatible waste materials. For more information about chemical waste, see Section 3 of this manual.

9) Storage in Refrigerators or Freezers - Laboratories must use properly designed refrigerators or freezers if such appliances are used for storing volatile flammables. The refrigerator/freezer must be certified by the manufacturer for flammable materials storage. More expensive, “explosion-proof” appliances are usually not required for the typical laboratory setting.

   If containers are placed on refrigerator/freezer door shelves, use secondary containers, additional barriers, velcro, or other protective measures to keep them from falling out when the door is opened. Accidents may occur from small bottles stored on refrigerator door shelves falling over, slipping under the shelf bar, and breaking on the floor when the door was opened.

b. Incorrect Storage Practices

1) Acids - Do not store inorganic acids with flammable solvents, flammable acids or combustibles (such as cardboard). Contact of a concentrated oxidizing acid with a flammable solvent may result in a fire or an explosion. Incompatible chemical storage practices are described above in section D.1 in more detail.

2) Heat/Direct Sunlight - Exposure of chemicals to heat or direct sunlight should be avoided. Even if the chemical is stable, plastic containers have degraded from sunlight.

3) Storage on Floors, on Bench Tops or in Fume Hoods - Chemicals should not be

stored on the floor or be so numerous as to clutter bench top work areas. Storing more than a few chemicals in a fume hood will compromise the effectiveness of the hood unless they are stored on a shelf a few inches above the work surface of the fume hood (so that air can enter the slot at the back of the work surface).

4) Storage Height – Do not store heavy containers on the floor or above waist level. Do not store corrosives above eye level. Do not store items closer than 18 inches from the ceiling if the area has fire sprinklers.

5) Hallway Storage – Do not store chemicals in hallways, corridors and exit ways.

6) Storage in or under Sinks – Chemicals (except cleaners) should not be stored under the sink, near the sink or in the sink, to minimize the chance of accidents and improper discharges to the sanitary sewer.

3. Chemical Storage Quantity Limits

a. Control Areas

Chemical quantities in most University buildings are limited by the Ohio Administrative Code 1301:7-7-59. A link to the code and table 5003.1.1(1) can be found here: https://codes.ohio.gov/assets/laws/administrative-code/rules/1301/7/1301$7-7-50_eff_1_5_19.pdf

b. Flammable Liquids in Basements

Flammable liquids are also limited in basement rooms to comply with the International Fire Code Chapter 59. The link can be found here: https://codes.iccsafe.org/content/IFC2015/chapter-59-flammable-solids#IFC2015_Pt05_Ch59_Sec5904

c. Additional Requirements

In a laboratory, a maximum of 20 gallons of flammable liquids, in approved containers, may be stored outside of a flammable liquid cabinet. See the following table, Table 2-2, Approved Flammable Liquid Storage Containers, for container types and limits (Reference: NFPA 30, Table 9.4.3). Flammable liquid containers larger than 5 gallons are not permitted in laboratories without specific approval.

Table 2-2 Approved Flammable Liquid Storage Containers

Container Type	Flammable Liquids			Combustible Liquids	
	Class I-A	Class I-B	Class I-C	Class II	Class III
	Flash Point < 73 °F Boiling Point < 100 °F (Ethyl ether)	Flash Point < 73 °F Boiling Point ≥ 100 °F (Hexane)	Flash Point ≥73 °F and < 100 °F (Diesel fuel)	Flash Point ≥ 100 °F and < 140 °F (Mineral spirits)	Flash Point ≥ 140 °F (Kerosene)
Glass	0.5 L (1.05 pt) *	1 L (1.05 qt) *	5 L (1.3 gal)	5 L (1.3 gal)	20 L (5.3 gal)
Metal	5 L (1.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)
Rigid Plastic IBCs (UN 31H or 31H2)	0	0	0	3000 L	3000 L

Composite IBCs w/flexible inner receptable (UN31HZ2)	0	0	0	0	0
Polyethylene UN 1H1	5 L (1.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	450 L	450 L
Safety Can	10 L (2.6 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)
* Containers may be up to 5 Liters for reagents of Analytical Purity Grade or High Grade.					

E. CHEMICAL LABELING

1. Original Container

The label on an original container must be legible and be written in English. It must include the chemical/product name as shown on the MSDS/SDS and the manufacturer's name and address. Do not accept materials if the label is illegible or missing required information.

Beginning on June 1, 2015, labels on chemicals/products shipped from the manufacturer must be consistent with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) There are six required elements after those dates:

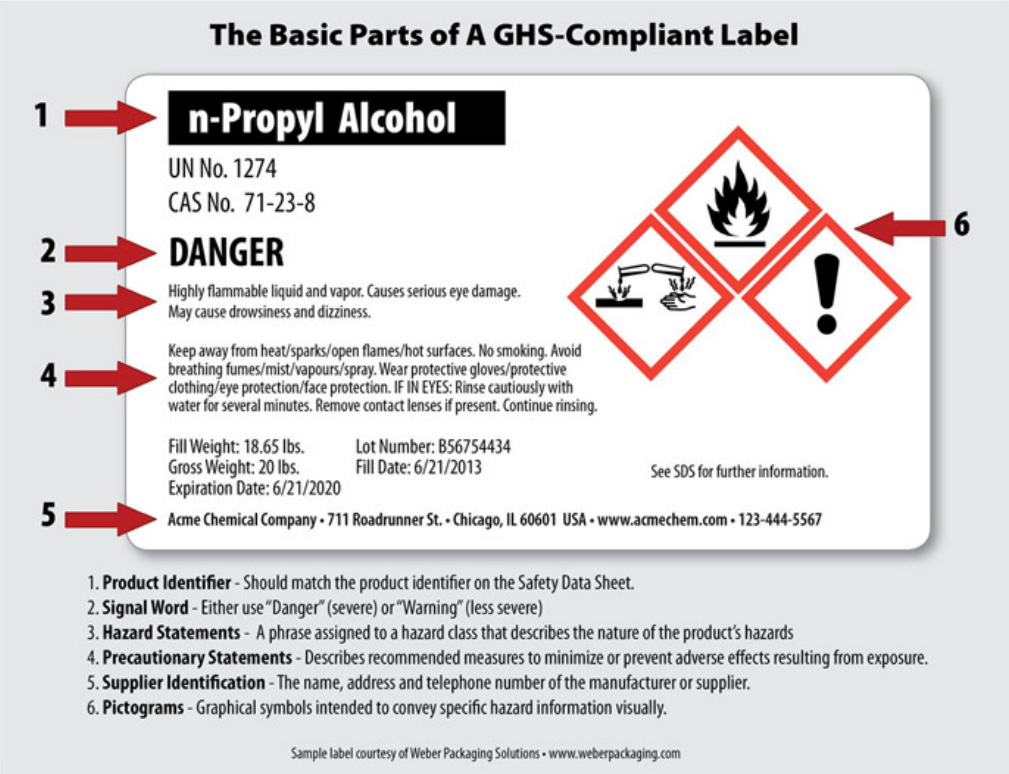
- Product name
- Manufacturer’s name and contact information
- Signal word (e.g., danger, warning or no signal word)
- Hazard statement(s) (e.g., toxic if inhaled, combustible liquid)
- Pictogram(s)
- Precautionary Statements (e.g., keep container tightly closed)

An example label is shown below in Figure 2-1, Example of Original Label.

Avoid damaging the original container’s label if possible. If a container label becomes illegible, replace the label. The replacement label must include the six required elements to comply with GHS rules.

Contact EHS at 216-687-2500 as needed for assistance in obtaining a replacement label.

Figure 2-1 Example of Original Label



2. Labeling Stock/Working Solutions

Containers of preparations, sample aliquots, and other working solutions are not required to be labeled if the container will be emptied before the end of the work shift and be used by only one person.

If a preparation or working solution will be kept for a longer period or be used by others, the container must be labeled with the following information:

- Identity of the contents. Spell out chemical names
- Signal word, if known or suspected (e.g., danger, warning)
- Hazards, if known or suspected (e.g., flammable, corrosive, irritant)

Information about the signal word and the hazards can be obtained from the MSDS/SDS, but dilutions and reactions may change the hazards and their severity. It is best practice to also label the preparation with the date of preparation and preparer's initials or name.

Your department may require a specific type of label. If so, describe in the laboratory-specific information section of your CHP. The method of affixing the label to the container (i.e., glue, tape or wire) is also at the discretion of the department/laboratory.

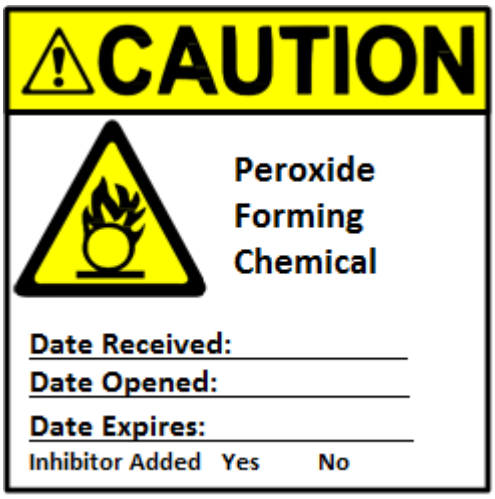
a. Labeling Specialized Containers

Containers that are too small for labels, installed into a process, or would become unusable for their intended purpose if labeled must still have their contents identified in some way. Use any labeling method that enables employees and visitors from other agencies such as the fire department to identify the chemicals and their hazards. Examples include a sign identifying the materials and their hazards, or color or numeric codes cross-referenced on a chart, or room diagrams identifying locations of the chemicals and hazards.

b. Additional Label Required for Peroxide-Forming Chemicals

Label chemicals that form peroxides with the date the container was first opened, using the label shown below.

Figure 2-2 Peroxide Label



General requirements for handling chemicals that form peroxides are described later in this section in paragraph G.2.b.

c. Labeling Waste Containers

Waste containers must be labeled following guidelines in this manual in Section 3 for hazardous chemical waste. If reusing a container to hold waste, the container must be compatible and appropriate for the waste. Completely deface all old labels on containers used for wastes.

F. TRANSPORTING CHEMICALS

Avoid transporting chemical containers which may have contamination on the outside (*i.e.*, avoid the need to wear gloves or other PPE while transporting chemicals). If gloves must be worn, either be escorted by another person to open and close doors and press elevator buttons or remove the glove from one hand and use it to open doors while holding the chemical in the other hand.

1. Transporting Between Floors and Buildings on Campus

a. Moving a Single Chemical

1) The person doing the moving must be trained in the hazards of the chemical and know what to do in the event of a spill of that chemical.

2) The exterior of the container should be clean enough that it could be handled without the need for protective gloves.

3) Chemical bottles must be labeled and should be securely capped and placed in a bottle carrier.

4) Chemical containers that are glass and do not have closing caps or handles

should be placed in bottle carriers or larger containers and surrounded by vermiculite or other absorbent material.

5) A lecture bottle should be moved in a manner that protects the valve. Larger gas cylinders must be moved using precautions listed in Section F.1.c below.

b. Moving Multiple Chemicals

1) The person doing the moving must be trained in the hazards of the chemicals and what to do in the event of a spill of those chemicals. The person must also have a spill kit that can handle the spill of those chemicals.

2) The exterior of the containers to be moved should be clean enough that they could be handled without the need for protective gloves.

3) Chemical containers must be labeled and securely closed. Lecture bottles should be packed in a manner that protects the valve.

4) Chemicals should be grouped by compatibility and by hazard class (e.g., flammable, toxic, etc.) and each group should be placed in larger containers or tubs while being transported.

5) Containers used to transport multiple chemicals should be lined with an absorbent material such as vermiculite to cushion the load and absorb and contain any spills. Multiple glass bottles in the same tub should be cushioned using the absorbent to prevent the bottles from rattling against each other.

6) Carts used to move chemicals should be stable under the load and have wheels large enough to negotiate uneven surfaces without tipping or stopping suddenly.

7) For laboratory moves across campus, EHS can arrange for a contractor to pack and move your chemicals for you, or you can pack and move them yourself using proper DOT packaging protocols. Refer to Section 10.B.2 of this manual for details.

c. Compressed Gas Cylinders

When moving compressed gas cylinders, they must:

1) Have the metal outlet cap/plug installed,

2) Have the valve cap installed if the cylinder has one, and

3) Be secured in a cart or container designed to prevent the cylinder from falling over while being moved.

(See subsection G.7 below for more information about compressed gases.)

2. Transporting Chemicals off Campus

a. Vehicle Use

Chemicals are not authorized to be transported off campus. Please contact EHS for a contractor to conduct this service for you. For more information, call 216-687-2500. If you are transporting chemicals for a move, please see F.2.d below.

b. Shipment by Others

If you ship hazardous materials by vehicle or air, you are required by law to be trained

and certified (see Section F.2.c, following). This includes situations when you use a commercial contractor (FedEx, United Parcel Service, Yellow Freight, *etc.*) to transport a hazardous material for you. You are responsible for complying with all applicable transportation regulations, which ensure the safety of your chemicals as well as those who transport them.

c. Training

Training is required for all people who classify, prepare, package, label, document, or offer a hazardous material for transport. Please contact EHS at 216-687-2500 to inquire about training.

d. Laboratory Moves

EHS will arrange to have a contractor package your chemicals and transport them to your new location if off-campus. There are some materials that they cannot transport (temperature restrictive materials, DEA regulated materials, and radioactive, infectious or explosive materials). See Section 10.B.2 for more details. For more information, call 216-687-2500

G. SPECIAL CHEMICAL HAZARDS

Personnel need to take special precautions with chemicals that are reactive, explosive, highly toxic, sensitizing or allergenic, synthesized chemicals, in compressed gas cylinders or at high pressure, present exceptional flammability hazard or have additional specific requirements due to federal regulations. If the degree of hazard is serious enough, the chemical is classified as a particularly hazardous substance. Criteria for particularly hazardous substances require expanded precautions for use including:

- Improving the security and integrity of the chemical storage,
- Reviewing proposed procedures by another PI,
- More intensive training on the chemical's hazards and the equipment to be used when handling the chemical,
- Requiring increased proficiency before any particular individual may perform any procedures,
- Requiring a second lab worker be in the lab in case of emergencies,
- Ensuring all safety measures are included in the SOPs, and,
- Checking that any additional measures for shipping such materials have been addressed.

1. Reactive Chemicals

A chemical is a reactive if it has the capability to undergo violent chemical change, such as explosions or production of toxic fumes, in certain situations. Purchase and use these chemicals in small quantities or find a suitable alternative. Take extreme care when handling and storing these compounds. Chemicals which have an NFPA rating of "3" or "4" for Reactivity are also considered to be particularly hazardous substances due to being highly dangerous, and the extra precautions taken as described in the opening paragraph of Section G above need to be documented in your SOPs.

a. Compounds That Generate Toxic Gases

Some compounds that contain sulfide or that have a cyanide (-CN) functional group can generate toxic gases in sufficient quantities to present a danger to human health when combined with other compounds, such as hydrochloric acid. Examples are shown in Table 2-3.

Table 2-3 Toxic Gas Generators examples

Copper (II) cyanide	Mercury (II) cyanide	Sodium cyanoborohydride
1,4-Dicyanobutane	Methyl sulfide	Sodium dicyanoaurate (I)
Diethyl cyanophosphonate	Octyl cyanide	Sodium sulfide
Fumaryl chloride	Potassium cyanide	Toluene diisocyanate
Heptyl cyanide	Sodium cyanide	

b. Oxidizers

Oxidizers are chemicals that initiate or promote combustion of other materials. Oxidizing agents include halogenated inorganics, nitrates, chromates, persulfates and peroxides. Examples of oxidizers are shown in Table 2-4.

Table 2-4 Examples of Oxidizers

Ammonium dichromate	Lithium perchlorate	Potassium chlorate
Ammonium nitrate	Nitric acid	Potassium permanganate
Chlorine (liquid or gas)	Nitric oxide	Sodium nitrate
Chromic acid	Oxygen (liquid or gas)	Strontium nitrate
Guanidine nitrate	Perchloric acid	Sulfuric acid

c. Chemicals That May Polymerize

Polymerization is a chemical reaction in which small molecules combine to form larger molecules. Polymerization can be hazardous when the reaction releases large amounts of energy or drastically increases the volume of the chemical. Examples are shown in Table 2-5.

Table 2-5 Chemicals that May Polymerize examples

Acrylic acid	Isopropenyl acetate	Vinyl bromide
Acrylonitrile	Styrene	2-Vinylpyridine
1,3-Butadiene		

d. Pyrophoric Chemicals

A chemical that will ignite spontaneously in air at or below 130 F is a pyrophoric. The oxidation of the compound by oxygen in the air proceeds so rapidly that ignition occurs spontaneously. Such chemicals would be considered “particularly hazardous substances” and the extra precautions taken as described in the opening paragraph of Section G above need to be documented in your SOPs. Examples are shown in Table 2-6.

Table 2-6 Pyrophoric Chemicals examples

Barium metal	Potassium metal	Sodium methylate
Lithium diisopropyl amide	Rubidium metal	Tert-butyllithium
Magnesium powder	Silane	Triethylphosphine
Methyl lithium	Sodium hydrosulfite	Tri-n-butylphosphine
Phosphorus sticks	Sodium methoxide	Trimethylaluminum

e. Water Reactive Chemicals

Water reactive chemicals react violently with water to release a gas that is either flammable or presents a health hazard. Alkali metals, many organometallic compounds, and some hydrides react with water to produce heat and flammable hydrogen gas. Some of these reactions proceed so violently that the chemicals are classified by NFPA as Reactive code 3 or 4 and the extra precautions taken as described in the opening paragraph of Section G above need to be documented in your SOPs. Examples of water reactive chemicals are shown in Table 2-7.

Table 2-7 Water Reactive Chemicals examples

Alpha-toluenesulfonyl fluoride	Oxalyl chloride	Sodium metal
Antimony trichloride	Phosphorus oxychloride	Tert-butyllithium
Calcium hydride	Phosphorus pentachloride	Titanium (IV) chloride
Hydrobromic acid	Phosphorus pentasulfide	Trimethylchlorosilane
Lithium aluminum hydride	Potassium metal	

2. Potentially Explosive Chemicals

An explosive chemical, when subjected to heat, impact, friction, electric, or chemical charges can produce a sudden, quick release of pressure, gas, and heat. When detonated in an uncontrolled or unexpected circumstance, explosives can result in serious bodily harm or extensive property damage. Shock sensitive explosives are known to detonate even when bumped or handled normally. Common potentially explosive chemicals at the CSU are:

a. Nitrated Compounds

Nitrated organics and inorganics constitute the largest class of compounds that are explosive when dehydrated.

Purchase nitrated compounds in small quantities. Do not break the seal on the cap until the chemical is needed.

When you purchase a nitrated compound, weigh the container and note the weight on the bottle. Prior to subsequent use, weigh the container again. If the container weighs less, add an appropriate solvent to replace the weight lost. After the reagent is opened and an aliquot is taken, again note the weight of the container. Visually inspect the container for problems prior to each use and wipe down the bottleneck, cap, and threads with a wet cloth before resealing.

Additional factors need to be addressed in your SOPs are described in the opening paragraph of Section G above. Examples of nitrated compounds are shown in Table 2-8.

Table 2-8 Nitrated Compounds examples

Diphenyl hydrazine	3-Nitrotoluene	Trinitrophenol (Picric acid)
Nitrocellulose	Trinitrobenzene	Trinitrotoluene

Picric acid is a nitrated compound usually purchased as a solid wet with 10% water. Extreme heat, blasting cap, or electric charge can detonate picric acid. It becomes highly unstable if allowed to dehydrate. When wet, picric acid is an orange color to yellow depending on concentration, compact crystalline solid with the consistency of lumpy sand. When dry, picric acid is a crystalline solid with visible air pockets below the surface.

Picric acid will readily form an explosive metal picrate. These metal picrates are extremely shock sensitive and will detonate with the slightest movement or vibration. Do not allow picric acid to contact metal that is readily oxidized or be stored in a container with a metal cap. Lead, iron, and copper metals are particularly dangerous due to metallic picrate formation.

b. Organic Peroxide-Forming Solvents

Organic peroxide-forming solvents become shock sensitive when allowed to oxidize and form appreciable quantities of explosive peroxides. Most of these solvents are also flammable. Most peroxide forming solvents are colorless, mobile liquids. Oxidation can occur when the solvent is exposed to atmospheric oxygen. This reaction is catalyzed by light as well as by temperature and pressure changes.

The additional precautions you take to control peroxide-forming hazards (described in the opening paragraph of Section G above and in this section) need to be documented in your SOPs. Below is a list of good laboratory practices. For more information, see the Peroxide Forming Chemicals Management and Assessment Guidelines

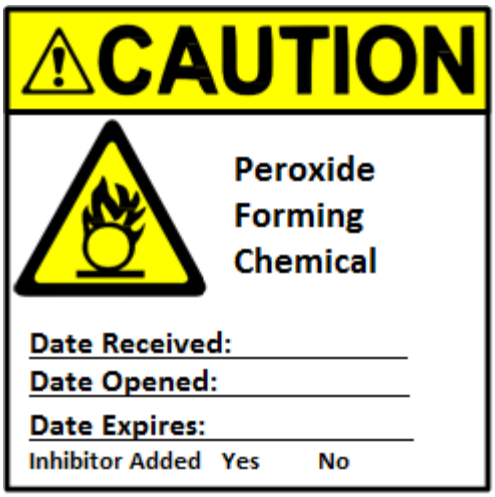
1) Highly Concentrated Peroxides - Over time, peroxide concentrations can increase to hazardous levels. Solvents with high concentrations of peroxides will appear viscous or contain needle-like crystals. If peroxides are visible, no further handling is recommended. Contact EHS at 216-687-2500 for assistance with professional testing and stabilization.

2) Explosive Capability - Peroxides formed in organic solvents have caused some laboratory accidents, including unexpected explosions during distillation and use.

   Such formulations are considered low powered explosives in that they will detonate in moderate concentrations by modest shock, friction, or when heated. The biggest dangers of organic peroxides in these solutions are opening the container and distilling. Do **NOT** open or move the container if you see crystals on or around the container cap. Call EHS for assistance if you are concerned about opening the container.

3) Required Procedures - Purchase peroxide forming solvents in small quantities that contain an inhibitor, such as butylated hydroxytoluene (BHT), which will delay the formation of peroxides until the inhibitor is used up. Label the container with the date received and opened. Label the container with the standard peroxide label (see Figure 2-4 below). Do not break the seal on the container until the solvent is needed. Once opened, store solvent in an airtight amber glass bottle or metal container, with an inert gas, such as nitrogen, in the headspace.

Figure 2-4 Peroxide Label



4) Testing Peroxides - It is a good laboratory practice to use test strips to test the solvent for peroxides prior to each use. After each use, wipe down the bottleneck, cap and threads with a cloth before resealing. Reduce formed peroxides and add an inhibitor as necessary to keep the concentration of peroxides below 10 ppm. Extreme caution should be exercised if concentrations of peroxides exceed 30 ppm.

5) Distillation and Evaporation Precautions - Always test for peroxides before distillation or evaporation because these procedures will increase the concentration of any peroxides present. Do not distill or evaporate solvents containing any amount of peroxides. Use a water bath over a hermetically sealed electrical mantle to safely heat the solvent. Use any distilled solvent immediately or add an inhibitor.

6) Use of Inhibitors - Inhibitors slow the formation of peroxides in the future. They do not reduce or remove peroxides. Organic peroxides should be reduced safely.

7) Monitoring Expiration Date - Use the solvent before the manufacturer's expiration date. Peroxide-forming solvents exceeding their expiration date cannot be discarded through EHS until the contents have been tested for peroxides. Examples of peroxide formers are shown in Table 2-9 below.

Table 2-9 Peroxide-Forming Chemicals examples

Severe Hazard	High Hazard	Moderate Hazard
3 months	**6 months**	**12 months**
Once exposed to oxygen, rapidly oxidizes forming explosive peroxides.	*Once exposed to oxygen, oxidizes at a moderate rate forming explosive peroxides.*	*Once exposed to oxygen, slowly oxidizes forming explosive peroxides.*

Diisopropyl ether	Acetaldehyde	Ethylene glycol ethers
Divinylacetylene	Cumene	Ethyl vinyl ketone
Potassium amide	Cyclohexene	Oleyl alcohol
Potassium metal	Cyclopentene	Tetrabutylammonium fluoride
Sodium amide	Diethyl ether	
Vinylidene dichloride (1,1-Dichloroethylene)	Di-n-propyl ether	
	p-Dioxane	
	Furan	
	Methyl isobutyl ketone	
	Tetrahydrofuran	
	Vinyl ethers	

c. Azides

Organic and inorganic azides, R-N_3, can explode when heated or exposed to ground glass joints. Some azides are shock sensitive. Metal azides are relatively insensitive to shock but may explode when heated. Sink disposal of azides can be extremely hazardous because they can form metal azides that are shock sensitive, like iron azide. Azides present a hazard around ground glass joints because they can be shock sensitive. Document additional precautions such as those described in the opening paragraph of Section G above in your SOPs.

d. Fulminates

Fulminates are compounds that contain a carbon-nitrogen-oxygen group. Metal fulminates such as mercury, silver, and gold are highly explosive. Explosions are typically initiated by heat. Silver fulminates can form in unopened Tollens' reagent. Document additional precautions such as those described in the opening paragraph of Section G above in your SOPs.

3. Highly Toxic Substances

a. Precautions for Use

In laboratories, "Particularly Hazardous Substances" includes those chemicals that are highly toxic. The procedures for using such chemicals require additional precautions, as described above in the opening paragraph in Section G. An important point to be aware of is that a highly toxic gas, like arsine, it is highly recommended not be used until proper engineering controls and fire department notification has been completed. Contact EHS at 216-687-2500 for assistance.

b. Categories of Highly Toxic Chemicals

Various regulatory agencies define highly toxic chemicals differently. CSU uses the same definition for "Highly Toxic" chemicals, that is used by the Occupational Safety and Health Administration.

The EPA and Ohio Environmental Protection Agency (OEPA) have other criteria for classifying a chemical as "extremely hazardous" or a "substance with high acute toxicity." These definitions affect their reporting requirements and waste accumulation and disposal requirements.

The Centers for Disease Control and Prevention recognizes "select agents and

toxins" which are listed at http://www.cdc.gov/od/sap/docs/salist.pdf. These materials are allowed in only specific spaces on campus and used by approved individuals. If you intend to use any of these select agents and toxins, pre-approval is required before obtaining them. Please contact EHS at 216-687-2500 to initiate the approval process.

4. Carcinogens and Reproductive Hazards

Additional care must be taken to minimize exposures to known and suspected carcinogens and reproductive hazard chemicals because inadequate information is available in many cases as to what level of exposure may impact the worker. Ways to minimize exposures include steps such as substituting chemicals if possible, using the smallest amounts necessary, and using a fume hood or other control system.

5. Sensitizing or Allergenic Chemicals

Potent chemicals which can cause sensitization or allergy may impact researchers by changing their style of life and in some cases forcing them to leave their areas of research. This hazard is not limited to "traditional" laboratory chemicals in that researchers handling animals can become allergic to animal dander and researchers in forest resources can develop allergies to molds, to give two examples. Additional examples are shown in Table 2-10.

Beryllium	Chromium	Isocyanates
1,2,4-Benzenetricarboxylic anhydride	Diazomethane	Latex
Bichromates	Formaldehyde	Nickel
1,2-Cyclohexanedicarboxylic anhydride	Gluteraldehyde	Phenols (certain types)

Once sensitized, a person may react to extremely low amounts of the chemical. Response may range from a contact dermatitis to anaphylactic shock.

Care must be taken to minimize exposures. Situations which may lead to a high, acute exposure, such as cleaning up a spill, should be carefully assessed to keep the exposure as low as reasonable. If a person is sensitized or allergic to a similar chemical, any control which will prevent exposure to the lab chemical should be implemented, whether improved ventilation, barriers, or improved procedures. If respirators are to be used, the person must comply with all steps in the CSU Respiratory Protection Program which can be found on the EHS website.

6. Synthesized Chemicals

Synthesized chemicals may present unexpected hazards. The first step should always be to perform a literature review concerning the expected hazards from the proposed procedures and the hazards from chemicals with similar structure, considering that these hazards are being assumed. Pay particular attention to hazards which may develop from reactions or during purification or subsequent activities. Generate minimal quantities until the basic hazards of the chemical can be determined.

a. Nanoparticles

The term "nanoparticle" is given to particles with at least one dimension less than 100 nanometers. They may be deliberately engineered or develop naturally. Such particles may be more reactive and toxic than bulk size chemicals. Take special care to prevent them from being released into the environment. If your laboratory

intends to create nanoparticles in such a manner that they may be aerosolized, measurements of the typical nanoparticle levels before the process begins may be taken and compared to subsequent levels.

b. Providing Synthesized Chemicals to Others

A laboratory synthesizing chemicals for use by others should consider themselves to be a separate entity from Cleveland State University. Staff synthesizing a hazardous chemical should provide those others with as much information about the safety precautions when using the chemical as possible.

7. Compressed gases and gas cylinders

Compressed gas and highly pressurized systems present the unusual hazards that the high pressure may result in a physical hazard from the hose, piping, or cylinder flying around if the gas were to escape through a leak, and that the large amounts of gas available may quickly injure personnel due to toxic or asphyxiation hazards from a gas release.

Prior to ordering these gases, contact EHS at 216-687-2500

a. Compressed Gas Shipments

Whenever possible, gas cylinders should be purchased through a local supplier that offers a cylinder return authorization program. Ordering information is provided on the CSU Magnus Mart web page with details given in section C.7 above.

Inspect the cylinder when it arrives to make sure it is the gas you ordered. Never accept a cylinder with damaged labels, dents, gouges, or burn/heat marks.

b. Safe Practices

The following safe practices should be followed when working with compressed gas cylinders:

1) All cylinders must be clearly labeled by the gas supplier or the user with the cylinder's contents, concentrations, hazard classifications, and safety precautions. Unlabeled cylinders must be disposed of as hazardous waste and users will be charged for an analysis of the contents before its disposal.

2) Secured Cylinders - Cylinders must be secured during storage, transport and use so that they cannot be knocked over. During use, an approved bracket anchored to a fixed structure must be used. It is recommended that the cylinder be secured by two straps or chains located at 1/3 and 2/3 of the cylinder height above the floor.

3) Valve Caps - Cylinder valve caps must be in place when the cylinder is being moved or is not in use for an extended period.

4) Moving - Cylinders should be moved with a cart or hand truck designed for strapping on cylinders. Avoid transporting compressed gas cylinders in passenger elevators, use a freight elevator if available.

5) Turning Off - Turn the gas supply off at the cylinder valve first, de-pressurize the system, and then turn off the regulator.

6) When Not Using - If the gas cylinder is not in use, separate oxidizing gases from flammable gases by 20 feet or a one-hour firewall.

7) Use, store, and transport cylinders in an upright position.

8) Highly toxic gases must be stored and used in an approved gas cabinet with fire suppression and release controls or in a certified Chemical Fume hood.

c. Returning or Disposing Cylinders

Whenever possible, gas cylinders should be returned to the supplier as described earlier in this section concerning procurement of gas cylinders (Section 2.C.7). Additional information about cylinder disposal is described in Section 3.P of this Laboratory Safety Manual. If returning full or partially full cylinders, shipping precautions must be followed.

d. Compressed Gas Piping and Tubing

1) Steel, copper or stainless steel must be used for all piping systems serving fixed system and apparatus that are permanently charged or charge while unattended. Qualified personnel must install piping.

2) Piping and tubing must be compatible with the gas.

3) Fuel gas Grade T flexible gas tubing with appropriate hose clamps must be used for all petroleum-based products. This tubing is available through Praxair or other industrial gas supplier.

4) Provide shut off valves, point of use valves, regulators, pressure relief valves, labeling appropriate for the application and in accordance with the International Fire Code and NFPA 45.

e. Regulators

1) Pressure regulators lower the gas pressure to a useable level. There are two kinds of pressure regulator designs: single and two-stage. They appear similar. Single stage regulators are used when precise control of delivery pressure is not required. Two-stage regulators give precise control.

2) Keep regulators clean. Regulators used for oxidant gasses should especially be free of surface oil and grease.

3) Do not use Teflon® tape, putty, or other such materials on the threads unless specifically required (or applied) by the manufacturer/vendor.

4) Always use the proper regulator for the gas in the cylinder. Plaques and decals on the regulator indicate which gas the regulator is designed for.

5) A volume restriction orifice installed downstream of the regulator is required for all toxic and highly toxic gases. Specify pressure and flow requirements when ordering compressed gas so that the vendor provides the proper restriction orifice.

8. Flammable and Combustible Liquids

Read the full SDS for more details before handling flammable and combustible liquids.

Know the flash points of the flammable or combustible materials that you are using. The flash point is defined as the lowest temperature at which a chemical can vaporize to form an ignitable mixture with air. Many of the common organic solvents and chemicals used in the laboratory have flash points well below room temperature. At or above the flash point temperature, there can be sufficient vapor to ignite if an ignition source is present. Flammable liquids are defined as those having a flash point less than 100 °F (37.8 °C). Combustible liquids have a flash point of 100 °F or higher but can still produce enough

vapor to burn if heated.

Highly flammable chemicals with an NFPA rating of 4 for “Flammability” are also considered particularly hazardous substances and need additional precautions as described in the opening paragraph of Section G above. Also, pre-plan for an emergency by adhering to the precautions in Section 9.A.2.c such as wearing lab coats which resist burning, preventing clutter, and providing clear access to eyewashes, emergency showers and evacuation routes.

The main objectives in working safely with flammable liquids are to avoid accumulation of vapors and to control sources of ignition.

a. Vapor Control

Use less hazardous chemicals if possible. Use the smallest amount of flammable liquid necessary for your procedure. Use closed systems whenever possible. If you must work with open systems, use a fume hood to prevent accumulation of flammable vapor. Close the fume hood sash when not performing your procedure but flammable chemicals are still present.

Each flammable liquid has two fairly definite limits defining the range of concentrations in mixtures with air that will propagate flames or explode. The limits are called the Lower Flammability Limit (LFL) and the Upper Flammability Limit (UFL). These limits are also sometimes referred to as the Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL). The range that a fire or explosion could occur becomes wider with increasing ambient temperature and in oxygen enriched atmospheres. The flash points and the ranges of LFL to UFL are shown for some typical laboratory chemicals in the following table (Table 2-11. Flash Points and Flammability Limits of Some Chemicals).

Table 2-11 Flash Points and Flammability Limits of Some Chemicals

Chemical	Flash Point °C / °F	Auto-Ignition Temperature °C / °F	Flammability Limits (% volume in air)	
			Lower (LFL)	Upper (UFL)
Acetone	-37.8 / -36	465 / 870	4	60
Benzene	-11.0 / 12	560 / 1040	1.3	7.1
Carbon disulfide	-30.0 / -22	80 / 176	1.3	50
Diethyl ether	-45.0 / -49	160 / 320	1.9	36
Ethanol	12.8 / 55	365 / 690	3.3	19
Methanol	11.1 / 52	385 / 725	6.7	36
Methyl ethyl ketone	-6.1 / 21	516 / 960	1.8	10
Pentane	-40.0 / -40	260 / 500	1.5	7.8
Toluene	4.4 / 40	480 / 896	1.2	7.1

If you are warming flammable liquids above the auto-ignition temperature, make sure there is no exposure to air or oxygen until the temperature drops below the auto-ignition temperature, such as those shown in the table above. Make sure the ovens are appropriately designed for flammable liquids (no internal ignition sources and/or vented mechanically).

If you need to heat flammable liquids, use devices that have good controls, such as steam baths, salt and sand baths, oil baths, heating mantles and hot air baths. Do not use open flames because along with being a potential ignition source, it is also harder to maintain exact control of the heat applied.

You should also minimize the total quantity of flammable materials in the lab and keep them stored in proper containers (plastic or metal containers or safety cans) as described in Section 2.D.3 above. Cap containers as soon as you have poured out the amount you will need.

To prevent the spill and release of vapors while transporting bottles, use bottle carriers. Dispose of unnecessary flammable chemicals to prevent inadvertent spills.

Be aware that the vapors of many flammable liquids are heavier than air and can travel considerable distances along a benchtop or the floor and can potentially be ignited by an ignition source located somewhere else in the lab or workspace. These vapors can be generated by a spill or during a simple transfer from one container to another.

b. Ignition Source Control

Control all ignition sources in areas where flammable liquids are used. Open flames and spark-producing equipment should not be used.

Use equipment with spark-free, intrinsically safe induction motors or air motors to avoid producing sparks. These motors must meet National Electric Safety Code explosion resistance specifications. Many stirrers, variacs, outlet strips, ovens, heat tape, hot plates, and heat guns do not conform to these code requirements.

Avoid using equipment with series-wound motors, since they are likely to produce sparks. Equipment On/Off switches can produce sparks when activated, especially if the equipment uses a lot of power. Place equipment switches as far as possible from any open systems using flammable liquids.

c. Grounding Concerns

Pouring flammable liquids can generate static electricity. The development of static electricity is related to the humidity levels in the area. Cold, dry atmospheres are more likely to facilitate static electricity. Bonding or using grounding straps for metallic or non-metallic containers can prevent static generation.

All metal and polyethylene containers larger than 5 (five) gallons (20 liters) must be grounded to avoid static charge when transferring flammable liquids to another container. Grounding can be direct, as a wire attached to both containers, and indirect, as through wires connected to a common ground system.

When grounding non-metallic containers, contact must be made directly to the liquid rather than to the container.

In the rare circumstance that static electricity cannot be avoided, and grounding is not possible, such as pouring small volumes of flammable liquids into a graduate cylinder or beaker, proceed slowly to give any static charge time to disperse. Or, conduct the procedure in an inert atmosphere.

9. Homeland Security Chemicals of Interest

Regulations at Title 6 Code of Federal Regulations Part 27 require all chemical facilities (including universities) comply with the Chemical Facility Anti-Terrorism Standards (CFATS). The rule requires that a chemical facility that either possesses or later comes into possession of listed chemicals in quantities that meet or exceed threshold quantities report them to the Department of Homeland Security (DHS). Under this regulation, a University building can be deemed a chemical facility and EHS is charged with reporting building exceedances to DHS. EHS relies on the accuracy of your chemical inventories to determine what is reportable. A list of chemicals of interest can be found here:

https://www.cisa.gov/sites/default/files/publications/appendix-a-to-part-27-508.pdf

DHS can require a facility to prepare a security vulnerability assessment and implement a site security plan. Failure to comply with these requirements can result in fines and/or imprisonment.

10. OSHA's list of Highly Hazardous Chemicals

If there is any chance that the quantities of hazardous chemicals handled at one time may exceed the threshold quantity limits of Highly Hazardous Chemicals, additional safety precautions must be taken. The basic regulation is viewable at and a table listing chemical limits in pounds that require implementation of this process is in Appendix A of that regulation:

https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.119AppA

Section 3 - Chemical Waste Management

Contents

Figures

A. HAZARDOUS CHEMICAL WASTE RESPONSIBILITIES

Hazardous chemical waste must be managed properly. The responsibilities of the laboratory worker and Office of Environmental Health & Safety (EHS) for hazardous waste are as follows:

1. Laboratory Workers

If laboratory workers generate chemical waste, they must be able to determine whether their chemical wastes are hazardous by using the guidelines in this chapter. For hazardous waste, they must identify the hazards of the waste and follow accumulation rules, which include labeling, storage, and handling requirements. They must know how to request collection of hazardous waste by EHS, and the rules for disposal of chemicals and contaminated items to trash and sanitary sewer. They must prevent the accumulation of "legacy chemicals" and "inherently waste-like chemicals" (defined in this section) by cleaning out their chemical inventory on a regular basis.

Training is required and is available through EHS in both classroom and online format.

2. CSU, EHS Service Programs

EHS collects hazardous waste and manages its proper disposal. EHS provides guidance and training for laboratory workers on proper hazardous waste management.

B. WHAT QUALIFIES AS HAZARDOUS WASTE?

A chemical or chemical mixture that exhibits any corrosive, ignitable, toxic, or reactive properties, may be chronically or acutely hazardous to human health, or may have a harmful effect on the environment. At CSU, some additional chemicals are managed as hazardous waste because they are carcinogenic.

In order to determine whether or not your chemical is hazardous, use your knowledge, the chemical's original label and/or the chemical's Safety Data Sheet (SDS) to determine if the waste is corrosive, flammable, toxic, reactive, "persistent in the environment" and/or mutagenic or carcinogenic, as defined in the below subsections.

1. Flammable/Ignitable

A waste chemical is flammable if it is one of the following:

- A liquid having a flash point less than 140 °F (*e.g.*, ethanol, xylene, diethyl ether). The flash point is defined as the lowest temperature at which a chemical can form an ignitable mixture with air (by evaporating above an open beaker, for example.) SDSs typically include information about flash points if the chemical has one. (Note: The hazardous waste designation of "Flammable" includes not only those classified as "Flammable" per NFPA as described in Section 2.D.3, but also those classified as "Class II Combustible.")
- A solid or gas capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and burns so vigorously and persistently that it creates a hazard.
- A solid, liquid, or gas that evolves oxygen at room temperature or under slight heating (*e.g.*, peroxides, chlorates, perchlorates, nitrates and permanganates.)

2. Corrosive

A waste chemical is corrosive if it has a pH of less than 2 or greater than 12.5

3. Reactive

Reactive wastes are unstable under "normal" conditions. They can cause explosions, toxic fumes, gases, or vapors when heated, compressed, or mixed with water.

4. Toxic

The EPA describes toxic waste as any chemical waste material that is harmful or fatal to living organisms when absorbed, ingested, inhaled, or injected. The waste can be poisonous, radioactive, carcinogenic, mutagenic, teratogenic, or bio accumulative.

5. Persistent

Persistent chemicals do not biodegrade quickly in the environment. The most well-known classes of persistent chemicals are: chlorofluorocarbons (CFC's), polychlorinated biphenyls (PCB's), per/polyfluoroalkyl substances (PFAS), perfluoroalkyl acids (PFAA's), and perfluorooctanoic acids (PFOA's).

6. Trash Rules

Non-hazardous solid chemicals can go in the trash. Known, probable or suspected carcinogens, irritants and sensitizers cannot go in the trash

Deface labels. Bag and label chemicals as "non-hazardous." Liquids and pressurized containers like non-empty aerosol cans can never go in the trash.

Uncontaminated or slightly contaminated items such as gloves, paper towels and empty containers can go in the trash. EHS recommends double-bagging and labeling these items as "non-hazardous" if there is evidence of contamination. Manage very contaminated items, such as spill cleanup materials, as hazardous waste. Also, empty containers for extremely toxic chemicals are hazardous waste unless you triple rinse them and dispose of the rinsate as hazardous waste.

7. Waste Evaluation Request

If you are unsure whether your waste is hazardous please contact EHS for an evaluation.

C. HAZARDOUS WASTE ACCUMULATION RULES

Follow the below rules for hazardous chemical waste accumulation.

1. Appropriate Containers

Accumulate waste in an appropriate container compatible with the waste. You may reuse containers, even containers that were used for other chemicals, if they have been rinsed and the original labels have been defaced (note that the rinsate may be hazardous waste according to the definitions in Section B, above.) Containers that were designed for solid chemicals should not be used for liquids. Use only containers that show no sign of damage or deterioration.

You must use containers with screw top closures. Waste containers must remain closed except when you are adding waste. Use spring loaded funnels for adding waste frequently to waste containers.

Finally, do not fill the containers completely. Each container must have at least a one inch of headspace above the waste when it is collected. Request collection of your waste ahead of time to avoid overfilling your containers.

2. Hazardous Waste Labels

Label the container using the Hazardous Waste Label, Figure 3-1, below.

Figure 3-1 Hazardous Waste Label

Fill out the label completely, including percentages of constituents, the hazards of the waste, and contact name. If you do not know the hazards of your chemical, use the SDS of the chemical to determine what they are. Do not date the container or label. Deface or remove any original labels remaining on the container to avoid confusion about the identity of the waste.

3. Location

Waste must be under the control of the individual(s) generating the waste. The waste should be in a physically safe area (*e.g.*, not on a windowsill.) Waste chemicals may be stored with unused chemicals if the containers are properly labeled, and your laboratory personnel know the storage location.

- Do not accumulate large amounts of waste in the fume hood.
- Use flammable liquid storage cabinets for flammable waste over ten gallons in volume
- Store the waste away from emergency equipment such as safety showers and emergency access panels.
- Do not block exits.
- Do not store the waste near or in sinks. If the waste is stored in an area that drains to a floor drain, the waste must be in secondary containment.

4. Segregation

Segregate regulated chemical waste by chemical compatibility. Refer to the segregation guidelines in Chapter 2 of this manual. Use secondary containment (tubs, basins, or buckets) for segregation of incompatible wastes accumulated in the same area.

5. Accumulation Volume Limits

Accumulate no more than 200 liters (55 gallons) of chemical waste per waste stream or one liter (one quart) of extremely hazardous waste per waste stream. Extremely hazardous waste is waste that is highly toxic, and the one-liter limit is designed to limit risk, especially in the event of a spill. See SDS to determine whether your waste is extremely hazardous waste.

Also, any one type of flammable chemical (including waste) cannot exceed the limits specified by the controlling fire department.

Leave some headspace (at least one inch) in each container to allow for pressure changes due to changes in temperature.

Chemical waste must not be accumulated (*i.e.* stored) for more than one year.

6. Large Containers (Drums)

If you are accumulating wastes in containers greater than five gallons in volume, make sure that drums used to accumulate regulated wastes are in good condition and are approved by Department of Transportation (DOT) for highway mode transportation. If the drums were shipped to you in the first place, they are very likely DOT-approved.

Drums containing liquids must have ten centimeters of air space between the liquid surface and the lid.

Collection must be requested before the drum is full, especially in the case of 55-gallon drums.

7. Inherently Waste-like Chemicals

"Inherently waste-like chemicals" include expired chemicals, chemicals in deteriorating containers and chemicals that appear to be or are unusable. State inspectors may issue fines or infractions for inherently waste-like chemicals in your laboratory. Do not keep chemicals past their expiration date, and conduct cleanouts when you do your annual chemical inventory update.

Please also see the section on "legacy chemicals" in Section G.3, below. Legacy chemicals are those that are left behind by laboratory staff when they leave the university or move laboratories. They become the responsibility of the new space occupants.

D. HAZARDOUS WASTE COLLECTION REQUESTS

1. Hazardous Waste Collection Overview

EHS collects hazardous chemical waste from all CSU owned and operated facilities. To arrange for a waste removal, contact EHS at 216-687-2500 and ensure the ***Hazardous Waste Inventory form*** is filled out and attached to the waste. A copy of the form can be found here: www.csuohio.edu/sites/default/files/hazardous_waste_inventory.pdf

2. Waste Cleanouts

If you are moving or cleaning out your workplace and will need EHS to collect a large volume of chemical waste, here are some guidelines.

If you think you have more than 100 containers of waste, call 216-687-2500 to arrange a cleanout appointment. Call at least a month before your deadline.

For fewer than 100 containers, fill out and send the copies of the hazardous waste

inventory sheet to EHS, making sure to put your name on each of the pages. Place completed CSU Hazardous Waste Labels on each waste container (not needed for containers with an original label and original contents).

Finally, remember to update your chemical inventory.

3. What Happens to Hazardous Waste?

EHS has a Waste Minimization Program that reuses, recycles and treats more than 50% of the total waste generated at Cleveland State University. Reuse, recycling, and treatment takes place both in laboratories and at the EHS hazardous waste facility. Some waste streams, like batteries, paint and oil, are sent offsite for recycling by contractors.

All hazardous waste at the Cleveland State University that is not reused, recycled or treated is sent to permitted hazardous waste recycling and disposal facilities. Flammable waste is used as an alternative fuel to incinerate hazardous waste. Most of the other waste streams are incinerated at high temperature. A few waste streams are placed in permitted hazardous waste landfills.

E. TRASH DISPOSAL

1. Trash Disposal of Chemicals

The following are **prohibited** in the trash because of their chemical or physical hazards:

- Hazardous chemical waste as defined earlier in this section
- Known, probable or suspected carcinogens, irritants and sensitizers (see a current SDS for the chemical to determine if the chemical is any of these)
- Free liquids of any type
- Pressurized vessels, including non-empty aerosol cans
- Laboratory glass and sharps
- Radioactive waste
- Batteries
- Mercury, including thermometers
- Biohazardous waste

To throw away chemicals that are not prohibited in the trash, deface any labels, securely double bag it and label it “non-hazardous” so that custodial staff know it is safe for them to handle the trash.

2. Trash Disposal of Empty Chemical Containers

"Empty" chemical containers may still contain enough chemicals in them to present a hazard to custodial staff. On the other hand, it can be difficult to completely empty a container.

The legal interpretation of the word "empty" acknowledges this difficulty. A container is legally empty when both of the following are true:

- Contents have been removed by "normal, no-nonsense means, such as inverting and draining, shaking, scraping, or scooping", and
- No more than 1% of the contents remain.

If the chemical is "extremely hazardous waste" or a pesticide marked with danger or

warning labels, then the container must be triple rinsed before it is legally empty. The rinsate from this process is also considered hazardous waste by law. Also, if your chemical is a known or suspected carcinogen, EHS strongly recommends that you have the container sent for disposal.

It is illegal to "dispose" of hazardous waste by leaving non-empty containers of chemicals in the fume hood or elsewhere to evaporate the chemical.

If you choose to dispose of the empty container, do the following:

- Dry the empty container, preferably in a fume hood. Ensure that there are no sources of heat or open flame in the fume hood when drying containers that contained flammable chemicals.
- With a pen or marker, cross out or black out the labels on the container.
- Leave the container uncapped. Throw the cap away separately.
- If the container fits in the trashcan, place it there. If it does not fit in the trashcan, place it next to the trash.
- Do not leave empty containers in public areas, such as hallways or loading docks, unless you have arranged with Custodial Services or EHS for pickup services.

Consider reusing the empty container for accumulation of waste for that same chemical or other compatible chemicals. If you do reuse a container, deface or remove the label on the container and then fill out and affix a hazardous waste label to the container. Defacing and labeling is required by law and helps others in your workplace know that the container contains hazardous waste, not the original chemical.

Do not recycle glass or plastic containers that contained chemicals. Recycled glass and plastic is used for beverage and food containers, so the recycling industry does not accept chemical containers.

3. Trash Disposal of Contaminated Items

Used gloves and other commonly used items (besides empty containers) can be placed in the trash if they are not “grossly contaminated” with hazardous chemicals. If you have an item that is “grossly contaminated”, dispose of it as hazardous chemical waste.

Examples of "grossly contaminated" items include used spill clean-up materials, items such as gloves and equipment contaminated from a spill and used equipment that contains hazardous chemical residue.

Finally, EHS encourages you to collect items that look like they might be contaminated by chemicals, such as weighing papers and gloves, in bags and then label the bags “non-hazardous waste” before you place them in the trash. Custodial staff members are sometimes understandably nervous when handling laboratory trash; a white residue or a few drops of water in the trash could be a dangerous chemical. Taking an extra step to bag these items can be a nice gesture.

F. SEWER DISPOSAL

All wastes discharged to the sanitary sewer system must be under the local Sewer Discharge Limits designed to protect surface waters and maintain the quality of biosolids from wastewater treatment plants.

1. Northeast Ohio Regional Sewer District Discharge Limits

If your waste qualifies as hazardous waste (according to the criteria in Section B above) then you may not sewer the waste.

The Cuyahoga County has published local discharge limits for commonly used chemicals. These limits are on the Northeast Ohio Regional Sewer District website here: www.neorsd.org/I_Library.php?SOURCE=library/2014%20Title%20II.pdf&a=download_file&LIBRARY_RECORD_ID=852

2. Soaps, Bleach, and Acetone

When you are washing glassware or equipment, you will likely use chemicals such as detergents and bleach. Standard household bleach and other cleansers may go down the drain.

Acetone may not go down the sink at any concentration. If you use acetone to rinse off items, you must collect any excess acetone in a securely capped, properly labeled waste container and dispose of it as hazardous waste. You may not store acetone squeeze bottles near the sink.

Do not use chromate-based cleansers. There are many less toxic and non-carcinogenic alternative cleansers that work just as well.

3. Scintillation Fluids

Do not sewer any Scintillation Fluid. Even though the manufacturer claims them to be Environmentally Friendly. Theses scintillation fluids may claim to be safer, but because they contain high concentrations of flammable surfactants, or have substances that damage aquatic life they are not approved for sewer disposal.

4. Dilution Prohibition

It is illegal to dilute your chemical waste solely to meet sewer discharge limits. However, you may sewer wastes such as equipment rinse water or any chemical treatment that you do as a normal part of cleaning up after an experiment, if it meets sewer disposal limits.

G. CHEMICAL WASTES OF CONCERN

1. Unknown Chemicals

Without an accurate chemical name and concentration range, unknown or unidentified chemicals cannot be safely handled or disposed of. The best way to prevent unknowns is to label all chemical containers and make sure that the labels stay in good condition over time.

If you have an unknown chemical, keep it where it is or store it temporarily in the fume hood, whichever you believe to be safer. Find out as much information as you can about the chemical by examining the container and interviewing anyone you think might know something about the chemical. If that fails, complete a Hazardous Waste Inventory Sheet, online here. Provide as much information about the waste as possible, such as the history, physical properties, and the results of any analysis performed on the unknown.

Identification analysis performed by an approved waste disposal contractor will be at the expense of the responsible department.

2. Potentially Explosive Wastes

Some common chemicals can become highly unstable explosives over time when stored improperly and cannot be collected as hazardous waste unless they have been deactivated and stabilized. The following segments highlight the most common of these troublesome chemicals.

a. Peroxide-Forming Chemicals

Peroxide-forming chemicals such as p-dioxane, diethyl ether, tetrahydrofuran and acetaldehyde that have exceeded the manufacturer's expiration date will not be collected for disposal until they have been tested for peroxides. These chemicals must be managed correctly. For more information, see Section 2.G.2.b earlier in this manual.

Chemicals containing more than 10 parts per million (ppm) peroxides must be deactivated before they will be collected by EHS.

b. Picric Acid and Other Polynitroaromatic Compounds

Polynitroaromatic compounds are commonly used in laboratories and are safe in the form in which they are sold. They are ordinarily sold with 3 to 10% water added to stabilize them. However, they will become explosive if allowed to dry out. Dry Polynitroaromatic compounds must be wet with 10% water before they can be collected by EHS.

c. Sodium Azide

Sodium azide, although not inherently unstable, can form highly explosive heavy metal azides if contaminated or used improperly. Do not pour sodium azide into the sanitary sewer. Disposal of sodium azide solutions to the sewer can cause the formation of lead or copper azides in plumbing. Routine sewer disposal of sodium azide has caused several serious explosions.

d. Nitrocellulose

Several nitrocellulose products, primarily paper and tubes, are used in some laboratories. Nitrocellulose burns vigorously in ambient conditions and may explode when heated under confinement. When completely dehydrated, it is considered a low-level explosive. As a result, these products should never be autoclaved for decontamination. Nitrocellulose products must be soaked in water before disposal through EHS.

3. Legacy Chemicals

Principal investigators are required to completely clean out laboratories before they leave, including all hazardous chemicals and waste (see Section 10, Moving In/Moving Out.) However, sometimes people leave without disposing of chemicals properly.

Legacy chemicals are unwanted chemicals that are sometimes left behind after a move. If you move into a laboratory that has legacy chemicals in it, you should tell your department administrator immediately. If your department cannot, for whatever reason, solve the problem, then these legacy chemicals are "yours" to manage. Unless you think that you will use them, arrange to request their collection as hazardous waste and follow all waste accumulation rules, including hazard identification, labeling and segregation.

H. HAZARDOUS WASTE MINIMIZATION

1. Chemical Procurement and Chemical Exchange

Purchase only what you'll use, especially if you're purchasing a hazardous chemical. One recent study suggested that up to 40% of the hazardous waste produced by laboratories are unused and expired chemicals. For more information, see the EHS chemical procurement program here:

www.csuohio.edu/sites/default/files/Chemical%20Procurement%20Program%202018%20bp.pdf

2. Treatment and Recycling in the Laboratory

You are encouraged to treat or recycle your own waste. EHS staff are available to help you get started. Please see https://www.csuohio.edu/sustainability/sustainability for more details.

I. SOLID WASTE AND RECYCLING

Below are guidelines for recycling several common non-chemical items in laboratories.

1. Paper and Cardboard

EHS encourages you to recycle boxes and packaging as soon as possible. Storing boxes in aisles or in front of emergency equipment, exits, or necessary fire panels is illegal and dangerous. Paper, cardboard, and other common recyclables are managed by CSU Movers. For more information, see CSU Recycling's procedures webpage at https://www.csuohio.edu/sustainability/waste-and-recycling

2. Plastic and Glass

Plastic and glass chemical containers are not recyclable. The glass and plastic recycling industry use recycled material to make food and beverage containers and bans chemical containers, even if rinsed clean, from their recycling streams.

3. Packaging Materials

CSU Movers also coordinates the recycling of wooden pallets, packaging "peanuts", plastic wrap and other packaging materials. Styrofoam packaging is handled on a case-by-case basis.

4. Printer Cartridges

Most types of printer cartridges and components can be recycled. Contact the FAST Coordination Center at 216-687-2500 to arrange for pickup.

5. Batteries

Battery collection is managed by EHS. Small amounts of batteries can in the battery collection bins located across campus. Large, heavy, and/or unusual research or clinical batteries can be collected by the CSU Movers. Contact the FAST Coordination Center at 216-687-2500 to arrange for a pickup.

J. "SHARPS" AND LAB GLASS

The following are guidelines for the disposal of "SHARPS" and "lab glass."

1. "SHARPS"

SHARPS are a regulated waste classification. The "sharps" definition specifically includes:

- All syringes
- All hypodermic needles
- IV tubing with attached needles
- Lancets
- Scalpel blades

"Sharps" also includes the following if contaminated with a biohazardous material (including recombinant or synthetic DNA/RNA):

- Broken glass
- Razor blades
- Pasteur pipettes
- Pipette tips
- Glass tubes
- Glass slides and cover slips
- Other, similar items

"SHARPS" must be disposed in a red plastic SHARPS container which is leak proof, rigid, and puncture resistant. It must be labeled with a biohazard symbol and be equipped with a tight- fitting lid for use during handling and transport. Various sizes of sharps containers are available from Biochemistry Stores and vendors.

Close and prepare for decontamination and disposal a SHARPS container when 2/3 full. If a sharps container is punctured or has needles sticking out of it, the entire container must be placed inside a larger SHARPS container prior to treatment and disposal. Do not attempt to empty a sharps container that has been punctured. Contact EHS to have your SHARPS waste remove by calling 216-687-2500 and requesting a pickup.

2. Biohazardous Glass Items

Any glassware that has been contaminated with biohazardous or Other Potentially Infectious Materials (OPIM) shall be disposed of in a SHARPS container. If the glass is not contaminated, it can be placed in a normal glass disposal box. No breakable glass shall be placed in the red bio-waste bins.

3. "Lab Glass"

"Lab glass" waste (including plastic items) is defined as items that could puncture regular waste bags and endanger waste handlers and is not contaminated with a biohazardous material. This category **never** includes syringes, lancets, scalpel blades, or hypodermic needles.

Examples of "lab glass" include:

- Broken glassware
- Empty chemical containers such as test tubes, pipettes and pipette tips, and centrifuge tubes
- Pointed swabs and sticks
- Razor blades
- Fragile glass items such as glass Pasteur pipettes, glass slides and cover slips.

Package such “lab glass” waste in a sturdy cardboard box lined with plastic. The box should never weigh more than 25 pounds and clearly identify the PI name and room number. Seal the box with pre-printed “lab glass tape” or create your own tape using clear packaging tape over writing indicating “lab glass.”

“Lab glass” boxes and tape can be purchased from the Chemistry stockroom or from vendors. Tape can also be purchased from Biochemistry stores.

The sealed box is placed alongside the regular waste container for collection by Custodial Services.

Never use a “lab glass” box for the disposal of chemicals, “SHARPS,” biohazardous materials, or liquid waste.

K. INFECTIOUS OR BIOLOGICAL WASTE

For infectious waste disposal requirements, refer to the CSU Infectious Waste Contingency Plan which can be found here:
www.csuohio.edu/sites/default/files/Infectious%20Waste%20Contingency%20Plan%202020.pdf

L. RADIOACTIVE WASTE

For radioactive waste disposal requirements, refer to the CSU Radiation Safety Manual which can be found here:
www.csuohio.edu/sites/default/files/Radsafety%20Program%20%202018_0.pdf

M. MIXED WASTE

Most mixed wastes consist of low-level radioactive wastes combined with hazardous materials.

Cleveland State University policy as well as state and federal law prohibit the disposal of mixed waste. There are no means for disposing of mixed material. If a lab attempts to dispose of mixed waste as either radioactive waste or chemical waste the fines and penalties to CSU will be severe and could result in a Cease and Desist Order. Fines and fees of up to $250,000 per year may be assessed against the University by federal and state agencies if mixed wastes were generated and/or stored on campus.

Exceptions to the production of mixed waste includes liquid scintillation cocktails which can be legally shipped to a contract waste disposal vendor to be burned, and radioactive materials mixed with a hazardous component that can be neutralized or deactivated in the laboratory.

For further information or questions, please inform the Radiation Safety Committee or the Radiation Safety Officer here: https://www.csuohio.edu/ehs/radiation-safety

N. LIQUID SCINTILLATION COCKTAILS

Several Liquid Scintillation Cocktail (LSC) manufacturers now produce non-hazardous fluids, some marketed as being sanitary sewer disposable. EHS still prohibits putting and scintillation fluids down the drain. Please contact EHS to arrange for a pickup.

O. ANIMALS AND ANIMAL BY-PRODUCTS

Special consideration is needed when disposing of dead animals, animal body parts/tissues, animal bedding, or animal waste.

1. Contaminated Animals and Animal By-Products

Animals and animal by-products contaminated by infectious agents, radioactive materials, highly toxic chemicals, or stored in fixatives require special disposal

procedures. Contact EHS at 216-687-2500 for disposal guidance

P. GAS CYLINDERS

Gas cylinder users should contact the vendor they purchased/rented the cylinder from for removal.

Any non-returnable cylinder must be disposed of through EHS. The cost of disposal will be charged to the purchaser. Any abandoned cylinders will be recharged to the associated department. Cylinders or lecture bottles containing an unknown substance must be analyzed prior to disposal. Currently, the cost of analysis on an unknown cylinder is approximately $1,600 per cylinder, paid by the laboratory.

Empty lecture bottles may be discarded as scrap metal after the main valve is unscrewed and detached and the bottle has been flushed with an inert gas or rinsed with an appropriate solvent.

Cylinders containing constituents which are normally part of air should be vented to the atmosphere until they are empty. Empty cylinders may be discarded as scrap metal after the main valve is unscrewed and detached and the cylinder has been flushed with an inert gas of rinsed with an appropriate solvent. Calibration gas cylinders containing hazardous constituents in the 1 to 100 ppm range may be eligible for venting.

Section 4 – Laboratory Equipment and Facilities

Contents

Tables

Figures

A. EMERGENCY EYEWASHES AND SHOWERS

Emergency washing equipment is required when using corrosives (acids and caustics), strong irritants (which cause inflammatory effects upon contact), and toxic materials that can be absorbed through the skin. Emergency washing facilities must be accessible (unobstructed) and personnel should be able to reach the equipment within 10 seconds (not more than 50 feet and perhaps closer if access is through a normally closed door). Equipment must always be accessible without requiring a key or overcoming other security safeguards.

Each emergency eyewash must be activated on a periodic basis in accordance with Ohio Administrative Code (OAC) 4101:3-4-01 to check that it works and provides a strong enough stream of water to reach the eyes of someone bending over it, and to help keep the water clean. During the monthly check, the eyewash should be operated long enough, approximately 30 seconds, so that there is no visible rust or contaminant in the water

Emergency showers are tested monthly by Facilities Operations to ensure they continue to meet ANSI standard water flow requirements. A tag indicating the most recent test date should be found on the equipment. Contact the FAST Coordination Center at 216-523-2500 if a test or maintenance is needed.

B. FIRE SAFETY EQUIPMENT

1. Flammable Liquid Storage Cabinets

Flammable liquid storage cabinets are required if you are storing over ten gallons of flammable liquids. Flammable liquid storage cabinets are **not** fireproof they are fire resistant. Cabinets are designed to protect the contents from extreme temperatures for a limited time only. Contact Access Control & Security Systems at 216-687-2500 for further information on flammable liquid storage cabinets.

a. UL or FM Approval

Flammable liquids should be stored in an Underwriter's Laboratory (UL) listed or Factory Mutual (FM) approved flammable liquid storage cabinet outfitted with approved automatic or self-closing doors. All new cabinets must have UL or FM approval.

b. Label

Cabinets must be labeled "Flammable - Keep Fire Away"

c. Capacity

Do not over fill cabinets. Check manufacturer's recommendations for storage limits.

d. Bottles

All bottles should be placed on the shelves, never stacked. Keep all containers tightly closed.

e. Incompatible Chemicals

Do not store incompatible chemicals in these cabinets.

f. Cabinet Doors

Cabinet doors should never be propped open unless the mechanism is a designed part of an approved cabinet.

g. Secondary Containment

There should be a secondary containment on each shelf and at the bottom of the unit. These plastic or rubber trays retain spills.

h. Unapproved Storage

Tops of cabinets are not storage shelves. Do not store combustible materials on or beside these cabinets.

2. Flammable Storage Refrigerators

Flammable chemicals or chemical mixtures that need to be stored below room temperature must be stored in U.L. listed flammable material storage refrigerators or freezers. These refrigerators and freezers are specifically designed by the manufacturer to have non-sparking interiors. All laboratory refrigerators and freezers must be prominently labeled with a warning sign indicating whether it can be used for flammable or non-flammable storage. For information regarding a flammable storage refrigerator purchase, contact EHS at 216-687-2500.

C. LABORATORY SIGNS

A list of required signs is provided in the following table and explanatory material is described in the following paragraphs.

Table 4-1 Safety-Related Signs

Description of Required Sign
Lab Caution Sign
NFPA 704 Hazardous Materials
Biohazard
Radioactive Materials
Entry requirements
Food and drink prohibitions
Lab contacts/phone numbers
Emergency Procedures for Laboratories (Phone tree sticker)
Laboratory floor plan
Emergency/safety equipment location signs
Area and equipment warnings
“Natural gas emergency shut off valve” (Must be posted if valve is present.)
“Laboratory water – do not drink” (Must be posted on non-potable water outlets.)

1. Lab Caution Sign

A standard CSU Lab Caution sign is required to be posted at each lab entrance in a plexiglass/plastic holder above or near the room number placard. The purpose of the sign is to warn emergency responders and visitors of potential hazards in the lab and to meet multiple regulatory requirements.

Lab caution signs are installed by EHS and updated by lab personnel. Once the signs are posted by EHS it is the responsibility of the lab personal (PI, Lab Manager, etc.) to update the signs if significant changes occur in chemical inventories, entry requirements, hazardous materials authorizations or lab contacts.

The lab caution sign consolidates signage requirements for National Fire Protection Association (NFPA) 704 Hazardous Materials, biohazardous and radioactive materials authorization, entry requirements, food and drink prohibitions and lab contact information.

More information on the contents of the signs is detailed below.

a. NFPA 704 Hazardous Materials Sign

The lab caution sign meets fire code requirements that visible hazard identification signs as specified in the NFPA 704 standard be placed at entrances to locations where hazardous materials are stored, dispensed, used or handled in quantities requiring a permit

Below the NFPA diamond on the lab caution sign will be a list of chemical hazard classifications (as defined by the NFPA 704 standard) that are found in the lab inventory in amounts that meet or exceed the fire permit threshold.

b. Biohazard Signs

The Lab Caution Sign will display a biohazard symbol if the lab is approved for biohazard use at Biosafety Level 1 (BSL-1). Additional signs are required for BSL-2 labs. The lab caution sign does not replace the biohazard sign required to be posted on the lab door when Select Agents are in use.

Biohazard areas are indicated by the symbol in Figure 4-1. All workers in the laboratory must be familiar with this symbol and aware of the presence of the hazard.

Figure 4-1 Biohazard Warning Symbol

c. Radioactive Materials Sign

The Lab Caution Sign will display a radiation propeller if the lab is approved for the use of radioactive materials. Separate signs are required for posting “radiation areas” and for X- ray radiation warnings.

Areas where radioactive materials are used or stored are indicated by the symbol in Figure 4-2. All workers in the laboratory must be familiar with this symbol and aware of the presence of the hazard.

For more information, refer to Section 10 of the CSU Radiation Safety Program available at the link below:
https://www.csuohio.edu/ehs/radiation-safety

Figure 4-2 Radiation Warning Symbol

d. Compressed Gas Symbol

Fire codes require that rooms or cabinets containing compressed gases shall be conspicuously labeled. The lab caution sign will display the following symbol when compressed gases are in the lab.

Figure 4-3 Compressed Gas Symbol

e. Entry Requirements

This area of the lab caution sign allows labs to indicate if there are personal protective clothing or eye protection requirements for entry into the lab. Occupational health requirements such as medical screening or immunizations can also be indicated here.

Figure 4-4 Entry Requirements

f. No Food or Drink in Laboratories

Since numerous regulations prohibit food or drink consumption or storage in laboratories, the lab caution sign will always display a “No Food or Drink” image. In addition, lab personnel must label refrigerators, freezers, microwave ovens and other locations where food and beverages are not to be consumed or stored.

Figure 4-5 No Food or Drink in Laboratories

g. Lab Contact Information

There is space to enter up to four lab contacts on the lab caution sign with two phone numbers for each. One name with a work phone number is required. After-hours phone numbers are strongly recommended. If after hours home or cell phone numbers are not included on the lab caution sign for privacy/security reasons, these numbers should be posted in the Chemical Hygiene Plan.

2. Emergency Procedures for Laboratories (Chemical Hygiene Plan)

Post the Chemical Hygiene Plan inside your lab in a prominent location. Provide numbers for lab personnel to be called in case of fire, accident, hazardous chemical spill or other type of emergency. This can also be stored in electronic format if all lab personnel have access and know where to locate it.

3. Laboratory Floor Plan

A plan showing evacuation route(s), as well as emergency and safety equipment locations should be posted prominently in each laboratory. See Appendix C for an example of a laboratory floor plan. If particularly hazardous substances are used in a designated area, the floor plan is mandatory.

4. Emergency/Safety Equipment Location Signs

Signs must be posted identifying the location of exits, safety showers, eyewash stations, fire extinguishers, first aid equipment, flammable storage cabinets, and other safety equipment. Contact Facilities Services to post these signs.

The Lab Caution Sign at the entrance to all laboratories shall display a "No Food or Drink in Laboratories" image.

5. Area and Equipment Warnings

Operation and warning signs and labels must be posted on such items as alarm systems, biosafety cabinets, and fume hoods (sash opening height). Warnings may also need to be posted in areas or on equipment where special or unusual hazards exist, such as biohazards, lasers, magnetic fields, radioactive materials, high voltage, restricted access, or particularly hazardous substance control areas. These signs may be mandatory depending on the degree of hazard and possibly on local codes. Contact EHS for information on specific requirements.

D. Laboratory Ventilation

The Occupational Safety and Health Administration (OSHA) has set full shift (eight hour) Permissible Exposure Limits (PEL's) and short term (15 minutes) exposure limits (STEL's) for many chemicals to prevent adverse health effects in workers (See Section 5.A.1). Local exhaust ventilation systems (such as fume hoods) may be needed in order to control airborne contaminants and reduce exposure levels to acceptable limits. For assistance in measuring chemical exposures, contact EHS at 216-687-2500.

1. Laboratory Design

a. Room Air Pressure

Room air pressure should be negative to the hallway so that accidental releases are kept in the lab and not released into the hallway and the building.

b. Vents

Do not block or cover supply and exhaust vents. Occupant changes to lab ventilation may compromise the safety features of the laboratory and local exhaust systems such as fume hoods, biosafety cabinets, etc.

2. Fume Hoods

A fume hood is ventilation equipment that vents separately from the building's heating, ventilation, and air conditioning (HVAC) system. The primary means of controlling airborne chemical exposure is a fume hood. Fume hoods should be used when working with toxic compounds or compounds with a boiling point below 120°C. (However, some aqueous solutions may be an exception to this rule.) It may be necessary to use a closed system such as a glove box or bag for highly hazardous chemical materials.

a. Fume Hood Use

1) Training – Personnel using fume hoods should take Lab Safety Training class presented by EHS. Please arrange with your college to schedule your class.

2) Verify Operation – Make sure the fume hood is operating before starting work. Some new fume hoods have monitoring devices that indicate acceptable working conditions. Otherwise, a strip of Kimwipe taped to the underside of the sash can be used as an indicator of air flow.

3) Exhaust Fan Speed – Some older buildings have fume hoods equipped with two speed exhaust fans with local control at the hood. The low exhaust setting is only appropriate for storage. The high setting provides protection for working with chemicals.

4) Minimize Cross Drafts and Eddy Currents – Air flow into the fume hood is adversely affected by cross drafts and eddy currents. Cross drafts occur when people walk in front of a fume hood or when nearby windows or doors are open. Eddy currents occur around the person using the fume hood and around objects inside it. To limit these effects, fume hoods should not contain unnecessary objects and the slots within the fume hood which direct air flow must not be blocked. The slot at the rear of the work surface is essential for proper air movement. If large pieces of equipment or large numbers of bottles are placed in front of the slot, they should be raised up on blocks or placed on a shelf to allow air to flow into the slot. Equipment should be placed as far to the back of the fume hood as practical. Work should be performed at least six inches inside the fume hood opening to prevent cross drafts and eddy currents from pulling contaminated air out of the fume hood and into the room.

5) Sliding Sashes – The sash should be kept as low as possible to improve overall performance of the hood. The more closed the sash is, the better protection from an unexpected chemical reaction. Procedures should be done with the sash at the level of the maximum approved sash height marking or lower. Use a separate safety shield, such as a face shield, when working with an open sash.

6) Chemical Evaporation – It is illegal to evaporate chemicals in the hood to "dispose" of them. Any open apparatus used in hoods which emit large volumes of volatile chemicals should be fitted with condensers, traps, or scrubbers to contain and collect hazardous vapors or dusts.

7) Storage – Do not store chemicals or supplies in the fume hood. Chemicals and supplies should be stored in approved cabinets.

8) Flammable Liquid Vapor – Laboratory fume hoods are designed to reduce flammable vapors below lower explosive limits when properly operated and maintained. As an added precaution, use only non-sparking and explosion proof electrical equipment (hot plates, stirring plates, and centrifuges) in fume hoods where a large volume of flammable liquid vapor may be generated. Take care with

flammable liquids and heat sources.

9) Containers – All containers of chemicals must be securely capped when not in use. A rule of thumb is that containers should be open for minutes at the most – which is the maximum time it normally takes to pour a small amount of chemical into another container and cap them. All containers must be labeled with the chemical identity and appropriate hazard warnings (or the material must be used up during the work period and the material must be under continuous control of the researcher using it.)

b. Fume Hood Prep for Maintenance

1) Prior to any maintenance of fume hoods the entire interior surfaces must be decontaminated and/or cleaned by the researchers using the hood as described below in Section G.2 Decontamination of Equipment for Service.

2) Maintenance may require access to the storage cabinets below the hood or to the sides of the hood. If this access is required, the entire cabinet and adjacent area also needs to be emptied, decontaminated, cleaned, and rinsed. Lab staff need to identify a contact for coordinating with Facilities Services regarding the work to be done.

c. Fume Hood Performance Testing

EHS performs a functional performance test as part of its laboratory survey program. This test is to be performed at least every two years but is typically done closer to an annual frequency to assure hoods are performing as designed. If a hood fails, it may need to be taken out of service until repaired. EHS will notify the researchers and post a “do not use” sign if repair is required.

Fume hoods can be tested using different functional performance criteria, depending upon the fume hood design. Some examples are face velocity, variable air volume (VAV) tracking, containment, and monitor functionality. Specific performance measures for each test are outlined below. For more information, contact EHS at 216-687-2500.

1) Face Velocity:
   - Standard Flow Hoods: 80 – 120 Feet Per Minute (FPM). Sash height should not be less than 18 inches.
   - High Performance Hoods: 60 – 84 FPM.

2) VAV Tracking - The sash is lowered about 50% from the target sash height to assure the HVAC system responds appropriately to maintain optimal capture velocity.

3) Containment Test – Using visual powder, dry ice, or smoke tube to check for effective containment.

4) Monitor Alarm Properly Functioning:
   - Confirm that the monitor has power and that it is properly calibrated. Raise the sash to reduce the face velocity below 80 LFM (60 LFM for low flow hoods) and to confirm that both the visible and audible alarm signals function.

- Test the monitor's mute function by pressing the mute button. Test the reset button.
- This test fails if the monitor fails to alarm, is more than 10 FPM out of calibration, or if it fails any functional test or is damaged.

d. Fume Hood Problems

If you are having problems with your fume hood, contact EHS at 216-687-2500. EHS will troubleshoot the problem and may refer it to Facilities Services for repair.

3. Perchloric Fume Hoods

Procedures using concentrated perchloric acid (>70%) or which heat any amount or concentration of perchloric acid must be performed in a closed system or within a specially designed perchloric acid fume hood with wash down systems to prevent the accumulation of explosive perchlorates in the hood and ducting. For assistance in locating a perchloric acid fume hood, call EHS at 216-687-2500.

4. Glove Boxes

Glove boxes generally operate under either positive or negative pressure to the lab, depending on the process or material used. Positive pressure glove boxes are used when you are trying to protect your material from contamination. Negative pressure glove boxes are used to provide increased operator protection. Glove boxes should be thoroughly tested before each use and there should be a method of monitoring the integrity of the system (such as a pressure gauge).

5. Biological Safety Cabinets

Biological safety cabinets (BSCs) are laboratory hoods designed to protect the worker and laboratory from the biohazards (infectious agents) of the experiment by drawing air across the samples and away from the worker and into a HEPA filter.

There are two types of BSCs. The Class II type A and Class II type B1 units recirculate filtered air into the laboratory and are not designed for chemical use for this reason. The Class II type B2 unit is designed for use of some chemicals but is not a substitute for a fume hood. The use of chemicals in this type of hood needs to be evaluated carefully so that the protective barrier (HEPA filters) is not destroyed by the chemicals.

BSCs are certified annually by EHS. If a BSC fails the certification, it may not be used until repaired, unless specifically authorized by the Institutional Biosafety Officer.

BSCs may not be repaired or moved until decontaminated.

For additional information on the proper use of BSCs, Class II type B2 design, cabinet certification, troubleshooting problems, or decontamination, contact EHS at 216-687-2500

6. Laminar Flow Hoods (Clean Air Bench)

Laminar flow hoods are designed to protect the work surface from contaminants and blow out into the face of the person using the hood. Therefore, any chemical use will cause the person to be exposed to the chemical. Toxic or volatile chemicals may not be used in a laminar flow hood.

7. Ductless Laboratory Hoods

In some cases, installation of a ducted fume hood may be impossible and use of a "ductless hood" is requested for approval by EHS. This type device uses special filters or

absorbents to clean the contaminated air in the hood prior to recirculating the air back into the room. Recirculation of potentially contaminated air into the room presents special dangers and special requirements must be met. The requesting department must demonstrate that the following concerns are addressed if the hood is in use:

a. Chemical Characterization

Each of the chemicals to be used in the ductless hood must be completely characterized as to the quantity which may be released within the hood at one time and the frequency of use. The hood manufacturer will need this information for the design of the hood. Once designed, use of other chemicals in the hood must be forbidden unless the hood manufacturer approves the alternate chemical. Records as to the design of the hood and the designated chemical usage must be maintained in the laboratory.

b. Ductless Hood Approval

The Principal Investigator (PI) must verify that the size, shape, and layout of the proposed hood as offered by the hood manufacturer is appropriate for the intended use. The PI must also develop a management plan for the hood which addresses staff training, procedures for using the hood including emergency procedures, ongoing maintenance and certifications for the hood, and recordkeeping. This plan needs to assure continuity if management of the hood is taken over by another individual. Hood approval by EHS is contingent on submittal of the hood design information from the proposed manufacturer and submittal of the management plan.

c. Laboratory Staff Information and Training

All personnel in the laboratory must be trained as to the fact that the ductless hood recirculates air back into the room, that only certain designated chemicals may be used within the hood, and that failure to operate properly and maintain the hood may result in personnel exposures.

Also, a sign must be placed on the hood identifying which chemicals may be used and warning that the air is recirculated back into the room from the hood.

8. Cold Rooms, Warm Rooms and Environmental Chambers

a. Room Design

Controlled environmental rooms generally are completely enclosed with no fresh air and with heating/cooling and other environmental systems independent of the building. Rooms large enough to enter should be designed or retrofitted with doors that allow anyone trapped inside to get out easily. The electrical system within environmental rooms should be independent of the main power supply so that people are never left in these areas without light.

b. Chemical Use

Controlled environment rooms usually recirculate the air using a closed air-circulation system. Hazardous chemicals must not be stored in these rooms because ambient concentrations of volatile chemicals can accumulate to dangerous levels.

Flammable solvents should not be used in controlled environment rooms. Ignition sources in these rooms could ignite vapors.

Avoid using volatile acids in cold rooms because vapors can corrode the cooling coils, leading to possible refrigerant leaks.

If solid carbon dioxide (dry ice) is placed into a cold room, its sublimation will raise the carbon dioxide levels within the room, possibly to dangerous levels. Use extra precautions if you must use or store dry ice in these spaces.

9. Other Ventilation Systems

A ventilation engineer must design all other local exhaust systems used in the laboratory. Do not attach canopy hoods or snorkel systems to existing fume hood exhaust ducts without consulting a ventilation engineer at Facilities Services, 216-687-2500. All local exhaust systems should have a visual indicator that the system is always functioning properly.

a. Discharge of Hazardous Vapors

Laboratory apparatus that may discharge hazardous vapors (vacuum pumps, gas chromatographs, liquid chromatographs, and distillation columns) must be vented to an auxiliary local exhaust system such as a canopy or a snorkel, if not already vented to a fume hood.

b. Hazardous Chemicals

Hazardous chemicals should be stored in approved cabinets.

10. Maintenance of Ventilation Systems

All ventilation systems need routine maintenance for blocked or plugged air intakes and exhausts, loose belts, bearings in need of lubrication, motors in need of attention, corroded duct work, and minor component failure. Contact Facilities Services if a ventilation system has a problem. When maintenance is scheduled for fume hood exhaust systems, warning signs will be posted on the affected fume hoods and researchers must cease fume hood use during the maintenance procedures in accordance with the requirements listed on the sign.

a. Filters

Filters should be replaced periodically in certain types of ventilation systems such as electrostatic precipitators, cyclones for dust collection, and BSCs. For laboratory-maintained equipment, keep a record of these filter changes in a notebook or file that can be easily located in case a regulatory agency requests a copy of this documentation.

b. Monitoring Devices

Monitoring devices should be included in new ventilation systems to make the user aware of malfunctions. All personnel within the laboratory need to understand the meaning of associated alarms and readout devices and the actions to take if an alarm or unacceptable reading occurs.

E. OTHER FACILITY CONDITIONS

1. General Laboratory Environment

a. Floors and Walkways

1) Flooring - Floors should be level, with no protuberances which could cause a tripping hazard. Openings in the floor should be covered, if possible, or else protected or guarded to prevent falls. If impervious mats are present, they

should have a non-slip backing or be fastened to prevent moving when someone steps on them. Material spills should be cleaned up as soon as possible.

2) Obstructions - Equipment and supplies should not be placed where it would impede exit, either during normal operations (such as a file drawer which may open into an aisle) or in case of equipment failure (such as chemical reactions escaping a fume hood placed at the entrance to a room). Hoses and electrical cords should be strung along the ceiling instead of crossing aisles on the floor.

b. Plumbing Systems

Place a strainer or mesh pad over all sink drains to prevent objects falling into the plumbing.

Piping systems and plumbing connections in a room should be labeled. Such plumbing systems may include sewage lines, potable water lines, non-potable water systems, cryogenic and pressurized gases, or other systems. All personnel should know what to do in case of a leak in any system.

If experimental procedures will require connecting laboratory apparatus to any plumbing, personnel must also know how to avoid improper connections (i.e., avoiding mistakes such as connecting to the wrong system or making an inappropriate cross connection). Public Health regulations require additional safeguards to the plumbing system when connecting chemical equipment or experiments to potable water systems. Check with EHS and Facilities Services prior to any connections to potable water systems.

c. Lighting

1) Light Fixtures – Light fixtures should be operational, and diffusers should be installed. If emergency lighting and exit signs are not functional, immediately initiate a work request with Facilities Services.

2) Lighting Intensities – Light intensities should be adequate for the tasks being performed. If lighting seems inadequate when all fixtures are working, consider obtaining additional fixtures, especially if the laboratory arrangement is temporary. If this will not resolve the problem, call EHS at 216-687-2500. In a few cases, increased lighting may be required to reduce potential hazards from activities such as laser use or ultraviolet light applications. In these unusual situations, contact EHS at 216-687-2500.

d. Noise and Vibration

When possible, equipment that produces irritating noise and vibration should be replaced with equipment designed to produce less noise and vibration. If equipment in the area is producing noise levels that require people to raise their voices to be heard while standing next to each other, potentially hazardous noise levels are being produced. These levels can be evaluated by contacting EHS at 216-687-2500.

Equipment should not be purchased which produces noise levels greater than 80 dBA without specific written approval from EHS. A formal hearing protection program may need to be implemented for the installation and use of such equipment.

e. Indoor Air Quality

1) Occupant Activities – Many complaints about odors are due to occupant generated problems. Such sources include dried out drain traps in sinks and floor drains, chemical spills inside a laboratory or adjacent area, rotting food

within a room, and expected or unexpected chemical reactions creating a stench. The room occupants should check these potential problems. If a dry trap is suspected, the trap should be filled with a few hundred milliliters of water at least once a month.

2) Facility Related – Recurring poor indoor air quality may be due to inadequate or malfunctioning general HVAC systems. In some cases, odors may come from a leak in a plumbing system (such as natural gas or sewage), an open drain that was never capped by Facilities Services when a piece of equipment was decommissioned, or a construction project in an adjacent area. If these conditions are suspected, contact Facilities Services.

3) If an unknown odor persists, contact EHS at 216-687-2500.

f. Asbestos, Lead and Other Hazardous Facility Components

1) Asbestos – Asbestos may be found in various building components (often in plumbing insulation and fireproofing, and sometimes in floor tiles, ceiling tiles, wall finishes and other building materials). Asbestos may also be found in various equipment components (such as fume hood and safety cabinet wallboard and in autoclave and oven gaskets) and various supplies such as heat resistant gloves and heat-resistant cloth. Non-asbestos materials should be used whenever possible in place of the asbestos materials and all personnel should avoid damaging suspected asbestos-containing materials. Do **NOT** use an ordinary vacuum cleaner or dry sweep to clean up suspect dust from these materials. Such materials are handled by a contractor through EHS.

2) Lead – As a building or equipment component, lead is frequently found in old paints on walls and metal surfaces, in paints used on the exterior of ships and buildings, as a barrier when density is needed (such as in an x-ray radiation shield) or as a weight when a heavy material is needed (such as an equipment counter balance). The primary health hazard would come from inhaling or ingesting dusts from these materials, but skin contact with these materials should also be minimized. If a laboratory operation routinely creates lead dusts or melts lead, the process should be evaluated by EHS.

3) Other Building Materials – Other structural materials that could present a health hazard include polychlorinated biphenyls (PCBs) in fluorescent light fixtures and transformers, liquid mercury switches in piped gas systems, mercury in fluorescent and high pressure light bulbs, flammable or toxic gases in piped gas systems, and potentially hazardous materials in sewage plumbing and ventilation ducts. If any leak of such material is suspected, contact Facilities Services.

g. Building Repairs and Alterations

Building occupants are not authorized to repair or alter facilities. Facility problems such as broken flooring and broken electrical cover plates should be corrected by initiating a work request with Facilities Services.

2. Electrical Hazards

Even small electrical currents passing through the body may cause injury or death. Observe the following precautions to reduce electrical risks.

a. Circuit Breaker Access

1) Access – Maintain at least three feet clearance in front of any circuit breaker panels within the laboratory.

2) No one should access an electrical panel without prior authorization from the CSU Electrical Department. Contact the FAST Coordination Center 216-687-2500 for assistance.

b. Permanent Wiring and Outlets

Request permanent wiring be installed for situations when you would be using extension cords for periods longer than eight hours. All building electrical repairs and wiring must be done by Facilities Services. If conduits appear damaged or cover plates over electrical outlet boxes are damaged or missing, please report that Facilities Services.

c. Equipment Cords and Extension Cords

1) Extension cords should be a minimum of 14-gauge size (heavy duty) and be in good condition with no splices, knots, deterioration, taping, damage, or sharp, permanent bends. Plugs (110 volt) must have three prongs with a grounding prong longer than the current prongs.

2) Extension cords may never be used in place of permanent wiring. Consider instead power strip outlets or surge protectors with build-in circuit breakers.

3) Carpeting, heavy objects, and equipment that may abrade or melt an electrical cord should never be placed on top of electrical cords. Cords should serve only one fixture or piece of equipment. Cords should never be strung through holes in walls or ceilings, or over metal fixtures such as pipes or equipment racks because cord movement may abrade the cord.

d. Chemical Splashes into Electrical Equipment

Place equipment to reduce the chances of a spill of water or chemical on the equipment. If a spill occurs while the equipment is unplugged, the spill should be promptly cleaned, and the equipment must be inspected before power is applied.

e. Grounding

Equipment must be properly grounded (using three prong plugs for 110-volt power), especially in “wet” areas. Electrical outlets in “wet” areas must have ground fault circuit interrupters (GFCIs). (However, these devices only interrupt flow of electricity to ground and may not stop flow of electricity when completing an electric circuit with two “live” wires.)

f. Equipment Modifications

Any problems with electrically powered equipment should be brought to the attention of the PI or laboratory supervisor. If equipment setup is modified, someone knowledgeable with the apparatus should check the new setup before power is applied. Equipment operators must understand the hazards of equipment and apparatus in use and be familiar with the correct operation of that equipment. Power line cords should be unplugged before any modifications or repairs are made to equipment. Even though power may need to be applied to equipment while calibrations are performed, the operator must remain wary of the energized state of the equipment and not adjust the equipment beyond safe operational parameters.

If there is a potential for a worker to contact live electrical circuits of 50 volts or greater while performing equipment installation, modification or maintenance, that person must take electrical safety classes including lockout/tagout procedures and

wear appropriate arc/flash protective clothing. If possible, equipment setup and maintenance must be performed with the equipment in a de-energized condition.

3. Lockout/Tagout Concerns

a. Hazardous Situations

In addition to common electrical hazards, other energy hazards may exist in the laboratory that require special procedures, called Lockout/Tagout procedures. These situations may include equipment with internal pressurized systems (hydraulic or gas), multiple electrical energy source systems (where electricity is supplied through more than one cord), systems containing batteries or capacitors, and gravity systems (where a weight is held at a height). Such systems must be labeled with a warning sign. Anyone using such systems must know of the hazards and that only trained and authorized individuals may repair and modify the equipment.

b. Precautions

Trained and authorized personnel must perform all repairs and modifications. When repairs and modifications are performed, the energy source must be prevented from being activated using appropriate techniques such as de-energizing the system, inserting blanks into pressure systems, and locking out controls with individualized locks. To view CSU's Lockout/Tagout program, please click here:

https://www.csuohio.edu/ehs/occupational-safety

4. Equipment Guards and Mounting

a. Guards

Belts, pulleys, and other exposed moving equipment parts must be guarded. Equipment covers should be in place.

b. Instruction Manuals

Operator manuals should be available. Workers using the equipment should know where such manuals can be found and should review the manuals prior to using the equipment.

c. Mounting

Equipment designed to be used in a certain location should be permanently fixed in place to prevent movement from vibration. This is especially important for equipment which may topple (e.g., a drill press) or which needs to be balanced (e.g., a centrifuge).

5. Confined Spaces

Laboratories may contain equipment (such as large tanks or ovens) or facility arrangements (such as tunnels, sumps or pits) that laboratory staff may need to enter. If potentially hazardous exposures may occur in a confined space; the space will need to be controlled as a permit-required confined space. Special training and other precautions are required for permit-required confined space entry. Contact EHS at 216-687-2500 for space evaluations and to arrange for training.

F. PRESSURE VESSELS AND SYSTEMS

1. Vessels

Pressure vessels, autoclaves, and steam sterilizers operating at pressures greater than 15 pounds per square inch gauge (psig) or larger than six inches in diameter fall within the Ohio revised Code for Boilers ORC 4104. As such, there are strict requirements for design, testing, and approval. The units must be placed on the University's insurance carrier's inspection list maintained by Facilities Services.

2. Pressure Systems

Pressure vessels and systems with operating pressures greater than 15 pounds per square inch gauge (psig) are of potential concern. Design should produce a protection factor of 4:1 up to 10:1 depending upon design parameters and whether the system can be safely tested. A pressure relief device to release safely pressures greater than 10% above the operating pressure should be installed.

3. Precautions

a. Large-Scale Processes

Large-scale processes (exceeding 100 psig or involving more than 10 to 20 grams of reaction compounds) should be carried out in containment devices designed for high pressures.

b. Hazards

Hazards from explosions due to over-pressurizations include flying scraps and glass, and spills of potentially harmful reaction compounds.

c. Small Scale/Low Pressure Procedures

Avoid damage during small scale/lower pressure procedures. Procedures to avoid damage include the use of barriers, use of undamaged components, use of tubing and glassware designed for the temperatures and pressures involved, and application of the minimal amount of cold (such as by using dry ice) or heat (such as by using low temperature steam) instead of application of extreme temperatures or spot applications.

G. DECONTAMINATION OF WORK AREAS

Laboratory personnel are responsible for providing a clean and unobstructed work area for all maintenance and service personnel. Floors should be cleaned regularly and kept free of obstructions.

1. Custodial Services

CSU Custodial Services will clean floors in laboratories only if requested. Contact Custodial Services at 216-687-2500. Custodial floor care equipment should not be used to clean up spills or chemicals.

2. Servicing of Lab Area or Equipment

To protect maintenance and facility workers, any laboratory area or equipment needing servicing is required to be unobstructed, emptied of chemicals, decontaminated with a decontaminating chemical as needed, washed with warm, soapy water, and rinsed. The area or equipment must have a signed and attached form before service will be provided.

Facilities Services and maintenance personnel are trained to reject servicing the requested area or equipment if it has not been decontaminated and/or cleaned. Conditions which can lead to service rejection include such things as visible debris from absorbents or glassware, “diapers” or papers taped to surfaces which were supposedly decontaminated and cleaned, and visible or sticky spilled materials.

If the laboratory is expected to be unattended when service personnel arrive, an informal note should be left stating a contact name and phone number in case there are questions about the work area or if equipment needs to be moved.

H. DECONTAMINATION OF EQUIPMENT FOR DISPOSAL

Laboratory equipment is often contaminated with hazardous materials and/or may be inherently unsafe. CSU Property Control cannot accept some types of laboratory equipment and cannot accept laboratory equipment containing hazardous materials.

To surplus contaminated or potentially contaminated laboratory equipment, you must first make sure that the equipment is safe for handling and resale. The Laboratory Supervisor or PI must attest that equipment has been decontaminated and affix a notice to the equipment. Property Control will not pick up equipment that does not have this notice attached or does not appear to be clean and empty.

Examples of equipment that must be decontaminated include centrifuges, incubators, fume hoods, cryostats, ovens, BSC’s, refrigerators, freezers, sinks, storage cabinets, lockers, bins, and tanks. (Tanks have the potential to be a confined space hazard and thus require special procedures. Call EHS at 216-687-2500)

Any equipment capable of generating dangerous radiation or containing radioactive sources must be checked by EHS prior to public sale. Please contact the Radiation Safety Officer at 216-687-2500. These items include:

- Gas chromatographs
- Germicidal UV lamps
- Lasers
- Scintillation counters
- X-ray equipment
- Any item with a radioactive sticker

The following items CANNOT be accepted by Property Control. Contact EHS at 216-687-2500 for information on how to dispose of these items:

- Capacitors and transformers (note: some equipment may contain transformers, such as x-ray equipment and electron microscopes. These transformers may be accepted but must be drained of oil and the oil must have been tested and certified by EHS as being non-PCB oil.)
- Gas cylinders and other pressurized containers/vessels
- Instruments containing mercury
- Equipment containing asbestos, including but not limited to autoclaves, laboratory ovens, fireproof file cabinets, anything that produces high heat.

The type of decontamination will vary depending on the hazardous material and the type of equipment. Note that personal protective equipment should be used when decontaminating equipment. Below are some requirements and guidelines for decontamination, as well as contact information for questions.

1. Equipment Used to Process/Store Chemicals

Safely remove or drain chemicals from the equipment, including any oil or coolant. Collect the chemical(s) for reuse or dispose of them as hazardous waste. If applicable, use an inert gas or liquid to purge or rinse out chemical residues. In some cases, rinsate will need to be disposed of as hazardous waste as well, call EHS at 216-687-2500 for questions regarding hazardous waste disposal of chemicals and/or rinsate.

Decontaminate the equipment as necessary. For example, use solvents to remove viscous or non-water-soluble contaminants. Then scrub decontaminated equipment thoroughly with warm soapy water. Rinse and dry. Wash and/or rinse water and solvents may need to be managed as hazardous waste. Contact EHS at 216-687-2500 for more specific information about decontamination.

2. Equipment Used to Process/Store Radionuclides

Conduct a thorough radiation survey of all accessible surfaces of the equipment with an appropriate instrument. If you detect radioactive contamination, you must clean the equipment with small amounts of warm detergent water. Avoid splash. Blot dry with paper towels. Commercial radiation decontamination solutions containing chelating agents may be helpful. Resurvey to assure that contamination is less than 100 counts per minute per 100 square centimeters of surface. If contamination persists or you have other questions, contact the EHS Radiation Safety Officer at 216-687-2500.

3. Equipment Used to Process/Store Biological Material

Remove all biological material from the equipment. Decontaminate with a 1:10 bleach solution. After 30 minutes of contact time, rinse metal surfaces. If you have specific biosafety questions, contact EHS at 216-687-2500.

**Before repair or relocation, BSC's must be decontaminated by EHS or by a service provider.

Section 5 – Employee Health and PPE

Contents

A. EXPOSURE MONITORING AND MEDICAL SURVEILLANCE

As a general principle, exposures to hazardous chemicals should be kept as low as possible and avoided when possible through good laboratory procedures. If there is reason to believe that exposure to a chemical routinely exceeds an exposure limit for a chemical, then the Principal Investigator (PI) or supervisor shall arrange to measure an employee's exposure to that chemical. For assistance in determining if air monitoring should be done, contact EHS at 216-687-2500.

1. Exposure Limits

Exposure limits can be defined by a regulation (identified as a Permissible Exposure Limit (or PEL) or by a guideline. PEL's are created by OSHA and have been adopted by the State of Ohio under the Public Employee Risk Reduction Act. The OSHA PEL table can be found here:
https://www.osha.gov/annotated-pels/table-z-1

Guideline limits are considered "recommendations" and exposures should not exceed these levels. These guidelines are typically more up to date than the regulatory limits. Various organizations publish guidelines, as shown in Table 5-1, Guidelines for Airborne Exposure Levels.

Table 5-1 Guidelines for Airborne Exposure Levels

GUIDELINE-PRODUCING ORGANIZATION	GUIDELINE TITLE
National Institute for Occupational Safety and Health (NIOSH)	Recommended Exposure Limits (RELs)
American Conference of Governmental Industrial Hygienists (ACGIH)	Threshold Limit Values (TLVs)
Occupational Alliance for Risk Science (OARS)	Workplace Environmental Exposure Level Guides (WEEL Guides)

In addition to the organizations listed above, guidelines may also be produced by other groups, nations, and chemical manufacturers. The recommended limits can be obtained from the publications of those organizations or may possibly be found on web pages or sometimes listed on safety data sheets. Contact EHS at 216-687-2500, concerning exposure limit questions. Due to lack of complete knowledge of the health effects of chemicals and possible chemical synergies, there may be an exposure issue even though levels do not exceed limits. Personnel should take reasonable steps to keep exposures and levels as low as feasible.

2. Possible Over-Exposure

Exposures exceeding recommended limits are considered "over-exposures." Such limits apply to airborne levels which may result from operations that generate air contaminants outside of fume hoods, from a spill of a volatile chemical, or a leak of a gas. Other routes of entry into the body besides inhalation - ingestion, direct skin or eye contact with a chemical, injection under the skin by a sharp object or high-pressure source, or a combination of these routes – may also present a significant exposure. These exposures may occur if safe practices are not followed.

In some cases, workers may show signs of exposure such as headaches, rashes, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, and loss of motor dexterity or judgment. Such conditions should be evaluated if there is no pathological cause for such symptoms. Follow-up is especially important if the symptoms disappear when the person leaves the exposure area and then reappear soon after the employee returns to work, or if two or more persons in the same laboratory work area have similar complaints.

For specific exposure response procedures, see Section 9 of the Laboratory Safety Manual.

3. Medical Evaluations

Laboratory employees who suspect they have been over-exposed or are having symptoms consistent with over-exposure to a chemical, should contact CSU Health & Wellness Services (216-687-3649), or the nearest medical facility.

Staff involved in any emergency situation should go directly to the nearest emergency room or call 911/CSU Dispatch (on campus 216-687-2020) for assistance.

4. Accident Reporting

Ensure a CSU Accident/Incident Report is filled out by any employee, student, or visitor if an injury/illness occurs in your laboratory. Signature of the employee's supervisor is required on the form. The form can be located at the link below:
https://www.csuohio.edu/ehs/report-occupational-injuryillness

B. PERSONAL PROTECTIVE EQUIPMENT (PPE)

The purpose of PPE is to reduce student and employee exposure to laboratory hazards. It is to be used when substitution or engineering controls are not feasible. Examples of PPE include gloves, eye and foot protection, respirators, and protective clothing such as aprons and lab coats.

See Table 5-2 for example PPE by hazard type.

Principal Investigators (PIs) or laboratory supervisors are required to assess the hazards and risks of exposure based on the procedures performed in the laboratory and the controls in use. The PI or supervisor may use the laboratory PPE hazard assessment guide, as a tool to perform the assessment. Before work is initiated, ask to see a copy of the completed assessment or other documents detailing the lab PPE requirements such as standard operating procedures.

If PPE is required, the University must provide PPE at no cost to an employee (except for prescription safety glasses and closed shoes).

The PI or supervisor must also instruct employees in how to select, inspect, use, maintain, and store the PPE. PPE training records should be maintained as described in Section 8 of this manual.

Although students must be protected to the same degree as employees, they may be liable for purchase of their own PPE, such as safety goggles or respirators. Some common use PPE such aprons or lab coats can be purchased and made available for student use by the department.

Table 5-2 Hazards and Example PPE

HAZARD	PERSONAL PROTECTIVE EQUIPMENT
Biohazards	Splash goggles, gloves, liquid resistant surgical masks, lab coats, aprons, sleeve covers

Chemicals	Gloves, chemical-resistant clothing, aprons, sleeves and shoe covers, vapor-proof or splash goggles; lab coats for general use
Cuts/Abrasions	Cut-resistant gloves (leather, Kevlar, chainmail)
Dust	Dust goggles, respirators
Electricity	Electrically resistant gloves, mats, hard hats
Explosions	Protective vests, face shields
Falling Objects	Hard hats, steel-toe shoes, metatarsal guards
Falls	Fall harness, strap-on hard hat
Fires	Fire-resistant lab coat
Flying Particles	Safety glasses w/ side shields, goggles, face shields
Hot Environments	Cooling vests, reflective suits
Hot or Cold Objects	Thermal gloves (Note: Asbestos gloves are prohibited and must be turned in as hazardous waste.)
Intense Light	Opaque glasses, goggles, welding hoods
Kneeling	Knee pads
Lifting	No PPE available, use engineering controls/training
Low Overhead Objects	Bump cap, hard hat
Noise	Hearing protection devices
Over-Water Work	Life vests, flotation devices
Radiation	Lead apron, for X-ray, lab coats/gloves for radioactive materials
Repetitive Motion	No PPE available, use engineering controls/training
Slipping	Non-skid shoes
Splashes	Splash goggles, face shields, chemical-resistant clothing, gloves, aprons, sleeves and shoe covers
Traffic	Reflective vest

1. Eye Protection

Appropriate eye protection must be worn when working with chemicals. Avoid use of contact lenses in the laboratory. If you wear contact lenses, notify the PI or lab supervisor and always wear chemical splash goggles or a face shield.

a. Prescription Safety Glasses

Prescription safety glasses are available from optical stores. Do not use regular glasses as safety glasses, they do not provide adequate protection.

b. Safety Glasses

Safety glasses with side-shields are designed to provide impact protection but provide little protection from chemical splashes, dusts, or hot particles.

c. Splash Goggles

Wear splash goggles with splash proof sides when there is a danger of a chemical splashing. Goggles that have screened sides or other vents are not splash proof but can be worn when working with apparatus that could produce flying particles (e.g. glassware under reduced or elevated pressure).

d. Face Shields

Face shields in addition to safety glasses or splash goggles provide maximum protection to the face and neck from flying particles and harmful liquids. Face shields may also be needed when a vacuum system is used.

e. Free Standing Barrier Shields

Free Standing barrier shields can be used to protect yourself and bystanders from possible explosion.

f. Specialized Eye Protection

Specialized eye protection is needed when working with intense light sources such as infrared light, ultraviolet light, glassblowing, welding, and lasers. Glasses, goggles, or face shields with adequate filtration are needed. For assistance, please contact the CSU Radiation Safety Officer, 216-687-2500.

2. Personal Apparel

a. Appropriate Clothing

The clothes you wear in the laboratory are an important consideration for personal safety and can influence the severity of consequences of spills, splashes, and burns. The following guidelines should be followed when working the laboratory:

- Shoes should fully cover the feet to protect against spills, no open-toed shoes or sandals are permitted, and shoes constructed of mesh (such as athletic shoes) are not recommended.
- Clothing should cover your legs.
- The materials you wear in the laboratory can make a difference. Many synthetic fabrics may be dissolved by solvents or may melt into your skin causing more extensive burns if they catch fire. Preferred materials are cotton, wool, and resistant polyester. Synthetic materials such as acrylics, rayon, polyester, and other synthetics are not preferred.
- Loose, flowing garments and scarves should be avoided as they may easily pick up spills, trail through a burner flame, or constrict blood flow if tightened or pulled in to rotating equipment.

b. Jewelry

Loose jewelry such as bracelets, watches and necklaces, should be avoided since they may catch on equipment. Also avoid rings that can damage protective gloves or make removing gloves difficult.

c. Hair

Tie back long hair so it does not get caught in equipment, come in contact with chemicals, or interfere with your field of view.

d. Lab Coats, Aprons and Sleeves

Contaminated personal clothing may spread hazards to family and friends, as well as contaminate public areas such as doors, hallways, elevators, and food services. Wear laboratory coats or aprons and sleeves whenever there is a potential for contaminating skin or clothing. Use clothing made from chemical-protective fabrics as needed. Flame resistant laboratory coats are required when working with pyrophoric chemicals, large volumes of organic solvents, and potentially explosive chemicals.

Lab coats should be removed before leaving the laboratory. Contaminated lab coats can be laundered through a service provider.

3. Gloves

a. When to Wear

Wear gloves whenever working with chemicals, rough or sharp-edged objects, or very hot or very cold materials.

Do not wear gloves around an unguarded, moving machine as it could snag the glove and pull your hand into it.

b. Selection

Select gloves based on the material being handled, the particular hazard involved, and their suitability for the procedures being conducted (such as whether the glove provides appropriate dexterity for the procedures). To select the appropriate chemical-protective glove, read the SDS or consult with EHS at 216-687-2500. Thin, disposable gloves should not be expected to provide long-term protection from immersion in a chemical; use thick gloves if immersing hands in a chemical.

Other types of gloves used in a laboratory may be designed to protect from biological hazards, sharp objects, and temperature extremes, among other hazards. Asbestos gloves are prohibited, and any found in a laboratory will be collected as hazardous waste.

c. Inspection

Inspect gloves before each use and discard if you see discoloration, punctures, and tears. Do not blow into gloves to check for integrity, but if there is no external contamination, the glove may be squeezed to determine if the trapped air is escaping through small holes.

d. Removal

Take off gloves before leaving the laboratory. If using reusable gloves, wash them with soap and water before removing them, to remove possible contaminants. Get in the habit of removing gloves without touching the outside of the glove to clothing or skin. Wash hands with soap and water after removing gloves.

e. Replacement

Replace gloves often, depending on their frequency of use and permeability of the chemical(s) handled. Do not re-use disposable gloves.

f. Contaminated Gloves

Dispose of contaminated gloves by carefully removing them and placing them in a plastic bag. If they are grossly contaminated with hazardous chemicals, then manage them as hazardous waste.

g. Latex Gloves

Do not wear thin latex gloves in the lab for chemical protection. They provide very little protection from chemicals.

Latex gloves can be the source of allergic reactions, which can range from powder abrasion dermatitis to a life-threatening hypersensitivity to the latex protein.

4. Respirators

Respirators should not be needed in a normal laboratory setting. However, if you suspect laboratory airborne hazardous chemical concentration is near the PEL contact EHS at 216-687-2500 for a consultation.

All use of respirators at CSU must comply with the CSU Respiratory Protection Program prior to first use. This program includes evaluating hazards and medical fitness of each user, training, selecting equipment and understanding its limits, fit testing, and annual re-certification. For more information, contact EHS at 216-687-2500 and refer to the Respiratory Protection Program web page here:
https://www.csuohio.edu/ehs/occupational-safety

5. Hearing Protection

Hearing protectors (earplugs or earmuffs) may be needed for some procedures or in some laboratory settings. If you suspect the noise levels may be potentially harmful, contact EHS at 216-687-2500 for an evaluation. (A rule of thumb is that if you are in a noisy environment for most of the day where you must raise your voice to be intelligible to someone standing next to you, the noise levels may be potentially hazardous.)

Section 6 – Standard Operating Procedures

Contents

A. STANDARD OPERATING PROCEDURES (SOP's)

Laboratories must provide employees with standard operating procedures (SOP's) to be followed when laboratory work involves the use of hazardous substances. The SOP's must address all requirements to perform the laboratory procedures safely. The requirements may either be stated in a cover sheet attached to the laboratory protocol(s) or be integrated into a protocol

B. SOP COMPONENTS

1. Required Components

The required elements are listed in the template. SOPs must address the following items:

a. Process Identification

Identify the chemicals, processes, or equipment involved. If there is any question as to the chemicals produced in the process, you should consider identifying the stock chemicals, intermediates, final compounds, and wastes involved. Factors such as use of catalysts, inert compounds, heat, cold, and varied operating pressures which are involved in the process should be explained.

b. Controls

List required methods to control potential exposures, including:

1) Use of engineering controls. Engineering controls provide a permanent means of protection and are preferred over other types of controls. Some examples of engineering controls are working in an area with good ventilation (*e.g.*, ducted exhaust from equipment, fume hoods or glove boxes), storing particularly hazardous chemicals in locked cabinets, and using built-in barriers to restrict access to the area or to protect from potentially explosive situations.

2) Use of administrative controls, *i.e.*, specific safe practices such as keeping the fume hood sash as low as possible, storing chemicals with secondary containment, substituting pre-formulated liquids instead of powders to be weighed and prepared, hygiene practices such as hand washing, and procedures for removal and disposal of contaminated PPE.

3) Use of personal protective equipment (PPE) such as gloves, lab coats, etc., which is the least preferred method of protection if alternatives are available. However, when PPE is required, the PPE must be specified completely, such as the type of glove to be used and whether it is necessary for the entire process or at certain steps. PPE is described in this manual located in Section 5.

c. Equipment Checks

Describe ways to verify that the fume hood and other control system(s) are operating correctly before using hazardous chemicals.

d. Potentially Hazardous Situations

Provide guidance for handling spills and identifying if a spill is causing a hazardous situation. For example, laboratory personnel may be able to safely handle a spill of a liter of dilute acid anywhere in the laboratory but may need to evacuate if 100 mL of a toxic chemical is spilled outside a fume hood. This also provides guidance when purchasing a chemical, as to the maximum size of a container.

e. Waste Management

Identify safe disposal methods for routinely generated wastes. This includes describing procedures to neutralize or treat wastes to make handling safer or to reduce the amount of hazardous waste.

f. Particularly Hazardous Substances

Provide additional details if "particularly hazardous substances" (highly toxic or dangerous chemicals, carcinogens, reproductive or select toxins) are used. These details should address using specific containment devices such as fume hoods or glove boxes, providing authorizations for using the substance(s), describing additional procedures for decontamination, safely handling waste, and establishing designated areas for the procedure.

g. Authorizations

Describe any requirements for obtaining authorization before being allowed to perform the procedure, operation, or activity. An example could be that a worker must have training documented before performing a certain procedure for the first time. Other required authorizations could include completing a medical examination before using a respirator when performing procedures involving certain hazardous substances. Authorizations should be required before a person could independently perform a process using particularly hazardous substances.

2. Appearance

SOP's obtained from other organizations and SOP's written in the form of step-by-step procedures can be used if all the basic components are addressed and as long as the SOP accurately describes your laboratory's safety requirements. If SOPs are provided by outside sources (such as equipment suppliers or another laboratory) or modified from a template, they must be carefully reviewed to ensure they describe your protective measures accurately, including describing specific types of PPE and control equipment you will use.

C. SOP DEVELOPMENT

To develop your laboratory SOPs, EHS suggests the following steps:

1. Step 1 – Modify Existing SOP's

EHS recommends you review and modify any generic SOP's that pertain to your laboratory.

2. Step 2 – Identify Requirements

Identify if any particularly hazardous substances are in use in your laboratory and identify which way of writing your SOP's will best cover your laboratory's chemicals or processes. SOP's can be written by one of the following ways:

a. By Process

Safety requirements could be noted either by integrating them into the steps in the process or by using a "cover sheet" of safety requirements for the process. If hazardous intermediates are created, carefully consider if there are specific precautions which should be noted, such as how to tell if a release or spill occurs, what symptoms may develop if a person is exposed, and any special precautions for spill clean-up and waste disposal.

b. By Individual Chemical

This approach may be most useful if a limited number of chemicals are used in the laboratory or if using a particularly hazardous substance.

c. By Class of Chemical

By class of chemicals, such as mineral acids, organic solvents or peroxidizable chemicals.

This approach may be most useful if several similar procedures are performed using similar substances.

3. Step 3 – Complete the SOP's

After modifying generic SOP's and identifying which ways of writing are most useful in your situation, continue by developing SOP's for processes, chemicals, and chemical classes not previously written. Ensure all elements of the SOP's are addressed if the SOP pertains to chemicals considered particularly hazardous.

4. Step 4 – File the SOP's

After completing the SOP's, file the master copies so that everyone can find them. If they are not physically filed in the laboratory-specific information section of your CHP, the laboratory- specific information pages should be annotated to identify where the SOP's are physically located.

5. Distributing Copies of the SOP's

If you provide working copies of your SOP's to your staff, keep track of how many copies you made and distributed. When you make changes, you will need to assure that the updated SOP's reach all those who perform the procedures.

6. Update SOP's as Needed

If you note changes to your process or chemical use which impact an SOP or recognize improvements that can be made to the SOP, update it as soon as it is convenient. Note the revision date on the SOP.

Notify all lab personnel of the revised SOP. Replace the previous SOP in your files and anywhere else they may have been placed, including the work copies which would be referred to daily by your staff and those which may be kept at the lab benches or in individual staff members' files.

Figure 6-1 Standard Operating Procedures (SOP) Template

Cleveland State University

Standard Operating Procedures for Chemicals or Processes	
#1 Process (if applicable)	> *The process or type of process that involves the use of hazardous chemicals in the laboratory. Describe in general terms, such as "extraction" and "distillation" or in more detailed terms, such as "spectrophotometer analysis of cholesterol extraction"*
#2 Chemicals	> *For each process, list all chemicals, reactants, and products and describe their hazards. SDS's may be attached.*
#3 Personal Protective Equipment (PPE)	> *1. List the protective equipment to use; when and why it is worn; how long the equipment will last; and how to store or to take care of the equipment.* *2. List unique types of clothing, eye protection, gloves, or respirators required.* *3. If respirators are needed, indicate how fit testing will be provided.*
#4 Environmental / Ventilation Controls	> *List the environmental controls and ventilation systems needed to safely use the chemicals. This may include hoods, environmental rooms, aerosol suppression devices, etc. Describe safety features on equipment.*
#5 Special Handling Procedures & Storage Requirements	> *Describe any special storage requirements for the chemicals. Include restricted access areas, special containment devices, and safe methods of transportation.*
#6 Spill and Accident Procedures	> *Indicate how spills or accidental releases should be handled and by whom.*
#7 Waste Disposal	> *Describe waste disposal procedures for these chemicals. For more information refer to Section 3 of this manual.*
#8 Special Precautions for Animal Use (if applicable)	> *Annotate "N/A" if no animal exposure is involved. If chemicals are being administered to animals, describe how employees should protect themselves from contaminated animals and animal waste. Include information about restricted access, administration of the chemical, aerosol suppression, protective equipment, and waste disposal.*
Is a particularly hazardous substance involved?	___ YES: Blocks #9 to #11 are Mandatory __ NO: Blocks #9 to #11 are Optional.
#9 Approval Required	> Optional
#10 Decontamination	> Optional
#11 Designated Area	> Optional
Name:	Title:
Signature:	Date:

Environmental Health and Safety

Section 7 - Safety Training

Contents

A. SAFETY TRAINING REQUIREMENTS

According to state/federal laws and Cleveland State University (CSU) Policy, PIs and laboratory supervisors are responsible for ensuring that all employees receive adequate training in order to understand the hazards present in their work area. Training must occur prior to assignments involving new hazards. Refresher training or retraining may be required by law and by CSU policy and procedures for personnel who demonstrate that they did not understand the initial training or are not following required procedures.

EHS will maintain the tracking of training new employees receive before working with hazardous chemicals and other hazards in the laboratory. All visitors must receive sufficient training to ensure that they too are aware of the hazards and of how to protect themselves while in the work area.

Cleveland State University takes the responsibility of employee safety very seriously. Mandatory safety training is a key component of this commitment.

Additional training may be required for laboratory research that is outside the scope of EHS.

B. EHS SAFETY TRAINING AND RECORDS

EHS currently offers training online or in person and maintains training records for all provided classes.

C. LABORATORY-SPECIFIC TRAINING AND RECORDS

Additional laboratory or specific training by the PI/supervisor will also be required.

The laboratory PI or supervisor must ensure records of all laboratory & safety training are maintained. The location of the training records should be noted in the Chemical Hygiene Plan.

The laboratory PI or supervisor must also keep a copy of safety training content, such as a lesson outline, to demonstrate the scope of the training. Such material is useful to provide proof of training during Safety Inspections and to help in training new employees.

Training records should be maintained for as long as any trained employee remains in the work area. Some training records may be required to be held for longer periods of time. Contact EHS 216-687-2500 for questions regarding records retention for training.

Section 8 – Record Keeping

Contents

A. CURRENT RECORDS MAINTAINED IN THE LABORATORY/DEPARTMENT

1. Chemical Hygiene Plan

The Chemical Hygiene Plan, comprised of the CSU Laboratory Safety Manual plus the laboratory-specific information such as Standard Operating Procedures, laboratory floor plans, chemical spill kit locations, and emergency procedures must always be accessible to all employees in the laboratory that they are working. The laboratory-specific information may be kept electronically or on paper and should be updated annually or whenever there are changes. The entire Chemical Hygiene Plan must be reviewed and **updated at least annually** by the PI or laboratory supervisor, and the review should be recorded in the laboratory-specific information area.

2. Chemical Inventory

Current chemical inventories must be recorded for each laboratory. A copy should be printed annually for easy reference. The current inventory could be filed in the laboratory-specific information area or in another location. All workers must know where the inventory is maintained. (EHS also recommends that the PI or laboratory manager have a current copy available at home in case of emergencies.)

3. Safety Data Sheets (SDSs)

Safety Data Sheets must be maintained for hazardous products. Colleges and Departments are encouraged to maintain accessible copies of SDSs for immediate reference in case of emergencies and for training purposes. See also the SDS section in Section 2.B.3 of this manual.

4. Incident/Accident Reports

Employee incident/accident report records are maintained at EHS (216-687-2500). The Principal Investigator or laboratory supervisor should keep copies of all incident/accident reports filed pertaining to the laboratory or involving laboratory staff.

5. Safety Training Records

Laboratories must maintain records of all work-related safety and health training. (Refer to Section 7 for information on what to include in your laboratory training documentation.)

EHS maintains records of employee attendance at their classes. Copies of these records are available to departments upon request.

6. Shipping Papers (Bills of Lading)

If chemical-containing items are mailed or moved on or off campus and require shipping papers, these papers should be kept for one year.

7. Sewer Discharge Logs

A Sewer Discharge Log is used to record the wastes discharged to the sewer from a sink or drain as described in Section 3. Keep these logs for three years. The logs must be available for review by county or state inspectors.

8. Exposure Monitoring Records

Departments frequently maintain copies of employee exposure monitoring, to provide immediate information to their workers if questions arise. These records can be kept in the laboratory or in the department. EHS maintains records for all exposure monitoring conducted by EHS. In some cases, laboratories conduct their own employee monitoring. If

this occurs, please forward a copy of the monitoring results to EHS. Exposure monitoring records must be maintained for at least 30 years after the exposure.

B. OBSOLETE AND SUPERSEDED RECORDS FROM THE LABORATORY

Changes in laboratory operations may cause records to become obsolete or be superseded.

1. Obsolete Exposure Information

Obsolete and superseded information concerning the chemicals in use in a laboratory should be archived and disposed after 30 years when no longer current. These documents include chemical inventories, SOPs, records of spills and accidents, and exposure monitoring records.

2. Other Obsolete Documents

Records not directly pertaining to potential chemical exposures can be discarded a year after they are no longer current. These records typically include shipping / receiving documents and training documents for individuals who have left the department.

3. Records from Decommissioned Laboratories

The department should archive any records pertaining to possible employee exposures for 30 years after decommissioning a laboratory.

C. EHS RECORDS

EHS maintains chemical procurement records for chemicals purchased through the CSU online purchasing system.

1. Records Concerning Individuals

a. Occupational Exposure Monitoring

EHS maintains records for all exposure monitoring conducted by EHS and any results of monitoring conducted by others that is reported to EHS.

b. Medical Records

Occupational health medical records for employees are maintained by the care provider who rendered services. Human Resources maintains documentation pertaining to Workers Compensation benefits. Confidentiality of medical records is maintained.

2. Centralized Records

EHS is the central repository for chemical procurement records, and training performed by EHS. Records are available upon request.

Section 9 – Emergency Preparedness and Response

Contents

A. BEFORE AN EMERGENCY

This section describes emergency guidelines and requirements for laboratory operations. It supplements emergency preparation and response procedures described in other documents, including your Departmental Continuity of Operations Plan (COOP) or your Building Emergency Plan (BEP). These other documents describe emergency preparedness and response for departments, buildings, and the entire campus respectively. Instructors teaching laboratory classes must also follow University and Departmental rules for emergencies during class.

Principal Investigators must prepare laboratory personnel for emergencies such as injuries, fires or explosions, chemical spills, floods, and power failures. To prepare for an emergency, laboratory personnel should plan, obtain response kits and materials, modify facilities, and practice responses. Staff should also be encouraged to prepare for emergencies at home.

1. Departmental Plans and Policies

As part of their new employee orientation, employees must be informed of evacuation procedures and the Designated Meeting Area(s) as described in the Building Emergency Plan (BEP). Personnel should practice these procedures periodically. Visitors, visiting researchers, volunteers, and temporary employees must also be informed of these procedures and assembly points. Generally, the department that is the primary occupant in a building will write the BEP with technical assistance from EHS at 216-687-2500.

Your department's Health and Safety Plan may also discuss first aid plans and training. If so, include this in your new employee orientations.

Employees must also be informed of all departmental safety policies, such as those regarding security or working alone.

2. Planning and Prevention

Emergency response at Cleveland State University is provided by the Cleveland State University Police Department and Cleveland Fire Department (CFD). Campus Safety will provide liaison with these organizations and provide advice, but each laboratory is responsible for accident prevention and planning for first aid and chemical spill response within the laboratory.

a. Accident Prevention

Help prevent emergencies in laboratories by doing the following:

1) Post emergency phone numbers and floor plans
2) Know locations of shutoffs for equipment including electrical, gas, and water
3) Train personnel to retrieve SDSs for laboratory chemicals.
4) Separate incompatible chemicals and put them in secondary containment
5) Frequently dispose of chemical wastes, and clean out unneeded chemicals and unneeded items
6) Ensure electrical wires and equipment are in good condition
7) Discuss accidents and near misses to prevent future accidents
8) Complete the laboratory inspection checklist periodically
9) Discuss safety topics periodically in staff meetings

b. Hazards Assessment /Risk Minimization

When a new experiment or process is in development, assess possible hazards and identify ways to reduce risks. This is the responsibility of the Principal Investigator. However, laboratory personnel are more likely to comply with the experimental procedures when they are involved with their development, and they may provide good perspective too.

Read the following sections about specific hazards such as fires and explosions. There are also sections about training and special authorizations for the use of particularly hazardous chemicals.

Information about material hazards can be found on the SDS sheets or from other PI's. If you're unsure, please contact EHS at 216-687-2500.

c. Fire and Explosion Prevention

To prevent and minimize the effects of fires and explosions, do the following when using flammable, reactive, or explosive materials:

1) Determine if a non-flammable substitute for your material is available
2) Use a minimum amount of the material at any one time
3) Maintain proper clearances for aisles, eyewashes, emergency showers and underneath and around sprinkler heads
4) Close fume hood sashes when they are not in use
5) Keep containers closed
6) Practice good housekeeping, such as recycling empty cardboard boxes and disposing of unnecessary or outdated chemicals
7) Have the appropriate fire extinguisher available for the materials in use
8) Wear fire-resistant lab coats instead of plastic
9) If using chemicals in a closed system, frequently check that connections are tight
10) Use chemicals and reaction systems in a ventilated enclosure such as a fume hood
11) Reduce or eliminate open flames and spark-producing equipment
12) Use a refrigerator/freezer designed to store flammable materials
13) Use barriers that provide adequate protection from an explosion
14) Consider if utility outages would increase risks while using the material
15) Anticipate that intermediates and wastes can be flammable or explosive
16) Use appropriate containers and locations to accumulate wastes
17) Train staff on the chemical hazards and precautions. Document the training. Exercise responses occasionally.

d. Spill Prevention

Laboratory supervisors should identify chemicals likely to be spilled during common laboratory procedures as well as during emergency events. The procedures for cleaning spills in a laboratory should be included in the SOP's developed for each of the laboratory's processes (see Section 6 of this manual). Pay special attention to additional precautions that may be desirable for pyrophoric, water reactive, and oxidizing chemicals, and those that may generate toxic gases if a reaction were to occur.

Chemicals should be acquired in small quantities for ease of handling and to limit the amount spilled if containers rupture. Chemicals should be transported between rooms in a tub or bottle carrier designed to prevent breakage and to hold the contents in case of breakage.

All laboratories should have a chemical spill cleanup kit appropriate for the chemicals in the lab.

e. Gas Leaks and Unknown Odors

All staff need to know what gases and volatile chemicals in their laboratory may produce an odor. Identify contents of pipes, hoses, or gas lines with labels. Staff should know the location of control valves used to shut off gas flow. Previous incidents with odors as well as possible odors from adjacent laboratories should be discussed during staff meetings if they are issues.

f. Utility Outages: Pre-planning and Mitigation

1) To pre-plan for utility failure, consider the utilities laboratory operations depend on and determine if interruptions are unacceptable. Utility outages that can affect laboratory operations include:

- Electrical power systems
- Backup power system or switching systems
- Compressed air systems
- Ventilation systems (fume hoods, biological safety cabinets, etc.)
- Natural gas system
- Supplied gas systems (medical air, O2, N2O, N2, EtO, etc.)
- Vacuum systems
- Potable water systems (loss or contamination)
- Non-potable water systems (loss or contamination)
- Sewage systems
- Heating systems
- Fire protection systems
- Refrigeration systems (refrigerators, cold rooms, walk-in freezers, etc.)
- Elevators
- Telephone systems
- Detection and alarm systems (fire alarms, low airflow alarms, etc.)

2) Actions that can be taken beforehand to mitigate the effects of shutdowns on laboratory operations include:

- Maintaining backup (split) samples at another location
- Maintaining records at another location
- Using emergency power circuits (if available) only for equipment that needs it
- Installing devices to improve services, such as water filters for potable water and surge protectors or Uninterruptible Power Systems for electrical power

- Planning the steps needed to be taken to safely shut the process(es) down and start it (them) up again
- Planning actions to prevent uncontrolled reactions
- Contracting for emergency supplies and services. For example, if refrigerators or freezers are used for specimens, locate a source for dry ice and liquid nitrogen freezers in case of electrical failure.
- Connecting incubators, refrigerators, and freezers to battery powered automatic phone dialing systems or alarm monitoring services which detect power interruptions and alert the designated person. Being alerted to an outage does not solve the problem but it can give employees extra time to react.
- Developing procedures for card reader doors and other security systems that typically have a four-hour battery backup and procedures to communicate changes to normal access routes if necessary
- Having flashlights in areas that do not have emergency lighting and periodically check their condition
- Being aware of the various alarm systems and the appropriate responses to them (including fire alarms, ventilation system alarms, fume hood low flow alarms, gas leak detection systems.)
- Advising staff that communication channels could be down during disaster situations. Plan on alternative communication venues.
- Maintaining good habits for safe chemical use, such as keeping containers closed
- Conducting periodic trainings, drills, or exercises.

g. Unattended Operations and Floods

Avoid leaving operations or experiments unattended. Post on the door to the room the name and phone number of the person responsible for the operation in case of emergency. In addition, identify the chemicals in use and post clear directions for shutdown so that an untrained person could shut down the operation during an emergency.

In general, to avoid failures in equipment while no one is in the lab, maintain and operate equipment properly. Replace damaged equipment and electrical cords. Do not use extension cords for hooking up to electrical power.

Water should never be left running unattended. Water can flood into the floor below your laboratory. If it is necessary to have water running unattended, install a commercially available water flow device that sets off an alarm if a leak occurs or use a shutoff valve that kicks in if the water level rises too high. Use copper tubing with proper fittings or Tygon tubing, which is less likely to become brittle than rubber tubing. If using tubing, make sure the ends are tightly connected and tied tight. Anchor outlet hoses into sinks or drains.

Do not leave open flames unattended.

h. Inclement Weather

Plan for inclement weather, including lightning, heavy snow, hail or ice storms, high winds, heavy rainfall, flooding, and even high heat loads, depending on the laboratory's location.

Staff must have an emergency kit on campus and should have emergency kits at

home. Laboratory-specific planning should include determining how communications between separated staff will occur and determining what procedures may be affected. If an activity must continue daily, such as an experiment or caring for research animals, devise a contingency plan for inclement weather. Consider who could travel to the laboratory and provide the necessary service. Realize that certain roads and building entrances that you usually use may not be available.

Plan for these events by considering the following beforehand:

1) How to protect personnel.
2) How to shut down experiments in a timely manner or safely continue experiments in emergency conditions.
3) How to protect experimental results and essential materials.
4) How to protect equipment and supplies from the weather.

i. Security Issues

Plan for ways to avoid and respond to violence, vandalism, suspicious people and suspicious packages. Laboratories can be targets for such activities.

In general, laboratory security can be improved if all staff:

1) Know all entry points.
2) Keep doors closed and locked when the lab is unoccupied.
3) Wear identification badges.
4) Never allow a stranger to enter the lab.
5) Do not leave out materials which may be attractive to thieves.
6) Properly dispose of hazardous agents which are no longer needed.

Depending on the materials in use in the laboratory, higher levels of controls may need to be implemented. These controls may include using codes to identify certain materials and securing them inside the laboratory with access by only designated personnel.

The PI, with the assistance of the department, should determine policies to increase security. All staff must be periodically reminded of these policies.

j. Field Operations

Plan for emergencies that may occur during field operations, it is desirable to write a safety plan. Consider the remoteness of the operation and the risks associated with the activities. Minimum considerations include:

1) Become knowledgeable about potential threats in the area.
2) Determine access to first aid, CPR, and medical response and have a first aid kit available.
3) Determine communications to be used in case of emergency.
4) Devise alternative plans for inclement weather.
5) Develop checklists to ensure necessary supplies and equipment are brought to the site.
6) Give itinerary to a colleague with a map of the area of study and a timeline when to check in with.

3. Spill and First Aid Kits

Purchase emergency spill kits appropriate for your laboratory. Inspect them routinely (*i.e*, semi-annually and after use) to make sure they are complete and ready for response.

a. Chemical Spill Kits

General-purpose kits are available for purchase. Ensure you are using the appropriate material for the chemicals you are using. EHS has mounted chemical neutralization powder in each lab. Please contact EHS whenever you use the powder and/or when you need more.

Table 9-1 General Purpose Chemical Spill Kit Contents recommendations

Item	Description
Absorbent	Five spill pads, universal for acid, base, oil, solvents
Neutralizer	One 64 oz. box baking soda for neutralizing acids
Brush and dustpan	One snap together dustpan and whisk broom
Plastic bags	Four 18 x 30, yellow hazardous material heavy duty waste bags
Plastic drum	One 5-gallon re-useable screw top plastic drum to store kit supplies and hold bagged spill waste
Goggles	One pair of chemical splash protection goggles
Impervious gloves	One pair Silvershield gloves (multi-layer construction, impervious to most chemicals)
Lightweight gloves	Eight pairs of powder-free nitrile gloves, various sizes
Forms	EHS Hazardous Waste Collection form

b. Mercury Spill Kits

A general-purpose kit is available through Magnus-Mart. These kits are designed to be appropriate for small mercury spills, such as those from a broken mercury thermometer.

Table 9-2 Mercury Spill Kit Contents Recommendation

Item	Description
Scraper	One plastic scraper
Syringe	One 1 cc syringe to aspirate visible mercury droplets
Amalgamating powder	One package, Hg-Absorb powder to amalgamate micro-droplets
Sponge	One sponge to wipe surfaces after using Hg-Absorb powder

Plastic bag	One 9 x 12 reseal-able bag for waste (holds kit contents)
Gloves	One pair, Nitrile gloves, large size
Forms	EHS Hazardous Waste Collection form

c. Biological Spill Kits

Please contact EHS at 216-687-2500 for information on biohazardous/infectious waste spills.

d. First Aid Kits

First aid supplies must be readily accessible to employees. The size of a first aid kit depends upon the number of people who may use the kit, as shown in the following table (Table 9-3, Typical First Aid Kit Contents). Each laboratory must establish procedures to assure that first aid kits remain stocked.

Table 9-3 Typical First Aid Kit Contents

Recommended Materials for your kits	
Quantity	**Items for first aid kit**
2	absorbent compress dressings (5 x 9 inches)
25	adhesive bandages (assorted sizes)
1	adhesive cloth tape (10 yards x 1 inch)
5	antibiotic ointment packets (approximately 1 gram)
5	antiseptic wipe packets
1	blanket (space blanket)
1	breathing barrier (with one-way valve)
1	instant cold compress
2	pair of nonlatex gloves (size: large)
2	hydrocortisone ointment packets (approximately 1 gram each)
1	Scissors
1	roller bandage (3 inches wide)
1	roller bandage (4 inches wide)
5	sterile gauze pads (3 x 3 inches)
5	sterile gauze pads (4 x 4 inches)
1	Oral thermometer (non-mercury/non-glass)
2	triangular bandages
1	Tweezers
1	First aid instruction booklet

The kit contents may vary depending on particular laboratory situations.

For example, laboratories using hydrofluoric acid must stock calcium gluconate gel in case of skin contact with the hydrofluoric acid. The gel should be kept in the first aid kit (but it could be kept in a spill kit or another location close to the work area and known by all personnel). The gel has a relatively short shelf life of six months, so the PI/laboratory supervisor needs to replace it periodically.

EHS recommends removing any ingestible medications such as Aspirin from any first aid kits.

4. Fire Extinguishers, Eyewash Stations and Safety Showers

a. Fire Extinguishers

Portable fire extinguishers are provided in University buildings and are available for use by trained personnel. All laboratory personnel should be trained to use the type(s) of fire extinguishers that are present in the laboratory. Training classes are available through Access Control/Fire Safety. Individuals who have been trained in the principles of fire extinguisher use and the hazards involved may attempt to extinguish small (trash can or smaller) and incipient (early stage) fires if there is an escape route. Individuals not trained in the proper use of extinguishers should not attempt to use one during a fire. Doing so could put them and others in danger.

Fire extinguishers should be conspicuously located, wall mounted, and easily accessible. The fire extinguishers available to the laboratory staff should be selected based on the materials inside or outside the lab. See Table 9-4 for the list of fire classes.

Table 9-4 Classes of Fires and Proper Fire Extinguishers

Class of Fire	Description	Proper Extinguisher
A	Ordinary combustibles such as wood, cloth, and paper	Dry Chemical (ABC) or water
B	Flammable liquids such as gasoline, oil, and oil- based paint	Carbon Dioxide (BC) or Dry Chemical (ABC)
C	Energized electrical equipment including wiring, fuse boxes, circuit breakers, machinery and appliances.	Carbon Dioxide (BC) or Dry Chemical (ABC)
D	Combustible metals (e.g., Na, Mg)	Special Extinguisher (D)
K	Used in kitchen (oil/grease) fires	Special Extinguisher (K)

b. Eyewash Stations

If chemicals can cause eye damage and are used in such a way that they may splash into eyes, an eyewash station is required. Laboratory personnel must be able to reach eyewash stations within ten seconds. The eyewash should be within 50 feet of where chemicals are being used, although this distance should be less if doors interfere with access. Always maintain clear paths to eyewash stations.

Chemicals can cause temporary or permanent blindness, which can make it very difficult for someone to find the eyewash on their own in an emergency.

Laboratory personnel should know the location and operation of the eyewash stations in their area. It is recommended that personnel practice locating the eyewash station while keeping their eyes closed. If possible, don't work alone when working with these chemicals.

Eyewashes are tested monthly by Facilities Services.

Refer to Section 4.A for additional information on eyewash stations.

c. Safety Showers

Laboratory personnel should know the location and use of the emergency showers in their area. Laboratory personnel must be able to reach showers within ten seconds. Always keep the area underneath the shower and the path to the emergency shower clear.

Safety showers are tested monthly by Facilities Services.

Refer to Section 4.A for additional information on safety showers.

5. Securing Equipment and Supplies

a. Attaching Equipment to Walls or Supports

Heavy or hazardous items that could topple over and create a hazard or block emergency exits must be secured to the walls or floor by Facilities Services. These items include shelving units, equipment racks, and file cabinets taller than 4 feet, distillation units, gas cylinders (attach at two heights, approximately one third and two thirds of the cylinder height), and cryogenic dewars which are taller than two and a half times their base diameters.

Any new apparatus should be constructed robustly and secured to supporting fixtures. If you need to route gas lines between apparatus mounted to different supports, the lines should either be made of a compatible material that is flexible or have flexing joints.

b. Modifying Shelves and Cabinets

Shelves holding chemical containers must have a two-inch tall lip or protective restraint devices to prevent chemical containers from being shaken off the shelf. Shelves higher than 4 feet above the floor should have matting or protective restraint device if used to hold heavy manuals, books, or equipment.

6. Training Staff for Emergencies

Train staff for emergencies as appropriate. Periodic drills and exercises, including “tabletop” discussions, keep knowledge current and interest fresh. Additional information on training and documentation is in Section 7 of this manual.

a. All Staff

Staff frequently entering the lab must be trained in emergency situations, know how to retrieve an SDS for any chemical in the laboratory, and the meaning of all alarms and the proper responses to them. Training must be commensurate with the hazards of the chemicals in use – corrosive, flammable, reactive, or explosive chemicals require more emphasis on emergency response than laboratories that have an inventory limited to irritant chemicals.

b. Training as Determined by the Department or PI

The department or PI may have specific policies concerning whether all staff or select staff will be current in First Aid/CPR Certification and Fire Extinguisher Training. EHS recommends all laboratory staff be trained in First Aid/CPR and fire extinguisher use.

B. RESPONSE TO SPECIFIC INCIDENTS/ACCIDENTS

1. Accidents Resulting in Personal Injury or Exposure

For any accident involving personal injury, call 216-687-2020 or 911 (and ask for Cleveland

State Dispatch) for emergency response as soon as possible while conducting the following first aid responses as appropriate. Do not remove equipment involved in the accident and do not move it unless necessary to provide aid to the victim(s) or to prevent further damage or injury. Depending on the seriousness of the injuries, a formal accident investigation may be required.

a. Chemical Exposure

If a hazardous chemical is in someone's eyes, flush eyes for at least 15 minutes in the eyewash, holding the victim's eyelids open. Call 911 as soon as possible.

If a toxic or corrosive chemical is on someone's skin, flush area affected for at least 15 minutes. If necessary, use the safety shower and remove contaminated apparel. (For hydrofluoric acid, when calcium gluconate treatment is available, instead flush skin for five minutes and immediately apply the calcium gluconate).

If a person is exposed to a toxic material in the air, remove the person to fresh air and call 911 as soon as possible. Do not re-enter an area that may still be contaminated.

All personnel in the laboratory should be able to retrieve an SDS for any hazardous chemical in the laboratory so they can bring it to the emergency room.

Contact Health and Wellness Services at 216-687-3649 if there is a concern about possible long-term health effects from a workplace exposure.

b. Reporting

After immediate emergency actions have been taken, report the accident or incident to the work area supervisor, department administrator, or other designated department contact as soon as possible. If the accident results in a fatality or hospitalization, also report the accident immediately to EHS at 216-687-2500. After routine office hours, EHS can be contacted via the CSU Police Department at 216-687-2020. If the accident involved a University vehicle, it must be reported immediately to the CSU Police Department via 216-687-2020 and to CSU Motor Pool using the procedures found in the vehicle's glove compartment.

All faculty, staff, students, and visitors are required to report an accident or incident within 24 hours of the incident or accident if a person was injured or property damage occurred. Also report any on-the-job incident that barely missed causing an injury or illness or property damage.

c. Medical Treatment Reports

An employee who seeks medical treatment for a work-related injury or illness must submit a Cleveland State University Accident/Illness Report Form to Human Resources.

The CSU Accident/Illness Report Form can be found here:
https://www.csuohio.edu/ehs/report-occupational-injuryillness

2. Fires and Explosions

In the event of a fire or explosion, activate the alarm system and evacuate as soon as possible. You may attempt to use an appropriate fire extinguisher to fight the fire if it is easily extinguished (*i.e.*, smaller than a trashcan), you have been trained within the last year on how to use a fire extinguisher, and you have a clear exit.

If a person's hair or clothing is on fire, smother the flames with a coat or by having the person roll on the floor. Call 911 and provide first aid. Assist to evacuate as needed. Remain in contact with emergency responders.

Report all fires and explosions immediately. Even if the fire was small, contained and readily extinguished by laboratory personnel, and you did not call 911, immediately report the incident to the CSU Police at 216-687-2020.

3. Spills

Your response to a spill depends on the danger it poses. Take the following action(s) as necessary.

a. Evacuate Building as Necessary

If a spill endangers people outside your laboratory (such as if a toxic gas could go down the hall, or a flammable solvent spill might catch on fire), pull the nearest fire alarm to initiate evacuation of your building. Pulling the alarm will also call the local police and fire departments who will respond to the spill. Evacuate immediately. If you are able (i.e., if you are not injured or assisting someone else), make yourself available to describe the situation to emergency personnel when they arrive.

b. Evacuate Room as Necessary

If a spill endangers people within your lab room, evacuate the room, shutting down any flame producing equipment if possible. Report the situation to 911 and your PI/Department staff as soon as possible. Keep people from re-entering the room. If the chemical is volatile and the laboratory has a fume hood or other ventilation exhaust system, it may be possible to let the chemical evaporate. Otherwise, a spill cleanup as described below may be necessary.

c. Responding to Exposures

If the spill caused or is likely to cause an injury or illness, call 911 and ask for CSU Dispatch. In all cases, explain your circumstances to the 911 operator. Injured personnel should be transported by trained medics and not volunteers.

d. Spill Cleanup

If you know what the chemical is and its hazards, have appropriate PPE, and spill cleanup materials, clean up the spill using care and referring to the SOP. If you are unable to clean up the spill due to lack of knowledge or materials, call EHS at 216-687-2500. EHS provides spill advice, conducts clean up procedures, or will call the hazardous materials response contractor if you cannot clean up your spill. All cleanup costs are paid by the responsible department.

A spill of a highly volatile chemical outside a fume hood may be handled best by preventing access to the laboratory and simply allowing the chemical to evaporate, especially if the laboratory has an operating fume hood. A large spill of a toxic, low-volatility chemical (such as 500 milliliters of formaldehyde or 20 milliliters of mercury) that occurs outside of a fume hood may be especially problematic. Evacuate the room and call EHS 216-687-2500 before attempting to clean up these types of spills. Even if you were approved for use of a respirator for that particular material prior to the spill, it may not provide adequate protection.

If a spill occurs after normal work hours, contact the CSU Police at 216-687-2020.

e. Spill Waste

Waste generated during spill cleanup is usually hazardous waste. There are a few exceptions, such as neutralized and absorbed acid spills. Place hazardous spill waste in double plastic bags or the plastic bucket, label as hazardous waste, and contact EHS for removal.

f. Documentation and Process Improvement

After the incident, fill out an accident report with your supervisor. Replace used clean-up materials. Determine if additional or other types of cleanup materials would be desirable. Also, discuss as a group what could have been done differently. Document any changes by updating the applicable Standard Operating Procedure(s).

g. Mercury Spills

All departments using mercury should replace their mercury devices if at all feasible. The following discussion primarily pertains to metallic mercury (such as is in a mercury thermometer). Spills of other compounds of mercury which may be easily absorbed through skin can be cleaned up by lab personnel also, but more care needs to be taken to avoid contact exposures.

Mercury may enter the body through skin or eye contact, but inhalation is the more serious exposure route, especially if the spill involves heated mercury. Because metallic mercury vaporizes very slowly at room temperatures, mercury exposure will probably not be a health concern if the mercury is completely cleaned up. It is nearly impossible to clean up mercury spills on soft surfaces such as carpeting and shoes and typically requires removal and disposal of these contaminated items as hazardous waste.

While cleaning the spill, extreme care must be taken to prevent personnel from stepping on spilled mercury or spreading the spill to uncontaminated areas. Personnel must be trained in spill cleanup and use appropriate techniques and materials. Advice about spill cleanup can be obtained from EHS at 216-687-2500. Laboratories with mercury or mercury containing equipment should have a mercury spill kit immediately available.

Follow-up monitoring should be done by EHS to assure that there is no residual mercury. This monitoring can be requested by phoning 216-687-2500. Personnel should stay out of the area and routine operations should not take place until after the area has been shown to be clean.

Mercury spills at elevated temperatures may cause significant exposure and require immediate actions to turn off the heating apparatus if possible and to evacuate the room until the surfaces involved in the spill have cooled.

4. Radioactive Material Spills

a. Notify Principal Investigator and Determine Hazard

Notify the Principal Investigator or Radiation Safety Officer. Determine the radionuclide(s) involved and group them by their “Annual Limit on Intake” (ALI). Determine each radionuclide’s approximate activity. Use this information to determine if this is a major or minor spill.

b. Major Spills (Spills Approximating the ALI)

A spill is a major spill if more than 10 millicuries of a Group I radionuclide, or more than 1 millicurie of a Group 2 radionuclide, or more than 0.1 millicuries of a Group 3 radionuclide, or more than 0.01 millicuries of a Group 4 radionuclide is spilled.

1) Clear the Area. Notify all persons not involved in the spill to vacate the room.
2) Prevent the Spread. Cover the spill with absorbent pads or diatomaceous earth, but do not attempt to clean it up. Confine the movement of all personnel potentially contaminated to prevent the spread.
3) Shield the Source. If necessary, the spill should be shielded, but only if it can

be done without further contamination or without significantly increasing your radiation exposure.

4) Close the Room. Leave the room and lock the door(s) to prevent entry.

5) Notify the Radiation Safety Office immediately 216-276-4324.

Group 1 ALI>10mCi	Group 2 1 mCi < ALI <10 mCi	Group 3 0.1 mCi <ALI< 1 mCi	Group 4 0.01 mCi< ALI< 0.1 mCi
H-3 Cr-51	C-14 S-35 Ca-45	P-32	I-125 I-131

c. Minor Spills (Less than Major Spill Quantities)

1) Notify persons in the area that a spill has occurred.

2) Prevent the spread by stopping persons from tracking through the area. Mitigate movement caused by air currents (hoods, fans, etc.), dripping water, dusting, mopping, or other physical actions. Cover the spill with absorbent paper or pads or spread absorbent diatomaceous earth.

3) Make a decontamination plan. A prudent action is to safeguard the area while making a thorough plan of the steps to be taken in the decontamination procedure. Protective clothing, footwear, gloves, and respirators should be used as needed. The use of remote handling tongs should also be considered whenever possible. Begin decontamination by removing absorbent cover materials. Carefully fold the absorbent paper or pads and scoop up any absorbent diatomaceous earth with cardboard. Always decontaminate the spill by working from the outside toward the center. Avoid using cleaning solutions during the first part of clean-up and only use them later if it can be assured that these cleaners will neither volatilize nor “fix” the radioactive material.

4) Make full use of appropriate instruments and available assistance. Each step of the decontamination should be monitored. One person should be kept clean to operate instruments and do other monitoring. If instruments become contaminated, any progress is compromised. Be sure to check the area around the spill, hands, and clothing for contamination. For most beta and gamma emitters, survey the area with a low-range, thin-window Geiger-Muller (G-M) survey meter. For I-125, survey with a thin crystal sodium iodide (NaI) detector. Survey H-3, C-14, and S-35 spills with wipes counted in a liquid scintillation counter (LSC).

5) Insert contaminated articles and cleaning materials into a plastic bag. Also, insert into the plastic bag all other potentially contaminated materials such as disposable gloves. Dispose the plastic bag in the radioactive waste container. In some instances, it may be better to dispose of a contaminated article than to attempt to decontaminate. Keep a record of the incident and decontamination procedures.

6) Notify the Radiation Safety Office of your actions and progress 216-276-4324.

d. Maximum Contamination Levels

Additional information about radiation safety is in the CSU Radiation Safety Program. Surface contamination control guidance is located at OAC 3701:1-38 General Standards for working with radiation sources in the Ohio Administrative Code and is summarized below:

1) Alpha Emitters (300 dpm/100 cm2 Maximum, and 100 dpm/100 cm2 Average). The maximum contamination should not be on an area more than 100 cm2 and measurement of the average contaminant should not be averaged over more than one square meter. Higher limits may be acceptable for certain alpha emitting radionuclides. Contact the Radiation Safety Office to make this determination.

2) Beta-Gamma Emitters (15,000 dpm/100 cm2 Maximum, and 5000 dpm/100 cm2 Average). The maximum contamination should not be on an area more than 100 cm2 and measurement of the average contaminant should not be averaged over more than one square meter.

3) Removable Contamination. Surfaces should be cleaned until removable contamination is negligible and cannot be distinguished from background radiation levels. If this is not possible, contact the Radiation Safety Office for assistance in determining removable contamination levels.

5. Gas Leaks and Other Odors

a. Natural Gas Leaks

1) Natural gas leaks are a potential cause of explosions. Natural gas contains an odorant that enables recognition even at low concentrations. If you smell natural gas in the laboratory, do the following:

- Turn off all sources of ignition (open flames, electrical equipment.)
- Check laboratory gas outlets for open valves.
- Call Facilities Services (216-687-2500) to have the location of the gas leak identified.

2) For strong, widespread and/or quickly worsening odor:

- Pull the emergency alarm at a pull station.
- Turn off all sources of ignition (open flames, electrical equipment).
- Close the emergency gas valve for your floor or area if one exists.
- Evacuate the building immediately and go to your Designated Meeting Area.
- If your Designated Meeting Area area is downwind of the building, move to an alternate area up wind at least 300 feet from the building.
- Do not return to an evacuated building unless told to do so by the on-scene authority (fire department, police department or other personnel).
- Submit an accident report.

b. Leaking Gas Cylinders

Do not over-tighten the valve to stop the leak. If the valve continues to leak, consider whether room evacuation and building evacuation is necessary. Take the following actions as appropriate:

1) Flammable, oxidizing, or inert gases – Wear PPE as necessary. If possible, allow the cylinder to exhaust into a well-ventilated area (such as a fume hood) with few or no combustible absorbent materials in the vicinity (such as

cardboard). Post a sign warning of the leaking cylinder. Avoid sparks and open flames.

2) Toxic or corrosive gases – Wear PPE as necessary. Exhaust cylinder into an absorbent or neutralizer if possible. If no absorbent or neutralizing system is available, exhaust the cylinder into an operating fume hood. If escaping gas is leaking out of the control device or no control device is available, evacuate the area. Post a sign warning of the leaking cylinder.

c. Unknown Odors

Check with co-workers to determine if they are doing something to produce an odor. If not, check adjacent labs to determine if the odor is widespread or if the source is obvious. Try to relate the odor to possible causes – such as whether it smells like a sewer, rotting food, over-heating electronics, or a distinct chemical. If the source is obvious, take action if possible to eliminate the cause or control the odor, such as taking a chemical reaction off the benchtop and putting it into a working fume hood.

If the odor isn't immediately found but appears to be appreciably stronger in one location, there is likely a source nearby, which can be a dried sink drain or floor drain (if a sewer- like or chemical-like odor), a chemical process gone wrong (if a rotting or unknown chemical odor), over-heating electronics (if devices are over-heating), or a chemical spill or a leaking process (if a distinct chemical). There are an unlimited number of potential sources, but familiarity with the lab's activities should help narrow the possibilities.

6. Utility Outage

The safety of you and those around you is the first consideration during a utility outage. Remain calm. Assess the situation; if conditions seem dangerous, evacuate the area while assisting others to evacuate. Do not re-enter the building until competent authority has determined it is safe to do so.

If the situation does not seem dangerous, notify your supervisor or the building coordinator of the failure, shut off work in progress that could cause hazards, close containers and fume hood/biosafety cabinet sashes, and return hazardous material containers to their proper storage locations. Some utility failures may have insignificant impact on your operations, and you can safely continue work as determined by you and your department/supervisor. Note: emergency lighting systems are meant to provide light for exiting, not routine work.

If the failure appears likely to last for a long period, follow your health and safety plan and directions of your department/supervisor. Keep refrigerator and freezer doors closed for as long as possible and implement backup procedures as necessary, such as obtaining dry ice to keep specimen refrigerators cold. When systems return to normal operation, immediately assess the work area (even on weekends if that is when service is restored) for any hazards that may be present, such as electric devices (heaters, ovens, centrifuges, etc.) left on when the outage occurred.

a. Electrical Failure Procedures

1) Assess the extent of the outage in your area.

2) On campus, report the outage to Facilities Services (216-687-2500).

3) Help co-workers in darkened work areas move to safe locations.

4) Implement pre-planned response actions, as necessary. Do not treat the outage as "business as usual."

5) If practical, secure current experimental work, then move it to a safe location.

6) Close any open containers of hazardous materials.

7) Close sashes on fume hoods and biological safety cabinets.

8) If you move chemicals on carts between floors, get assistance. Hazardous spills are a significant risk during transport.

9) Keep lab refrigerators or freezers closed throughout the outage.

10) Unplug personal computers, non-essential electrical equipment, and appliances.

11) Open windows for additional light and ventilation (during mild weather).

12) If you are asked to evacuate your building, secure any hazardous materials work and leave the building.

13) To obtain information about a prolonged outage, listen to service announcements in the local media or call the service provider.

14) Release personnel during an extended outage if directed to do so by the department director.

15) When power is restored, immediately assess the affected area for potentially hazardous situations, such as devices left "on." This is also required if power is restored at a time that the facility would be normally unoccupied.

b. HVAC/Fume Hood Failure Procedures

1) Notify other occupants of the situation.
2) If necessary (*e.g.*, because smoke is coming into the room), evacuate area and pull fire alarm if the situation is widespread.
3) Notify your supervisor or building coordinator of the situation.
4) Shut down work in progress if safe to do so:
   - Shut off equipment and supplied gases and liquids
   - Close open containers
   - Close sashes on fume hoods, biological safety cabinets
   - Note the step in your process when work was stopped
   - Return specimens to freezer, storage containers, *etc*.
5) Open windows if staff are to remain in the workplace.
6) If staff remain in the workplace, periodically check on their wellbeing and evacuate if anyone is adversely affected.
7) Prior to re-starting work in the area, review work to identify possible hazards.
8) If the outage caused damage, submit an accident report.

7. Laboratory Floods

If your laboratory is flooded, notify Facilities Services immediately (216-687-2500). If you

discover the source of the leak, shut the water off. If safe, also shut down any equipment that could cause a dangerous electrical situation during a flood. Cover equipment and desks if water is dripping onto them. Then, get help quickly. During work hours, contact your building coordinator. After hours, call CSU Police at 216-687-2020.

If the water is contaminated by chemicals, call EHS at 216-687-2500.

8. Inclement Weather

During thunderstorms, shut off electrical equipment that may be sensitive to voltage fluctuations. For other anticipated weather conditions, which may affect your lab's operations, take response actions as indicated in your pre-emergency plans.

Minimize your driving and your lab staff's driving during heavy snow, ice storms, and extreme icing conditions. Listen to the radio or local news station or the Office of Emergency Management web page for instructions pertaining to University operations and use email and telephones to maintain contact with your department and laboratory staff.

9. Intruders, Suspicious Packages and Demonstrators

Contact CSU Police immediately to report a suspicious intruder or if there is something missing. If a person is acting in a way that indicates he or she may become violent, follow protocols for handling potentially violent situations as set up by the University and department (such as contacting police, using code words, and maintaining an exit pathway if possible).

If you find a suspicious package, do not handle it. If you suspect that a package could be explosive, evacuate the area and call 911 from a safe location. If you see wiring, or hear noise coming from the package, the weight of the package is odd for its size, there is liquid or powder leaking from the package, a chemical odor is present, there are odd stains on the package, or there is excessive packaging, this should alert you that it could be explosive.

If you find a suspicious letter or package, do not handle it. Evacuate the area and call 911. For more information, see the US Postal Service Poster on Suspicious Packages online at: http://about.usps.com/posters/pos84.pdf

In case of a demonstration adjacent to your laboratory, do not provoke, obstruct, or get into a verbal altercation with the demonstrators. If necessary, simply move on. Demonstrators are prohibited from blocking free entry to, and exit from, buildings and free movement in public spaces, and disrupting or causing obstacles to regular University activities.

When you leave your office or lab, be sure the door is closed and locked, even if you are just going across the hall "for a minute." Do not leave items unattended.

If you see anything suspicious, criminal in nature, or if a disturbance seems threatening, immediately report it to the police, alert other personnel in the area of the situation, lock doors and windows, and evacuate if necessary.

10. Emergencies During Field Operations

Do the best you can to stabilize injuries. Call for aid. After the emergency response, submit an accident report to HR even if you are outside the United States.

Section 10 - Chemical Hygiene Plan Responsibilities

Contents

A. MOVING IN: OCCUPYING A NEW OR REMODELED LABORATORY

Occupants moving into new or remodeled laboratory space must comply with many health and safety regulations designed to keep workers and students safe.

1. Before the Move

a. Clearing of Laboratory by Previous Occupants

If possible, visit your space in advance to ensure that it has been completely decontaminated and cleared for reuse. If you believe that the space is still contaminated or has not been properly cleared out, contact EHS immediately for assistance in locating the department and researcher previously occupying the room.

b. Laboratory Design

If you are modifying an existing laboratory or constructing a new one, refer to the CSU Office of the University Architects (OUA) for their Architectural and Engineering guidelines here: https://www.csuohio.edu/architect/architect-engineer-info. For more information, contact OUA directly at 216-687-2500.

Facilities Services must be used for certain physical work involved with the installation of equipment. This may include but is not limited to bolting items to walls or floors and electrical and plumbing work.

Ensure that any physical modifications are complete before you begin to handle hazardous materials. This includes electrical work, plumbing, air balancing in the building, and other considerations. Also ensure that any fume hoods and biosafety cabinets have been certified by EHS.

If your laboratory does not meet your needs, consider obtaining access to another laboratory's equipment or space. For example, you may want to share a fume hood with another group.

c. Ordering Specialized Equipment

Order specialized equipment such as flammable liquid storage cabinets, acid and base storage cabinets, flammable material or explosion proof refrigerators, fume hoods and biosafety cabinets in advance. Many of these items require approval; see Section 4, Equipment and Facilities. New fume hoods and biosafety cabinets must be tested and certified before use.

d. Transporting and Storing Hazardous Materials

Plan about how and where you will transport and store your materials and equipment so that you can pack and unpack most efficiently. You must not block hallways, doorways, or emergency equipment while packing or unpacking. Special arrangements must be made with a hazardous materials mover for chemicals, gases, and other hazardous materials. Call EHS at 216-687-2500 for assistance with moving arrangements for hazardous or radioactive materials.

2. After the Move

Once you have moved in, consider using the Lab Self-inspection Checklist which can be found here: https://www.csuohio.edu/ehs/research-safety

B. MOVING OUT: VACATING A LABORATORY

Whether a laboratory is being completely or partially vacated, you must leave your portion of the laboratory in a clean and safe condition for the new occupants or construction crews. Prior to vacating the laboratory, you must remove all chemical, biological, radiological, and any other hazardous materials and you must decontaminate all work surfaces. You must also remove all equipment (unless other arrangements have been made) and any garbage or other items that will not be wanted by the new occupants. EHS is available to assist with the clearance of your laboratory. It is helpful to contact EHS at least 90 days prior to your move.

Thorough planning of a laboratory move is essential. EHS recommends that each laboratory or department develop a checklist of all the tasks needed and which people are responsible.

The responsibilities of the Principal Investigator, Department, Project Manager (if applicable), and EHS are listed below.

1. Responsibilities

a. Principal Investigator

The Principal Investigator is responsible for managing the safe removal of hazardous materials and decontamination of the laboratory and equipment when leaving, moving, or closing a laboratory. The PI is required to remove the hazards associated with their work and to provide information about potential hazards remaining in the space. The PI is responsible for ensuring the removal of all chemical, biological, and radioactive materials and their residues from the labs in which their work was conducted. The PI may delegate tasks to lab staff and colleagues appropriate to their level of training, knowledge, and ability to address them; however, in all cases, it remains the PI's responsibility to ensure the tasks are completed satisfactorily according to the guidelines and specified protocols.

b. Project Manager

The Project Manager is responsible for ensuring that all steps of a construction or remodeling project are completed. For department-managed projects, this person may be a department employee, and for Facilities Services projects, this person may be a Facilities Services employee. Either entity may contract for project management services; if they do, then it is the contracted individual who assumes responsibility for assuring project tasks are completed according to plan and schedule.

c. Department/College

The Department is responsible for ensuring that Principal Investigators and designated Project Managers manage laboratory closures or moves responsibly. In the event a PI is no longer available to fulfill their duties, then the Department must ensure the completion of tasks ordinarily assigned to the PI. If hazardous materials are not responsibly managed and require removal by EHS or by an outside contractor, the Department or College will be responsible for incurred costs. Any regulatory action or fines resulting from improper management or disposal of chemical waste will be the responsibility of the Department.

Departments also retain records about chemical exposure and other chemical safety issues. Records retention is discussed in Section 8 of this manual.

d. Environmental Health and Safety

EHS is available for advising a Department, PI, or Project Manager on environmental, health and safety-related aspects of laboratory deactivations and moves.

- If laboratory operations have involved radioactive materials, please refer to the Radiation Safety Program here: https://www.csuohio.edu/ehs/radiation-safety
- If laboratory operations have involved biological materials, some items may require decontamination before being removed. Please contact EHS for assistance (216-687-2500).

2. Transportation Requirements and Logistics

a. Moving Equipment and Non-Hazardous Items

You may choose to hire an outside moving company or CSU Movers to pack and/or move equipment and non-hazardous materials such as glassware, books and computers. Moving companies, CSU Property Control, and CSU Movers are not authorized to move hazardous substances (see next subsection for information about moving hazardous substances).

Moving companies are also not authorized to remove materials and equipment that are attached to the building (*e.g.* removing a laboratory bench from a wall) or would impact the building materials (*e.g.* removing a cork board that is glued to the wall). Facilities Services or a contractor managed through Office of University Architects must be hired for tasks involving removal of materials and equipment attached to the walls and floors and electrical and plumbing work.

Lab equipment may need to be decontaminated before it is moved. Information on decontamination is in Section 4.G and 4.H of this manual. The CSU Decontamination Procedures can be found here: https://www.csuohio.edu/ehs/laboratory-safety-0.

b. Moving Hazardous Materials

Investigators have the options of moving their hazardous chemicals themselves with the guidance of EHS or hiring a hazardous materials contractor. The contractor will not move any hazardous wastes.

If you choose to move your chemicals yourself, you can use a cart if transporting them on campus. If you use a cart, refer to the requirements (*e.g.* spill kits, spill training, PPE) under Transporting Chemicals in Section 2.F of this manual.

Chemicals are not authorized to be transported off campus. Contact EHS for assistance 216-687-2500.

c. Moving Radioactive Materials

For short moves of radioactive materials between locations on campus, an investigator may choose to “hand carry” these materials to a new location. Radioactive materials transported in this manner shall be in a closed container and contain diatomaceous earth or similar absorbent in order to mitigate any possible spill.

For any move of radioactive materials over public roads or long enough distances to require the use of a vehicle, contact EHS to complete the move 216-687-2500. Radioactive materials must never be transported by laboratory personnel in either

private vehicles or university vehicles. All vehicular transport of radioactive materials must be performed by contracted service providers.

d. Document and Enforce Appropriate Safety Practices

When transporting biological materials, follow the instructions in the Infectious waste Contingency Plan, located here: https://www.csuohio.edu/ehs/environmental-compliance-0.

e. Moving Freezers

A moving company or service provider cannot move any freezers containing materials that would be considered infectious, including viral stocks, human or primate diagnostic specimens, liquid nitrogen freezers, or Dewar flasks. Special arrangements must be made with EHS to move freezers and Dewar's containing infectious items. Specialized moving companies can move freezers and Dewar's that do not contain infectious materials.