

**Carnegie Mellon University Policy and Procedures on
Occupational Exposure to
Hazardous Chemicals in Laboratories
29 CFR 1910.1450**

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This plan is available at <http://www.cmu.edu/ehs/chemical/forms.html>

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Introduction: Purpose and Policy

Purpose

This is a statement of official University policy to establish the process for compliance with the Occupational Safety and Health Administration (OSHA) regulation “Occupational Exposure to Hazardous Chemicals in Laboratories.” The purpose of the process is to protect employees from the health hazards of the hazardous chemicals in their laboratories and to keep chemical exposures below the OSHA Permissible Exposure Limit (PEL).

Policy

Carnegie Mellon University is dedicated to providing safe and healthy laboratory facilities for students and employees, and to complying with federal and state occupational health and safety standards. Laboratory administrators, managers, faculty, staff and students all share responsibility for minimizing their exposures to hazardous chemical substances. Lab workers must not be exposed to substances in excess of the permissible exposure limits (PEL) specified in OSHA rule 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances.

The standard applies where “laboratory use” of hazardous chemicals occurs. OSHA defines laboratory use as handling or use of chemicals on a “laboratory scale”. “Laboratory Scale” is when the work involves containers which can easily and safely be manipulated by one person, when multiple chemical procedures or chemical substances are used, and when protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposures to hazardous chemicals.

The Chemical Hygiene Plan (CHP) shall be reviewed and evaluated at least annually for its effectiveness, and updated as necessary. It shall be made available to all applicable employees and employee representatives.

The CHP is currently located at <http://www.cmu.edu/ehs/chemical/forms.html>

Carnegie Mellon’s Chemical Hygiene Plan (CHP) includes: 1) periodic monitoring of the performance of ventilation systems, 2) periodic safety inspections of laboratories, 3) procedures that ensure that disposal of waste chemicals occurs at regular intervals, and 4) training opportunities for all laboratory workers. Implementation of these CHP procedures is a regular, continuing effort, endorsed by administration and faculty. All Carnegie Mellon University laboratory faculty and staff shall follow its recommendations.

Responsibilities

Organizational Chart

See University organizational charts available at:

<https://www.cmu.edu/hr/directory/forms/university-org-chart.pdf>

*Roles and
Responsibilities
Roles and
Responsibilities*

President

- The president has ultimate responsibility for chemical safety at the university and must, with other administrators, provide continuing support for the University's Chemical Hygiene Plan (CHP).

Administration

- The provost, vice provosts, and deans shall require department heads to adhere to the CHP.
- The provost shall provide administrative and financial support for lab safety issues.
- Department heads shall require laboratory managers, professors, researchers, and principal investigators to adhere to the CHP.

Environmental Health & Safety

- The Director of Environmental Health & Safety (EH&S) is responsible for the training of EH&S staff and providing appropriate facilities, suppliers, references, instruments, etc., to survey and evaluate safety systems and processes.
- The Director of EH&S shall ensure the preparation, review, and distribution of the University's Emergency Response Plan.
- EH&S shall conduct periodic inspections of fire extinguishers.
- EH&S shall conduct periodic lab safety surveys.
- EH&S shall conduct periodic inspections of exhaust hoods.
- EH&S shall serve as an advisory source and create safety policies.
- EH&S shall maintain safety training records of appropriate faculty, staff, and students.

Laboratory Safety Committee (LSC)

- Advise EH&S on safety standards and practices regarding the use of chemicals in laboratories
- Establish laboratory safety program goals and acceptable performance levels.
- Determine the additional academic, research and administrative units to be represented on the LSC and recommend appropriate persons for appointment as these additional representatives.
- Perform annual assessments of the Chemical Hygiene Plan to ensure that it contains current and appropriate procedures, objectives and requirements.
- Determine where changes in university policies, guidelines and resources are needed to ensure the Chemical Hygiene Plan is implemented effectively.
- Aid in the resolution of issues involving application of safety rules/practices or engineering controls in Carnegie Mellon laboratories.
- Assist EH&S in the arranging of training of appropriate faculty, staff and students within their department.
- Relay information between the LSC and the departments represented.

Facilities Management Services

- The Director of Facility Management Services shall make repair and maintenance of installed laboratory safety equipment a high priority.
- The Director of Facility Management Services is responsible for the prioritization and the performance of maintenance and repair of installed laboratory safety devices, for the training of service personnel, and for providing them with the necessary tools for installed safety system maintenance. He or she further ensures that laboratory safety systems are maintained in a serviceable condition, according to specifications from EH&S. Fire extinguishers are maintained under the management of the EH&S Fire Safety Specialist.
- Work orders to repair or renovate laboratory facilities may be initiated by principal investigators, laboratory instructors, or by FMS or EH&S personnel.

Chemical Hygiene Officer (CHO)

- Work with administrators, staff, and students to develop and implement chemical hygiene policies and practices.

Roles and Responsibilities

- Prepare the CHP with annual review and revisions as needed.
- Make the CHP available via electronic means or, upon request, by hard copy.
- Provide technical assistance and consultation on laboratory safety issues.
- Provide for the disposal of hazardous waste.
- Assist Campus Design and Facility Development (CDFD) to incorporate safety in new construction and renovations.
- Remain current on regulatory issues.
- Direct periodic laboratory safety audits to determine regulatory compliance, and recommend corrective action.
- Provide training to laboratory workers concerning the provisions of the Chemical Hygiene Plan and hazardous waste disposal.
- Provide hazard awareness training to ancillary workers.
- Conduct exposure assessments as needed upon request or if an employee shows signs or symptoms associated with hazardous chemical exposure.
- Investigate reported workplace injuries of chemical exposures and incidents.
- Meet with LSC to form policies and plans, and update the LSC concerning changes to governmental safety regulations.

Laboratory Managers /Principal Investigators (LM/PI)

- Implement all provisions of the Chemical Hygiene Plan for laboratory facilities under their control.
- Keep updated lists of the employees working in their laboratories in the University's BioRAFT system. Laboratory inspectors will confirm current lab worker lists during inspections, to confirm all applicable personnel are trained.
- Ensure that appropriate personal protective equipment is available and that it provides adequate protection.
- Notify Environmental Health & Safety (EH&S) when the need to use respirators occurs.
- Ensure that facilities, equipment, and materials are adequate for intended use; e.g., corrosive chemicals are near a continuous-flow eyewash and emergency safety shower.
- Ensure preparation, maintenance and implementation of written standard operating procedures (SOP) regarding safety and health considerations for each hazardous procedure.
- Require laboratory workers to obtain specific permission for deviation(s) from an SOP.
- Complete laboratory safety training and ensure that laboratory workers have received basic lab safety training from EH&S.
- Train laboratory workers regarding the specific work practices, and procedures according to the provisions of their laboratory's SOPs.
- Maintain a hazardous chemical inventory in the University's ChemTracker program, specify those chemicals that are particularly hazardous substances (PHS), and maintain a hard copy of the corresponding Material Safety Data Sheet/Safety Data Sheets (MSDS/SDS) of PHSs in laboratory facilities under their control. Ensure the review of the inventory periodically.
- Ensure the performance of inspections for housekeeping and safety.
- Ensure that employees are familiar with electronic MSDS/SDS searches. Maintain hard copies of MSDS/SDS for PHSs and those chemicals not available electronically.
- Report to the Chemical Hygiene Officer (CHO) all workplace injuries, chemical exposures, incidents, or unsafe conditions.

Individual Researchers and Laboratory Users

- Complete Carnegie Mellon's hazard communication, laboratory safety, and hazardous waste training.
- Follow Standard Operating Procedures (SOP) and the requirements of the Chemical Hygiene Plan.
- Report all workplace injuries, chemical exposures, incidents, or unsafe conditions to their LM/PI as soon as possible.

- Assist with the maintenance of the inventory of all hazardous chemical substances, and identification of PHS on the inventory. Maintain PHS MSDS/SDSs for their laboratory.
- Contact LM/PI and/or the CHO when safety questions arise.
- Work with LM/PI to evaluate existing SOPs and develop new SOPs as needed. Review new procedures with LM/PI.

Employee Information and Training

Training

The purpose of Laboratory Safety training is to provide employees with information about the physical and health hazards of the hazardous chemicals in their work area and of the methods and procedures employees should follow to protect themselves from these materials. It is a requirement of OSHA that all laboratory personnel who work with hazardous chemicals have this training. The training occurs at two levels:

- General chemical safety training is provided by the Department of Environmental Health and Safety. The employee should receive this training within the first thirty days of a laboratory assignment.
- Laboratory-specific training is to be provided by the laboratory Principal Investigator or his or her designee. This training should be performed and documented before the employee is permitted to work unsupervised in the laboratory.

Refresher training in laboratory safety is to be performed every three years, through either re-attendance at the general EH&S initial training class or through the EH&S refresher training via BioRAFT, the university's training and inspection tool. Reading the monthly CHO Newsletter is highly recommended to ensure lab workers stay current with any compliance or safety law changes between three year periods.

[Note that any personnel involved with the generation of hazardous waste must also attend Hazardous Waste Generator training, also offered by EH&S concurrently with the Lab Safety Class.]

1. General Chemical Safety Training

EH&S will provide training, Laboratory Safety and Hazardous Waste, to laboratory workers (e.g., faculty, principal investigators, supervisors, researchers, etc.) within 30 days of their initial assignment to the laboratory work area. Ensuring that each worker obtains the training will be the responsibility of department and laboratory supervisors.

The training will include the following topics:

- This Chemical Hygiene Plan and its content.
- The contents of the OSHA standard (29CFR1910.1450) http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106 and its appendices.
- The availability of the Chemical Hygiene Plan.
- Location of reference material on the hazards (including Material Safety Data Sheet/Safety Data Sheets), safe handling, storage, and disposal of hazardous chemicals found in the laboratory.
- Methods and observations that may be used to detect the presence or release of hazardous chemicals.
- Protective measures an employee or student can take to prevent or reduce exposure to a hazardous chemical.
- Emergency response procedures.

Training documentation, including attendees, dates and subjects addressed, shall be maintained by EH&S.

The Chemistry Department offers two courses which satisfy the requirements of the Laboratory Safety and Hazardous Waste training. They are 09-221, Laboratory I: Introduction to Chemical Analysis, and 09-202, Undergraduate Seminar II.

2. Laboratory Specific Training

Laboratory supervisors will ensure that training is provided to laboratory personnel for the procedures/experiments they are performing. This training should be provided before laboratory work begins for the employee. It should include specifics of the hazardous materials to be used and the specific safe work practices for each.

3. Stockroom/Storeroom Training

Training for stockroom/storeroom personnel shall be addressed under the Carnegie Mellon University Hazard Communication Program.

Information

Material Safety Data Sheet/Safety Data Sheets (MSDS/SDS)

Material Safety Data Sheet/Safety Data Sheets (MSDS/SDSs) are critical elements to a chemical safety program. All laboratory employees should be able to read and understand the relevant MSDS/SDS and also know where they can be obtained. The program **MSDSonline** is available from the EH&S web page and is accessible by all Carnegie Mellon staff, faculty and students. This program provides easy access to millions of MSDS/SDS. Search engines may also be helpful in finding MSDS/SDS by searching for the chemical name and the phrase MSDS/SDS. For MSDS/SDSs not available at the following link, or by internet search, employees should contact EH&S.

<http://www.cmu.edu/ehs/MSDS/SDS/index.html>

A current MSDS/SDS for each chemical must be available for review in the work/storage area. This may be through the use of a paper copy or as accessible from the internet. Instructions for accessing items from the webpage are provided in the EH&S webpage instructions.

In 2012, due to changes in the OSHA Hazard Communication Standard, Material Safety Data Sheets are now referred to as Safety Data Sheets (SDS.) These MSDS/SDS may have a different format. There is guidance on the EH&S web page that outlines these changes. See: <http://www.cmu.edu/ehs/fact-sheets/index.html>.

General Information

Assistance will be provided by EH&S to any department, PI or employee requesting guidance or training to satisfy implementation of this policy.

Control Measures

Engineering Controls

The best way to prevent exposure to airborne hazards is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices. Operations such as running reactions, heating or evaporating solvents, and transfer of chemicals from one container to another should be performed in a hood when there is reasonable potential for hazardous material exposure.

1. General Laboratory Ventilation

General ventilation must not be relied on to control chemical vapors, gases, and mists

2. Fume Hoods

Use the fume hood for operations that might result in release of hazardous chemical vapors, gases, mists, or dusts.

Confirm adequate hood performance before use; typically, it is best to maintain the hood sash at a working height of approximately 18 inches; keep materials stored in hoods to a minimum and do not allow them to block air flow.

In the event of ventilation hood failure, stop all experiments within the hood (if possible), lower the sash completely, notify EH&S. If there is a possibility of the release of a significant health hazard, the building should be evacuated.

Laboratory hoods shall be provided according to the following specifications:

- Where applicable, the hood shall have a working sash.
- When the hood sash is open approximately eighteen inches, an average face velocity of 80-150 fpm at the hood face shall be provided.
- The hood enclosure should be fire- and chemical-resistant.
- In new construction, consideration shall be given to locating the hood such that ambient air currents do not unacceptably reduce the containment efficiency of the hood.
- In new construction the hood shall be designed to produce laminar airflow.
- The hood shall have only modifications approved by EH&S. Any modification must not detract from the hood performance.
- In new construction, the room in which the hood is located shall have a source of sufficient make-up air to replace the air that is exhausted out.
- All fume hoods shall have a monitoring device to measure airflow.
- It is recommended that the utility controls be outside of the hood.
- The fume hood should be appropriate for the material used within (i.e., perchloric acid usage.)
- Airflow shall be such that contaminants within do not escape the fume hood, as shown by a smoke tube test.

Face velocity and airflow monitors will be evaluated by EH&S upon installation of laboratory hoods. Each laboratory hood at Carnegie Mellon University is re-checked periodically for usage and performance. Where performance parameters fall outside specifications, work orders are initiated to repair the hoods. When appropriate, a notice is placed on the hood indicating that it is not to be used until its performance is within the specified performance parameters.

Non-venting hoods (e.g., laminar flow hoods with in-room venting) shall be clearly labeled as such. No work with volatile hazardous chemicals shall be performed in hoods that do not vent outdoors.

Laboratory hoods are not to be modified without the involvement of the Chemical Hygiene Officer. Changes in airflow quantity and airflow patterns can significantly affect laboratory exposure potential, and the Chemical Hygiene Officer will ensure that modifications will not degrade the safety of the laboratory environment. Prior to putting modified hoods into service, airflow testing will be conducted by EH&S specialists to ensure that airflow specifications have been met.

3. Other Local Ventilation Devices

Exhaust air from glove boxes and isolation rooms should release into the hood exhaust system.

4. Special Ventilation Areas

Procedures involving radioactive aerosols, powders or gaseous products, or procedures that could produce volatile radioactive effluents shall be conducted in an approved hood, glove box or other suitable closed system. Such fume hoods shall be designed with smooth, non-porous materials and possess adequate lighting to facilitate work within. The hoods shall have a minimum face velocity of 100 ft/min. Contact the Radiation Safety Office for further information on hoods for radioactive materials.

Personal Protective Equipment

Each laboratory should have access to protective apparel and equipment appropriate for the hazards present. Appropriate protective apparel and equipment should be determined by the laboratory PI or lab supervisor, in consultation with EH&S. The PI or Lab Supervisor must assure that all persons, including visitors, wear appropriate eye protection where chemicals or hazardous materials are stored or used.

1. Respiratory Protection

Engineering controls should maintain all contaminant levels below the PEL or other applicable standard. When efficient engineering controls are not possible, suitable respiratory protection should be provided. Respirator use **must** be approved by EH&S and **must** follow the Carnegie Mellon Respiratory Protection Program. Refer to the Carnegie Mellon University Respiratory Protection Program for further details: <http://www.cmu.edu/ehs/chemical/forms.html>

2. Protective Clothing

Protective clothing such as chemically-resistant gloves, lab coats, aprons, or suits should be used when working with hazardous materials. Wear a lab coat or an apron specific for the hazards of the procedures performed in the laboratory. This includes, but is not limited to, using flame resistant clothing for use with pyrophorics, acid resistant protection when working with acids (especially HF), and protective items when working with hot or cold materials. The Principal Investigator or Laboratory Instructor is responsible for determining the protective clothing needed. The Chemical Hygiene Officer may be consulted as a resource for clothing selection.

Protective clothing should be inspected prior to each use. Laboratory coats should be laundered as needed. Care should be taken to avoid producing further contamination when having the lab coats laundered. Consult the EH&S web page for further details on lab coat laundering options.

Wear appropriate gloves when the potential for contact with hazardous materials exists. Disposable gloves should not be reused and should NOT be washed or rinsed before disposal. Reusable gloves should be washed or cleaned before removal to prevent contamination. Always inspect all gloves before each use. Gloves should not be worn outside of the laboratory.

3. Eye Protection

Eye protection is mandatory for all entries into a work area within a laboratory where hazardous chemicals are used. The Principal Investigator or Laboratory Instructor will determine the level of eye protection required. All eye protection used should meet the ANSI Z87.1 requirement. For additional information about selecting proper eye protection please contact EH&S.

Standard

Standard Operating Procedures prepared by the laboratory should be made available to all applicable

**Operating
Procedures**

laboratory personnel and to EH&S and/or auditors.

**Administrative
Controls**

Chemical Inventory

All locations where chemicals are stored and/or used must have an accurate inventory of the chemicals, maintained currently in the University's designated program, *ChemTracker*.

Housekeeping, Maintenance, and Inspections

Inspections

EH&S performs laboratory safety inspections annually to ensure that adequate safety equipment is available and functioning, personal protection is available, chemicals are properly used and stored, MSDS/SDSs are readily accessible, and good housekeeping is being practiced. Inspections may be performed more frequently as deemed necessary by EH&S. Follow-up inspections will be performed as necessary, to confirm completion of corrective actions. The results of these inspections can be viewed online by the Principal Investigator as well as the Co-investigators or Compliance Liaison(s) for the lab. Access is through the EH&S system, BioRAFT, accessible from the main EH&S web page. The web address for access is:

<https://www.cmu.edu/ehs/BioRAFT/index.html>

Internal housekeeping and chemical hygiene inspections are recommended and should be conducted by the principal investigator, laboratory instructor, or appointed representative at least quarterly. Internal inspections can be conducted using the "Self-Inspections" function in BioRAFT. Please refer to the link above.

Repair

Facilities Management Services (FMS) Service Response should be contacted if safety equipment is malfunctioning. Malfunctioning fume hoods should be marked "Do Not Use" if they are to be repaired. If the fume hood is not to be repaired, it should be labeled "Out of Service". To re-start an "Out of Service" fume hood, contact EH&S. Malfunctioning eyewashes and safety showers should be marked "Do Not Use".

Maintenance

Laboratory personnel should inspect eyewashes frequently, by operating them until the water runs clear, and to ensure both outlets have sufficient and even supply. FMS coordinates periodic testing of safety showers.

Personal housekeeping

Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation and at the end of each day. Stairways and halls should not be used for storage. Access to exits, emergency equipment, and utility controls must never be blocked.

**Administrative
Controls**

Usage of laboratories

Work conducted in Carnegie Mellon laboratories is for research or instructional purposes. Work is laboratory scale in nature, and activities are conducted within the physical limitations of the laboratory facilities and safety equipment, especially local exhaust systems. EH&S shall be informed

by the Lab Manager or Principal Investigator should chemical usage fall outside of typical laboratory scale operations.

Working alone

If possible, avoid working alone in a laboratory. A working definition of “working alone” is only one person in a lab or contiguous space who is working with hazardous materials, hazardous procedures or hazardous equipment. If necessary, working alone in a laboratory requires the Principal Investigator to complete, sign, and submit to the EH&S office a Permission to Work Alone form, which is available here: <https://www.cmu.edu/ehs/Laboratory-Safety/chemical-safety/document-list.html>. When filling out the form, careful consideration should be given to the hazards and potential hazards of the materials present in the laboratory and of the work being performed. Advance planning should be made in these cases to address emergency response procedures and including consideration of when to inform outside parties of the employee’s work plan and schedule. The work alone form offers suggestions to assist in this advance planning. All Permission to Work Alone forms should be submitted to EH&S and will be uploaded into BioRAFT.

Special Medical Conditions

Lab workers should contact their supervisor, PI and/or EH&S if they have any of the following:

- A medical condition that may be affected by their laboratory work
- A medical condition that may affect the laboratory’s general safety environment or ability to participate in and obey the university’s emergency response plans.

Other University Safety Programs

Laboratory personnel who work with biological agents and radiation sources or radiation producing devices, are subject to the requirements of the University’s Biological Safety and Radiation Safety Programs, respectively. Further information on each is available at www.cmu.edu/ehs

Chemical Usage Procedures

Minimizing Chemical Exposures

It is prudent to minimize all chemical exposures by any route, and to observe good laboratory practice by using an exhaust hood, wearing eye and hand protection, and a laboratory coat or apron. The cardinal rule for safety in working with hazardous substances is that all work with these materials in a laboratory should be performed in such a way that they do not enter the body by any mode, including inhalation, injection, absorption or ingestion. Quantities of vapors or dust should be prevented from entering the general laboratory atmosphere. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals have been adopted in addition to specific guidelines. These general hazards for handling chemicals in the laboratory may be classified broadly as physical or chemical.

Physical hazards include those of fire, explosion or electric shock. Other physical hazards arise from high or low pressure, such as cylinders of compressed gases and experimental vessels, cryogenic equipment, furnaces, refrigerators and glass apparatus.

Chemical hazards are associated with their health effects and may be sub-classified as acute or chronic. Acute hazards are those capable of producing prompt effects (such as burns, inflammation, or damage to eyes, lungs, or nervous system). Some chemicals are extremely dangerous in this respect and a small amount can cause death or severe injury very quickly. Other toxicological effects of chemicals may be delayed or develop only after exposure over long periods of time and are referred to as chronic hazards. (See: "Particularly Hazardous Substances," Page 17.) Do not smell or taste chemicals. Vent apparatus that may discharge

toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust ventilation systems. Inspect gloves and test glove boxes before use. Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained re-circulated atmospheres.

***Understanding
Chemical
Hazards***

Avoid Underestimation of Risk

Under some circumstances, all chemicals can be hazardous. Even for substances of no known significant hazard, exposure should be minimized; for work with substances that present special hazards, special precautions should be taken. One should assume that any mixture would be more hazardous than its most hazardous component. Especially in the research laboratory where new preparations are constantly being developed, it is wise to maintain at least the same level of safe practice in the disposal of chemical waste and residues as in the actual preparative procedure. All substances of unknown hazard must be considered hazardous until proven otherwise.

***Routes of
Chemical Entry***

Hazardous chemicals may enter the body in a number of different ways; all should be considered in identifying protective practices:

- Through inhalation of vapors, dust or fumes,
- Through skin or eye contact or absorption,
- Through the mouth or other mucous membranes, or
- Through a cut, puncture or other opening in the skin.

***Environmental
Monitoring and
Surveillance***

All environmental monitoring and surveillance will be performed by or overseen by Environmental Health and Safety (EH&S). All concerns of overexposure should be addressed to EH&S.

Routine sampling will occur when initial monitoring results are at or above any applicable exposure limit or action level.

NIOSH or OSHA validated sampling methods, or equivalent methods, will be used to perform air sampling:

- Appropriate quality assurance will be used for all sampling and monitoring.
- Laboratory analysis shall be performed by an AIHA accredited laboratory where applicable

Non-routine Sampling is conducted for short-term operations or other reasons such as those listed below:

- A single step operation where verification of process controls is desired.
- Requests by the principal investigator, laboratory instructor, or laboratory worker.
- Laboratory accidents involving release of air contaminants.

Observe the PELs, TLVs

The permissible exposure limits (PEL) of OSHA and the threshold limit values (TLV) of the American Conference of Governmental Industrial Hygienists (ACGIH) should not be exceeded. This may be achieved by a combination of experimental design and engineering controls. In general, use of a hood is recommended when working with a volatile substance. These exposure limits may be found on a chemical's Material Safety Data Sheet/Safety Data Sheet.

Environmental Monitoring and Surveillance

- Air sampling may be performed for any chemical process where laboratory hood/filtered glove box or comparable exposure control device is not used to contain the contaminant.
- Air sampling will be performed where respiratory protection is required.
- Air sampling will be performed upon the request of the Principal Investigator, Laboratory Instructor, or laboratory worker.
- Air sampling will be performed in any situation where there is reason to believe a PEL or similar exposure standard has been exceeded.
- Air sampling specifications, including frequency and test method will be determined by the Chemical Hygiene Officer, in consultation with lab and EH&S personnel.
- Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories, but may be appropriate when testing or redesigning hoods or other ventilation devices, or when a highly toxic substance is used regularly (e.g., 3 times/week). All monitoring results shall be prominently posted and/or provided to applicable employees within 10 days of receipt.

Chemical Hazard Types

Corrosive agents

Corrosive agents shall always be handled using proper personal protective equipment appropriate for the type of material, the quantity being used and the potential exposure route. This may include gloves, lab coat or protective apron, goggles or face shields. Volatile corrosives shall be used in a fume hood when there is any potential for inhalation exposure. Be aware that many corrosive materials (i.e., hydrofluoric acid, phenol) exhibit additional hazards that must be addressed when they are used in the laboratory.

Handling flammable materials

Do not use an open flame to heat a flammable liquid or to carry out a distillation under reduced pressure.

Use an open flame only when necessary, and extinguish it when it is no longer needed.

Before lighting a flame, remove all flammable materials from the immediate area. Check all containers of flammable materials in the area to ensure that they are tightly closed.

Store flammable materials properly.

When volatile flammable materials may be present, use only non-sparking electrical equipment.

Performing activities with explosion potential

Safety shielding shall be used for any operation having the potential for explosion:

- When a reaction is attempted for the first time, small quantities of reactants should be used to minimize hazards.
- When a familiar reaction is carried out on a larger than usual scale (i.e., 5-10 times more material).
- When operations are carried out under non-ambient conditions.

Shields must be placed so that all personal in the area are protected from hazard. Also, be sure to inspect equipment and pressure/vacuum connections prior to starting the procedure.

Fire and explosion hazards.

In the event of a small-scale fire (sized less than a square foot) the room fire extinguisher can be used to extinguish the fire, provided the extinguisher is appropriate for the type of fire. For fires that are larger or of a material inappropriate for the extinguisher, contact Security at 412-268-2323. Be familiar with the location of the closest fire extinguisher and fire alarm pull stations. It is

recommended that all users of fire extinguishers should Fire Extinguisher Training available here: <https://www.cmu.edu/ehs/Training/index.html>.

All building occupants MUST evacuate when building alarms are sounded. Individuals may be fined by the City of Pittsburgh for non-compliance with evacuation requirements.

In the event of an explosion of any size or type, contact University Police at 412-268-2323

Labeling

Signs and Labels

All Carnegie Mellon University personnel who work with chemicals must be familiar with conventions used for hazard communication via signs and labels. This information is provided in EH&S Laboratory Safety training and in the handout supplied at that class. The Lab Safety and Hazardous Waste training is available on-line through BioRAFT.

Labels on incoming containers of hazardous chemicals are not to be removed or defaced until product is emptied from the container. In March of 2012, OSHA revised the Hazard Communication Standard which addresses the format of chemical container labels. Specifically, there is a new system of label requirements, designed to meet the Globally Harmonized System used throughout much of the world. Information on the new details of these changes is available from EH&S through written documents and on the web site, <http://www.cmu.edu/ehs/chemical/index.html>.

Secondary use containers (containers used for dispensing from bulk containers or containers of “made-up” chemical mixtures) should be labeled with the identity of the contents of the container, as a minimum. It is recommended that secondary use containers also be labeled with the substance name, type of hazard, name of laboratory worker who prepared the container, and date of preparation. Customized secondary-use container labels are available from EH&S.

Laboratories shall prominently post:

1. Emergency telephone numbers.
2. Location signs for safety showers, eye washes, fire extinguishers, spill response kits, and first aid equipment.
3. Warning signs at areas or equipment where special or unusual hazards exist.

(Contact EH&S for assistance in obtaining appropriate signage)

EH&S prepares and posts laboratory door safety signs outside each laboratory. Contact EH&S if the information on your door sign changes or needs to be updated.

Procurement and Storage of Chemicals

Procurement of Chemicals:

No container shall be accepted without an adequate identifying label. Delivery should be refused for leaking containers. Persons who receive hazardous chemical shipments must take DOT Hazardous Materials Receiving on-line training, accessed at this location: <https://www.cmu.edu/ehs/Training/index.html>. This training outlines further requirements for hazardous chemical receipt.

In order to minimize the presence of hazardous materials at the university, chemicals should be ordered in the smallest quantity needed to conduct the work. For situations where you are in need of a chemical material for a single test or a preliminary evaluation of an experiment, consider contacting

EH&S to see if the material is present already on campus. Another chemical owner may be willing to let you use some of his or her stock, in such limited situations. All of these transfers MUST be performed from PI to PI.

EH&S shall be contacted in advance of any acquisition of chemicals that will not be purchased but are to be transferred to the Carnegie Mellon University from another university or organization.

Note: University Procurement Services places restrictions on how hazardous chemicals may be purchased. Use of a Purchase Order is the preferred method; some materials are prohibited from purchase using a purchasing card. Check this link to view Procurement policies: <http://www.cmu.edu/finance/procurementservices/policies-procedures/index.html>

Stockrooms/Storerooms:

Hazardous substances in storage should be segregated by hazard categories, following manufacturer recommendations. Containers of Particularly Hazardous Substance (PHS) materials should be placed in secondary containers. Stored chemicals shall be examined periodically (at least annually) for replacement, deterioration, and container integrity.

Stockrooms and storerooms should not be used as preparation or repackaging areas.

Laboratory Storage:

Storage in laboratories will be performed as follows:

- Chemicals will be stored so incompatible chemicals are separated. Compatibility information is available on the chemical's Material Safety Data Sheet/Safety Data Sheet.
- A UL (Underwriters Laboratory) Functional Safety Listed flammable storage cabinet must be used to store flammables when there are more than five gallons total present in the lab.
- A corrosive storage cabinet is strongly recommended for storage of acids and bases. Corrosive materials should only be stored in cabinets approved by the manufacturer for this use.
- Acetic acid should be treated as a flammable rather than a corrosive.
- Refrigerators used for storage of flammable liquids should be either flammable or explosion proof.
- New construction should follow NFPA 45 for guidelines on flammable and combustible liquid storage.
- Chemical storage in hoods and on bench tops should be minimized.

Transport & Shipment of Chemicals

Chemical Transport

The following safety precautions should be taken for chemical transport:

- Chemicals should be transported in safety containers, or on a wheeled cart with a design capable of containing leakage or spillage and negotiating uneven surfaces (e.g. expansion joints or floor drains) without tipping the chemical container or cart.
- Chemicals should be transported on freight rather than passenger elevators where possible.
- Chemical containers should be sealed during transport.
- Cylinders should be strapped to a hand truck specifically designed for that purpose and cylinder cover caps should be in place.
- Transportation of hazardous materials on any public road, aircraft, railway or navigable waters should NEVER be performed except under the oversight of EH&S. This transportation is highly regulated and the University MUST ensure that all regulations are followed for such moves. The regulations include personal or commercial transportation by any vehicle, including cars, trucks, trains, buses, watercraft, vans or aircraft. Additionally, persons offering hazardous materials for shipment, for example by FED EX or similar carrier, MUST arrange for this shipment through EH&S. Visit the EH&S web page at <http://www.cmu.edu/ehs/chemical/shipping/index.html> to request shipment advice and guidance, or to learn more about the requirements.

Chemical Segregation

Refer to the Material Safety Data Sheet/Safety Data Sheets of each hazardous material to identify any incompatible material. Incompatible materials may NEVER be stored together. Common storage incompatibilities are as follows:

1. Flammable materials must be separated from oxidizers (this includes gases as well as liquids)
2. Acids and bases must be separated in storage

General Laboratory Rules

The following rules should be followed for all laboratory work with chemicals and hazardous materials:

- Know the safety rules and procedures that apply to the work that is being done. Determine the potential hazards and appropriate safety precautions before beginning any new operation.
- Know the location of and how to use the emergency equipment in your area, as well as how to obtain additional help in an emergency, and be familiar with emergency procedures.
- Be alert to unsafe conditions and actions and call attention to them so that corrections can be made as soon as possible. Someone else's accident can be as dangerous to you as any you might have.
- Use equipment only for its designed purpose.
- Use only those chemicals for which the quality of the engineering controls and protective equipment is appropriate for safe handling.
- Eating, drinking, smoking, gum chewing, or application of cosmetics are never permitted in areas where laboratory chemicals are present. Laboratory workers should be sure to wash their hands before eating, drinking, smoking, etc. outside the laboratory environment. Personnel must adopt safe practices by eating or drinking outside of laboratory areas, and only after washing their hands.
- Storage of food and beverages is not allowed in refrigerators, cold rooms or ice chests that contain any hazardous chemical, radioactive, or infectious materials. Storage of food and beverages is prohibited except in designated break areas away from laboratories.
- Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur.
- Leave all protective equipment in the lab when exiting including lab coats and protective gloves. Wash areas of exposed skin well before leaving the laboratory.
- Avoid practical jokes or other behavior that might confuse, startle, or distract other workers.
- All new procedures should be evaluated for potential hazards associated with the work. The following resources are available for this evaluation.
 - Contact Environmental Health and Safety.
 - Review the MSDS/SDSs for the materials in question.
- NEVER use mouth suction for pipetting or starting a siphon.
- Confine long hair and loose clothing. Wear closed-toed shoes at all times in the laboratory; **SANDALS ARE NOT PERMITTED TO BE WORN IN THE LABORATORY.** Appropriate protective clothing (e.g., aprons, lab coats, safety glasses, etc.) should be kept in the laboratory and worn routinely.
- Be alert to unsafe conditions and see that they are corrected when detected.
- Do not leave hazardous experiments unattended. Standard Operating Procedures must be submitted and approved by the laboratory Principal Investigator or his/her designee when there are any plans to leave an experiment unattended.

Particularly Hazardous Substances

Introduction

The Occupational Safety & Health Administration's (OSHA) Laboratory Standard (29 CFR 1910.1450 (e) (3) (viii)), requires that provisions be made for employee protection for work with particularly hazardous substances. These include select carcinogens, reproductive toxins, and acutely toxic substances. Specific consideration should be given to the establishment of a designated area, the use of containment devices, and procedures for the safe removal of contaminated waste, and decontamination.

Definitions

Particularly Hazard Substances (PHS) are defined as belonging to one of three groups:

1. Select carcinogens, acutely toxic chemicals, reproductive toxins and chemicals known to have undesirable biological effects. (Refer to the information document "Particularly Hazardous Table" (<https://www.cmu.edu/ehs/Laboratory-Safety/chemical-safety/documents/cmuphstable.pdf>) for lists of PHS and guidance in identifying them.)
2. Chemicals for which reliable toxicity information is not available, but are highly suspected to be a PHS because of their similarity in chemical structure or function to known toxic agents.
3. Chemicals that are explosive or otherwise violently reactive, such as pyrophorics and water-reactive materials.

Select carcinogens are any substance that meets at least one of the following criteria:

- Regulated by OSHA as a carcinogen or;
- Listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) or;
- Listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer (IARC) Monographs or;
- Listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens " by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
 - After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m³
 - After repeated skin application of less than 300 mg/kg of body weight, per week or
 - After oral dosages of less than 50 mg/kg of body weight per day

Acute toxicity is the ability of a chemical to cause a harmful effect after a single exposure. Parameters for assessing the risk of acute toxicity of a chemical are its LD50 and LC50 values. Acutely toxic chemicals meet the following criteria:

- Chemicals with an oral LD50 in rats <50mg/kg
- Chemicals with a skin contact LD50 in rabbits <200mg/kg
- Chemicals with an inhalation LC50 in rats <200ppm/per hour

Lethal Dose 50 (LD50) is defined as the amount of a chemical that when ingested, injected, or applied to the skin of test animals under controlled laboratory conditions will kill one-half (50%) of the animals.

Lethal Concentration 50 (LC50) is the concentration of the chemical in air that will kill 50% of the test animals exposed to it.

Reproductive toxins are substances that cause chromosomal damage and substances with lethal or teratogenic effects on fetuses.

Designated areas are areas that may be used for work with particularly hazardous substances. A designated area may be the entire laboratory, an area of a laboratory, or a device such as a laboratory hood or glove box.

Responsibilities

It is the responsibility of the principal investigator or laboratory manager to ensure that PHS determination is conducted on all existing chemical inventories and on all future chemical purchases. Furthermore, prior to beginning work with a PHS, or once the PHS determination is made, employees of Carnegie Mellon University shall complete a PHS Safety Protocol Form. All employees approved to work with a particularly hazardous substance shall comply with that form.

Particularly Hazardous Substance (PHS) Safety Protocol Forms

The purpose of the **Particularly Hazardous Substance (PHS) Safety Protocol Form** is to ensure that all employees (including faculty, staff and paid students) are adequately trained and familiar with the PHS chemical/physical properties, health hazard information, and toxicity data prior to the use of the material. Procedures for containment, storage, and waste management shall be described in detail. Safety precautions shall be addressed including: assignment of a designated area, personal protective equipment, ventilation requirements, methods of monitoring exposure, first aid procedures, and spill or leak clean-up procedures.

The principal investigator or laboratory manager shall approve all PHS Safety Protocol Forms where applicable. Consultation with Environmental Health and Safety is recommended to ensure that procedures and safety precautions are adequate. The approved protocol shall be kept on file in the laboratory (readily accessible for use in an emergency), and be made available to EH&S upon request. A copy of a blank PHS Safety Protocol Form is located at: <https://www.cmu.edu/ehs/Laboratory-Safety/chemical-safety/documents/PHSformblank.pdf>

Principal investigator or laboratory manager approval:

A written PHS Protocol must be approved and signed by the Principal Investigator or laboratory manager before work with PHS chemicals may begin. The entire PHS Safety Protocol Form shall be reviewed by the principal investigator or laboratory manager for accuracy. These procedures shall be reviewed and changed at the time of any process change.

Additional employees may be added to an existing PHS Safety Protocol Form, or an existing protocol form may be approved for use in another laboratory. In these cases, the protocol form must still be reviewed by the principal investigator and approved for use for each additional employee. All personnel authorized to use a PHS must complete the employee information sheets and attach it to the PHS Safety Protocol.

Record keeping

The original approved copy of the PHS Safety Protocol shall be kept on file in the laboratory. Employee information sheets should be kept on file with the PHS Safety Protocol Form in the laboratory.

Designated areas

PHS are to be used in designated areas ONLY. The designated area must be identified and the boundaries clearly marked (See: "Warning signs", below). Unauthorized personnel (i.e., persons who are NOT approved for use on the PHS Protocol form) are restricted from entry into a designated area while work with the PHS is being performed.

Warning signs

When the PHS is being used, designated areas must be posted with signs that denote the nature of the hazard. Contact EH&S for appropriate signage, which will be supplied to properly address the type of

designated area identified by the laboratory, and will provide suitable hazard warnings.

Personal protective equipment

Chemically compatible gloves shall be used with particularly hazardous substances. It is recommended that glove manufacturers and/or EH&S be contacted for compatibility information and assistance in selecting the appropriate glove. Other protective equipment and apparel such as a fully closed laboratory coat and chemical splash goggles and/or a face shield may be required according to the approved PHS Safety Protocol Form.

Containment

PHS should be used in a fume hood or glove box. Spill protection in the form of plastic backed matting or chemical resistant pans should be employed. All weighing operations involving PHS shall be performed in a certified laboratory hood, glove box, or approved vented enclosure. Air exhausted from glove boxes where PHS are handled must be vented to a certified hood or exhaust system.

Storage

PHS containers should be labeled as such (EH&S can provide labels for this activity). Refer to other sections of the Chemical Hygiene Plan for general information on proper chemical storage, transportation and compatibility.

Decontamination and Waste

Every effort should be made to minimize spills or loss of PHS. All PHS compounds shall be disposed of as hazardous waste. During decontamination, all equipment should be thoroughly rinsed with a suitable solvent. This solvent should be collected as hazardous waste. Care should be exercised to prevent contamination of the outside of the waste container. In the event that decontamination is not feasible, the equipment should be placed in an impervious container that is sealed and properly labeled and disposed of as hazardous waste.

All solid PHS wastes shall be sealed in double-lined plastic bags and disposed of as hazardous waste. Carnegie Mellon's Hazardous Waste Certification Tags, with all pertinent information, shall be attached.

When composed of finely divided solid materials, spills of PHSs should be cleaned by wet wiping, or mopping. Dry sweeping should not be done. Contaminated toweling used for the clean up of hazardous materials shall be disposed of as a PHS hazardous waste.

Laboratory workers should leave protective apparel in designated areas and wash hands and arms before leaving designated areas if possible.

Safety precautions

Ensure that all laboratory occupants are aware of the hazards involved with each PHS. Keep first aid procedures and materials readily accessible for use during an emergency.

Exposures

Never exceed exposure limits (consult MSDS/SDS). Know how a particular chemical can enter the body and symptoms of exposure. Notify your supervisor and Environmental Health and Safety if you suspect exposure. Seek medical attention if you suspect exposure.

Carnegie Mellon University provides all employees who have received a hazardous chemical exposure the opportunity to receive medical attention.

Items Not Covered

Any items not covered by this amendment should be submitted to the Carnegie Mellon Laboratory Safety Committee on an ad hoc basis for consideration.

Animal Work

Access

*with Chemicals
of High Chronic
Toxicity*

For large-scale studies, special facilities with restricted access are preferable.

Administration of the Toxic Substance

When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar airflow directed toward HEPA filters.

Aerosol Suppression

Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood).

Personal Protection

When working in the animal room, wear latex, nitrile, or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed, due to incomplete suppression of aerosols, other apparel and equipment (e.g., shoe and head coverings, respirator).

Waste Disposal

Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products; otherwise, package the waste appropriately for burial in an EPA-approved site, as a biohazard waste.

Emergencies and Exposures

*Emergency
Operations Plan*

The University has prepared and has made available to appropriate persons an Emergency Operation Plan. Details of the plan may be found at <http://www.cmu.edu/ehs/emergency-response/index.html>. Questions about the content of any response activity should be addressed to Environmental Health & Safety (412-268-8182).

*Emergency
Response
Equipment*

Eyewashes

Plumbed eyewashes should be present in or near all lab areas in which there is a potential for hazardous chemicals to be splashed into the eyes. Individual laboratories are responsible for the weekly testing of their eyewashes (ANSI (American National Standards Institute) Z358.1-2014)

Safety Showers

A safety shower should be present in or near all lab areas in which there is a potential for toxicologically significant quantity of a hazardous chemical to be splashed onto the body. Facilities Management Services (FMS) performs annual testing of emergency showers.

Fire Extinguishers

A fire extinguisher must be present in or near each laboratory area. The extinguisher must be appropriate for the classes of fires possible in a particular laboratory.

Spill Response

A spill response kit must be present in or near each laboratory area that contains hazardous materials with a potential for spillage. The spill kit needs to accommodate the largest container of each type of hazard present, and be appropriate for the specific hazards present in the lab, such as acids, bases and solvents.

***Emergency
Response Guide
for Labs***

Planning and Preparation

A written Emergency Operations Plan has been prepared for and is circulated throughout Carnegie Mellon University. A summary document, Emergency Response Guide for Laboratories is available from EH&S and should be posted in each laboratory. This document identifies procedures for medical assistance, evacuation, and reporting of accidents.

***Accident
reporting***

Accident Notification

Accidents involving fire or explosions will activate installed automatic alarm sensors and fire extinguishing systems. Where automatic systems do not exist, manual alarms are installed in egress routes and must be activated during evacuation.

Accidents involving major chemical spills (as defined in Emergency Response Guideline), fires, or explosions shall be immediately reported to Carnegie Mellon University Police at 412-268-2323. Security will contact the appropriate Carnegie Mellon University and City of Pittsburgh fire/medical/hazmat response personnel including Carnegie Mellon EH&S.

Reporting of accidents to Security should be clear and concise, including the following information:

- Nature of the accident
- Hazardous material involved
- Nature of any injuries
- Location
- Name of the caller
- Phone number where caller can be reached

Personnel at the immediate scene of the accident should take actions that will mitigate the extent of the accident without jeopardizing their health and safety. When in doubt, warn others in the area, evacuate the area, travel to a safe location, and call Security (412-268-2323).

Accident Investigation and Reporting

Accidents involving injury or illness must be reported on the Supervisor's Injury/Illness Report form (available from Human Resources) located at this link: <https://www.cmu.edu/ehs/Workplace-Construction/documents/WCforms.pdf> and distributed as indicated in the form.

All other accidents and near-miss accidents (injuries, fires, spills, explosions) shall be reported to EH&S (412-268-8182 or safety@andrew.cmu.edu) as soon as possible after the occurrence. "near - miss" incidents and accidents without injury can be reported on the "Non-Injury and Near-Miss Incident Reporting Form" located here: <https://cms-staging.andrew.cmu.edu/ehs-2/Workplace-Construction/documents/Non-Injury%20%20Near-Miss%20Incident%20Form.pdf>

***Medical
Consultations &
Examinations***

Medical consultations are offered for the following:

1. Documented exposures above established action levels or airborne concentrations above the PEL, TLV, or other recognized exposure limit.
2. Personnel exhibiting signs or symptoms consistent with exposure to the chemicals with which they are working.
3. Personnel exposed to hazardous chemicals as a result of a significant spill, leak or explosion.

The licensed physician performing the initial consultation will identify the need for further medical

examination.

Medical Examinations

1. The medical exam criteria will be determined by the licensed physician.
2. Where medical exam guidance exists, such as for OSHA regulated substances, these criteria will be included in the physician's exam.
3. For examinations resulting from exposures to OSHA regulated substances, the examination frequency will be the period set within the OSHA standard.
4. For examinations resulting from potential overexposure to hazardous substances, the licensed physician will determine the examination frequency.
5. The following information will be provided to the examining physician.
 - The MSDS/SDS for the applicable hazardous chemical(s)
 - A description of the conditions under which the exposure occurred, including monitoring data and accident reports.
 - A description of the signs and symptoms of exposure that the employee is experiencing.
6. Upon completion of the exam, the physician will provide the following reports.
 - Any medical condition of the employee which places them at risk as a result of exposure to hazardous chemicals found in their workplace
 - Recommendations for further examination
 - Results of the examination to the employee
 - A statement that the employee has been informed by the physician of the results of the exam and consultation

First Aid

- Personnel trained in first aid are available during working hours and emergency room facilities with medical personnel are located nearby. Emergency Medical Services and Carnegie Mellon University Police provide transport to local hospitals 24 hours a day. Coordinate through Security at 412-268-2323.
- First Aid shall only be performed by persons suitably trained to do so.

Waste Disposal

Hazardous Waste Program

Hazardous Waste:

Information on the identification, handling, storage and collection of laboratory wastes, and personnel safety of waste generators, is presented in the Carnegie Mellon University hazardous waste written program. This document includes procedures for hazard identification, hazardous waste accumulation, requesting removal of hazardous waste, and the disposal process. Also included is information on waste minimization activities. The written program may be found at <http://www.cmu.edu/ehs/chemical/waste/index.html>. Hazardous waste generator training is a requirement for all generators of hazardous waste. Regular refresher training in hazardous waste generation is strongly recommended (see the TRAINING section on page 7 of this document).

Non-Hazardous Waste

Non-hazardous Waste (as defined by EPA) must be handled in the following fashion:

- All "sharps" or needles must be disposed of in "sharps" containers available from EH&S. (Sharps are defined broadly as any laboratory waste item that can puncture human skin. This includes needles, syringes with needles, lancets, scalpels, razor blades, precision knives, pipettes and pipette tips. Broken glass is specifically excluded as it is addressed below. For disposal of sharps that are contaminated with chemicals, biological agents

and/or radioactive materials, check the EH&S web page for further details of both accumulation requirements and requesting disposal of filled containers.)

- All broken glass must be disposed of in broken glass containers or in completely sealed cardboard boxes. Filled containers should be completely sealed with sturdy tape (to prevent puncture), marked "For Disposal", and placed in the hallway outside the lab. Custodial services will pick-up and remove the container. The box must be in sound condition, lidded, and with a poly lining of at least 2 mils.
- Finely divided powders, such as silica gel or toners, must be placed in tightly sealed containers before disposal.
- Biological and/or radioactive wastes are addressed separately from other laboratory wastes. Contact EH&S for information about these wastes.

Sink Disposal

Do not discharge any waste to the sewer that is or may:

- an irritant
- malodorous
- a lachrymatory agent (producing tears)
- interfere with the biological activity of a waste water treatment plant
- create a fire hazard
- cause structural damage or obstruct the flow of the system

Physical Hazards

Compressed Gases

Compressed Gases

Please refer to the EH&S Guideline: Compress Gas Cylinder for additional information and requirements, such a use of gas cabinets, detection and warning systems and special controls, for certain high hazard compressed gases. This document is available from EH&S (412-268-8182)

1. Compressed gas cylinders shall be stored and secured in an upright position.
2. In areas of gas cylinder storage, cylinders shall be segregated according to their properties. Additionally, signs shall be posted identifying type of cylinders permitted and identifying any potential hazard. When more than one cylinder is stored together, cylinders shall be kept tightly nested and secured with straps or chains.
3. On cylinders not equipped with a valve shutoff, a wrench shall be provided and kept on the valve at all times to permit rapid emergency shutoff.
4. Cylinders shall be stored with the protective valve cap in place. No cylinder shall be stored with the regulator still installed.
5. Cylinders of compressed gases should be securely strapped or chained to a wall or bench top.
6. Close the gas cylinder at the top of the tank when not in use.
7. All compressed gas cylinders and chemical containers should be stored away from heat sources and direct sunlight.
8. Only use regulators and equipment approved for the gas being handled.
9. Cylinder handling will be performed using equipment appropriate for the task, i.e., cylinder hand carts.
10. Wherever carbon monoxide or hydrogen sulfide are present in quantities greater than one standard lecture bottle size, detection alarms must be present and properly tested and maintained.

	<p>11. Wherever hydrogen is present, all tubing must be of braided stainless steel hose. Alternative tubing materials will be approved by EH&S on a case by case basis, to ensure that the alternative meets fire protection requirements.</p> <p>Compressed gases present hazards due to their compressed nature, in addition to any hazard presented by the gas itself (for example, flammable, corrosive or oxidizing gases).</p>
Electrical Safety	<p>The hazards associated with the use of electricity include electrical shock and electrical fires caused by shorts and overloaded circuits or wiring. In addition, sparks from electrical equipment can serve as an ignition source for flammable or explosive vapors or combustible materials. Most incidents are a result of unsafe work practices, improper equipment use, and faulty equipment.</p> <p>Refer to the EH&S Fact Sheet “<u>Electrical Safety in the Lab</u>” for further information on working safely with electricity. This fact sheet is available on the EH&S web page, under “Fact Sheets/Fire Safety”.</p>
Trip Hazards	<p>Equipment, tubing, cables, and other items, such as boxes and floor clutter can become trip hazards in laboratories. Aisles and hallways need to be free of items that impede egress, at a minimum of 36 inches. Store all materials in cabinets, on shelves, and out of the paths of travel. Eliminate floor clutter. Be sure to position equipment such that wires and tubing do not cross aisles. If wiring or tubing must run across an aisle, suspend it from the ceiling via an overhead rack, or affix it to the floor with a cord protector or durable tape.</p>
Pressure and Vacuum	<p>Pressurized and vacuum operations (including use of compressed gas cylinders)</p> <p>Reactions should never be carried out in, nor heat applied to, an apparatus that is a closed system unless it is designed to withstand the pressure that may be created. Pressurized apparatus shall have an appropriate pressure relief device.</p>
Cryogenics	<p>Low temperature procedures (cold traps and cryogenic hazards)</p> <p>Cryogenic liquids are:</p> <ol style="list-style-type: none"> Refrigerated, liquefied gases having a boiling point colder than a temperature of minus 130F at a pressure of one atmosphere absolute. Stored at low pressures in multi-walled, vacuum-insulated storage containers. Examples of cryogenic liquids include oxygen, nitrogen, argon, neon, krypton, xenon, hydrogen, helium, liquefied natural gas (LNG)/methane, and solid carbon dioxide (dry ice). <p>Before working with cryogenics, please refer to the EH&S Guideline: Cryogenics for additional information and handling instructions. d when there is a potential exposure to the cryogen.</p>
High Temperature Applications	<p>High Temperature Equipment Safety</p> <p>High temperature equipment in a laboratory, such as furnaces and ovens, present hazards due to their elevated temperatures.</p>
Ergonomics	<p>Laboratories present special challenges in the prevention of repetitive stress injuries. Laboratory personnel are urged to attend the Training Session “Laboratory Ergonomics” offered by EH&S. For information and training dates, go to this link:</p>

<https://www.cmu.edu/ehs/Training/index.html>

***Nanomaterials
and Related
Inhalation
Hazards***

Nanomaterials and Related Inhalation Hazards

Work with nanomaterials and work with equipment that may generate nanomaterials may pose hazards yet undermined, due to the limited safety research performed addressing these materials. Current information on nanomaterials and reducing exposure to them is presented in these EH&S Fact Sheets:

Nanoparticle Safety: <http://www.cmu.edu/ehs/fact-sheets/nanoparticle-safety.pdf>
3D Printing Safety: <https://www.cmu.edu/ehs/fact-sheets/3D-Printing-Safety.pdf>

Recordkeeping

Records

Records Retention

1. Carnegie Mellon Department of Human Resources (HR) maintains illness and accident reports.
2. The Department of Environmental Health and Safety (EH&S) maintains documentation of the annual review of the Chemical Hygiene Plan.
3. EH&S oversees the University's chemical inventory program, CHEMTRACKER. For additional information about CHEMTRACKER please visit: <https://www.cmu.edu/ehs/Chemtracker/index.html>
4. Human Resources (HR) maintains all medical records relating to chemical exposure and potential chemical exposures.

Internal Program Evaluations

Records of EH&S laboratory inspections and hood evaluations will be maintained in the EH&S office for a minimum of three years. Laboratory inspections are maintained through BioRAFT. For additional information about BioRAFT please visit: <https://www.cmu.edu/ehs/BioRAFT/index.html>

External Program Evaluations

Reports of external (regulatory) inspections will be retained by EH&S.