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

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Introduction: Purpose and Policy

Purpose

This is a statement of Environmental Health & Safety policy to establish the process for compliance with the Occupational Safety and Health Administration (OSHA) regulation "Occupational Exposure to Hazardous Chemicals in Laboratories" (29 CFR 1910.1450). The purpose of the process is to protect employees from the health hazards involved with use of 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 (i) the work involves containers which can easily and safely be manipulated by one person, (ii) multiple chemical procedures or chemical substances are used, and (iii) 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 https://www.cmu.edu/ehs/Laboratory-Safety/chemical-safety/index.html

Carnegie Mellon's 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 recommendations of this plan.

Responsibilities

Organizational Chart

See University organizational charts: https://www.cmu.edu/leadership

Roles and Responsibilities Roles and Responsibilities

President

- The president has ultimate authority for chemical safety at the university and shall, with other administrators, provide continuing support for the University's 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 principal investigators, professors, laboratory managers, and researchers to adhere to the CHP.

Environmental Health & Safety

- The Director of Environmental Health & Safety (EHS) is responsible for the training of EHS staff and providing appropriate facilities, suppliers, references, instruments, etc., to survey and evaluate safety systems and processes.
- The Director of EHS shall ensure the preparation, review and distribution of the University's Laboratory Emergency Response Guide. EHS shall serve as an advisory source and create safety guidelines and programs.
- EHS shall conduct periodic lab safety inspections.
- EHS shall ensure the safe disposal of waste chemicals.
- EHS shall maintain safety training records of appropriate faculty, staff and students.

Laboratory Safety Committee (LSC)

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

Roles and Responsibilities

Facilities Management & Campus Services

- The Director of Facility Management & Campus Services (FMCS) shall ensure that proper maintenance and repair of installed laboratory safety equipment is a high priority.
- The Director of FMCS 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 the maintenance of the installed safety systems.
- Work orders to repair or renovate laboratory facilities may be initiated by principal investigators, laboratory managers, or by FMCS or EHS personnel.

Chemical Hygiene Officer (CHO)

- Work with administrators, faculty, staff, and students to develop and implement chemical hygiene guidelines and programs.
- 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 actions.
- 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 in case when an employee shows signs or symptoms associated with hazardous chemical exposure.
- Investigate reported workplace injuries from 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 up to date list of the personnel working in their laboratories within the University's SciShield system (the university's training and inspection tool). Laboratory inspectors will confirm current personnel lists during inspections, to confirm all that applicable personnel are properly trained.
- Complete laboratory safety training and ensure that laboratory workers have received basic lab safety training from EHS.
- Ensure that appropriate personal protective equipment (PPE) is available and that it provides adequate protection.
- Notify EHS when the need to use respirators arises.

Roles and Responsibilities

- 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.
- 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, and specify those chemicals that are particularly hazardous substances (PHS). Ensure the review of the inventory quarterly.
- Ensure the performance of inspections for housekeeping and safety.
- Ensure that employees are familiar with electronic SDS searches, especially for Particularly Hazardous Substances (PHS).
- 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 trainings.
- 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 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 areas 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 (EHS). 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 PI 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 an on-line refresher training via SciShield. In addition, reading the EHS Quarterly Newsletter is highly

recommended to ensure that lab workers stay current with any compliances or safety law changes between three year periods.

[Note that any personnel involved with the generation of hazardous waste must, in addition to Laboratory Safety training, also attend Hazardous Waste Generator training, offered by EHS concurrently with the Lab Safety Class, or on-line.]

1. General Chemical Safety Training

EHS will provide Laboratory Safety and Hazardous Waste training to laboratory workers (e.g., PIs, faculty, 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 departments and laboratory supervisors.

The training will include the following topics:

- This Chemical Hygiene Plan and its content.
- The contents of the OSHA standard (29 CFR 1910.1450) 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 EHS in SciShield.

The Chemistry Department offers two courses that 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 will be performing. This training should be provided *before* the employee begins laboratory work. It should include specifics of the hazardous materials to be used, and the specific safe work practices for each hazardous material.

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)

In 2012, due to changes in the OSHA Hazard Communication Standard, Material Safety Data Sheets (MSDS) are now referred to as Safety Data Sheets (SDS.) These SDS may have a different format and rating system. Always use the most current version, or recent year, in the GHS SDS format.

SDSs are critical elements of a chemical safety program. All laboratory employees should be able to read and understand the relevant SDS and know where they can be obtained. The program **MSDSOnline** is available from the EHS web page and within SciShield ChemTracker, and it is accessible to all Carnegie Mellon staff, faculty and students. This program provides easy access to most up-to-date millions of SDSs. Chemical manufacturers and distributors are also a good source for SDS. For SDSs not available at the following link or by internet search, employees should contact EHS.

A current SDS for each chemical must be available for review in the work/storage area, either as a paper copy or from the internet. Instructions for accessing items from the MSDSOnline webpage are provided in the EHS webpage instructions.

General Information

Assistance will be provided by EHS to any department, PI, employee and student requesting guidance or training to satisfy implementation of this policy.

Globally Harmonized System

The Globally Harmonized System (GHS) is used to identify and evaluate chemical hazards. Through a series of pictograms and a number rating, GHS provides a quick reference for evaluating the hazard(s) of a chemical. The hazard categories are numbered from 1 to 5. The LOWER the number, the GREATER the severity of the hazard. Thus, category 1 hazards are the most dangerous. The pictograms are as follows:

Explosive

- Explosives
- Self-reactive substances
- Organic peroxides

Flammable

- Flammable gases, aerosols, liquids, and solids
- Pyrophoric liquids or solids
- Self-heating substances
- Self-reactive substances
- Substances that emit a flammable gas upon contact with water
- Organic peroxides

Corrosive

- Skin corrosion/burns
- Eye damage
- Corrosive to metals
-

Oxidizer

- Oxidizing gases, liquids, and solids

Compressed gas

- Gases under pressure

Irritant

- Irritant (skin and eye)
- Skin sensitizer
- Acute toxins
- Narcotic effects
- Respiratory tract irritants
- Hazardous to ozone layer (non-mandatory)

Toxic Substance

- Acutely toxic substances that may be fatal or toxic if inhaled, ingested, or absorbed through the skin

Environmental Hazard (non-mandatory)

- Acute aquatic toxins
- Chronic aquatic toxins

Health Hazard

- Respiratory sensitizers, Aspiration toxins
- Carcinogens, Mutagens, Reproductive toxics
- Target organ toxins, single exposure or repeated exposure

Control Measures

Standard Operating Procedures	Standard Operating Procedures prepared by the laboratory should be made available to all applicable laboratory personnel and to EHS 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 within SciShield, known as ***ChemTracker.*** **Inspections, Maintenance, and Housekeeping** <u>Inspections</u> EHS 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, SDSs are readily accessible, and good housekeeping is being practiced. Inspections may be performed more frequently, as deemed necessary by EHS. Follow-up inspections may be performed to confirm completion of corrective actions. The results of these inspections can be

Administrative Controls

viewed on SciShield by the PI, as well as the Co-investigators or Compliance Liaison(s) for the lab. SciShield, is accessible from the main EHS web page.

Internal chemical hygiene inspections, as well as housekeeping, are recommended and should be conducted at least quarterly by the PI, Laboratory manager, or appointed representative. Internal inspections can be conducted using the "Self-Inspections" function in SciShield. Please refer to the link above.

Maintenance

Laboratory personnel should inspect eyewashes monthly, by operating them until the water runs clear, and to ensure that outlets have sufficient and even supply. FMCS coordinates annual testing of safety showers.

Repair

Facilities Management & Campus Services (FMCS) 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 EHS. Malfunctioning eyewashes and safety showers should be marked "Do Not Use" until repaired.

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.

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. EHS 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. The definition of "working alone" means that only one person is present in a lab or contiguous space, and that person is working with hazardous materials, hazardous procedures or hazardous equipment. If working alone is necessary, the lab worker and Principal Investigator are required to review, complete, sign, and submit (either by uploading to SciShield or submitting to EHS) the "Working Alone in Lab" form. 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, 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 uploaded to the lab members SciShield documents. EHS can be asked to review forms, and will review forms during inspections. Some work scenarios do not

allow working alone and require the buddy system, such as: working with pyrophoric materials, acutely toxic materials, and highly hazardous equipment. NOTE: Schools, Departments, and Principal Investigators may set a higher level of safety regarding working alone.

Special Medical Conditions

Lab workers should contact their supervisor, PI and/or EHS is 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 https://www.cmu.edu/ehs/Laboratory-Safety/index.html.

Engineering Controls

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

1. General Laboratory Ventilation

General ventilation must not be relied on to protect personnel from chemical vapors, gases, mists, and dust.

2. Fume Hoods

Fume hoods must be used for operations that might result in the release of hazardous chemical vapors, gases, mists, or dust.

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, and notify EHS by calling 412-268-8182. If there is a possibility of the release chemicals that pose a significant health hazard, campus police must be contacted by calling 412-268-2323 and 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.

Engineering Controls

- In new construction, consideration shall be given to locating the hood such that ambient air currents do not significantly reduce the containment efficiency of the hood.
- In new construction, the hood shall be designed to produce laminar airflow.
- The hood shall be modified only upon approval by EHS. Modifications 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, or at a minimum have a low flow alarm.
- 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 EHS 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. Ductless fume hoods should be reviewed and approved by EHS.

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 negatively affect the safety of the laboratory environment. Prior to putting modified hoods into service, airflow testing will be conducted by EHS specialists to ensure that airflow specifications have been met.

3. Other Local Ventilation Devices

Exhaust air from glove boxes and isolation rooms should be released 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 enclosed 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 used 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 EHS. 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 EHS and ***must*** follow the Carnegie Mellon Respiratory Protection Program. Refer to the Carnegie Mellon University Respiratory Protection Program for further details.

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 work 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 manager are 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 EHS 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 manager 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 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.* 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, 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 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 research laboratories where new protocols are constantly being developed, it is wise to maintain at least the same level of safe practices for the disposal of chemical waste and residues as the original protocol. All substances of unknown hazards 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 (absorption),
- Through the mouth or other mucous membranes (ingestion), or
- Through a cut, puncture or other opening in the skin (injection).

Environmental Monitoring and Surveillance

All environmental monitoring and surveillance will be performed by or overseen by EHS. All concerns of overexposure should be addressed to EHS.

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

Sampling methods validated by NIOSH or OSHA, 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 PI, Laboratory Manager, or laboratory personnel.
- Laboratory accidents involving release of air contaminants.

Observing 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

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 PI, Laboratory Manager, or laboratory personnel.
- 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.

OSHA Recognized Carcinogen List

Working with an OSHA Recognized Carcinogen may require personal sampling, or at a minimum review by EHS for exposure control planning. The current list of OSHA Recognized Carcinogens is as follows:

- 2-Acetylaminofluorene
- Acrylonitrile
- alpha-Naphthylamine
- 4-Aminodiphenyl
- asbestos
- Benzene

- Benzidine
- beta-Naphthylamine
- beta-Propiolactone
- bis-Chloromethyl ether
- 1,3-Butadiene
- Cadmium
- Coke oven emissions
- 3,3'-Dichlorobenzidine (and its salts)
- 4-Dimethylaminoazobenzene
- 1,2-dibromo-3-chloropropane
- Ethylene oxide
- Ethyleneimine
- Formaldehyde
- Inorganic arsenic
- Methyl chloromethyl ether
- Methylene Chloride
- Methylenedianiline
- 4-Nitrobiphenyl
- N-Nitrosodimethylamine
- Vinyl chloride

Workers should contact EHS for a review and potential exposure monitoring.

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

- 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.
- Do not use an open flame to heat a flammable liquid or to carry out a distillation under reduced pressure.
- When volatile flammable materials may be present, use only non-sparking electrical equipment.
- Check all containers of flammable materials in the area to ensure that they are tightly closed.
- Store flammable materials properly.

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. All fires shall be reported to Campus Police at 412-268-2323 (re: Clery Act). Lab workers should be familiar with the location of the closest fire extinguisher and fire alarm pull stations. It is recommended that lab workers complete Fire Extinguisher Training, which can be schedule through SciShield.

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 EHS Laboratory Safety training, which is available both on-line, and in-class through SciShield.

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. This system of label requirements, and is designed to meet the GHS used throughout much of the world. Information on this system, and changes is available from EHS through written documents, on the EHS web site, Laboratory Safety Training and within this document (pages 8-9.).

Secondary use containers (containers used for dispensing from bulk containers or containers of "made-up" chemical mixtures) should be, as a minimum, be labeled with the identity of the contents of the container. 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 EHS.

Laboratories shall prominently post:
1. Emergency telephone numbers.

2. Location signs for safety showers, eyewashes, fire extinguishers, spill response kits, and first aid equipment.
3. Warning signs at areas or equipment where special or unusual hazards exist.

(Contact EHS for assistance in obtaining appropriate signage)

EHS prepares and posts laboratory door safety signs outside each laboratory. Contact EHS 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 EHS to see if the material is already present 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.

EHS 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, or the HAZMAT P-Card, is the preferred method. Some materials are prohibited from purchase using a purchasing card. Check with EHS (safety@andrew.cmu.edu), or Procurement (procurement-inbox@andrew.cmu.edu) if there are any questions.

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.

Procurement and Storage of Chemicals

- 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 and should be properly labelled.
- New construction should follow NFPA 45 for guidelines on flammable and combustible liquid storage.
- Storage of chemicals 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 EHS. 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 EHS. Visit the EHS web page at https://www.cmu.edu/ehs/Laboratory-Safety/chemical-safety/shipping-dangerous-goods.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
3. Corrosives away from acutely toxic materials

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.

General Laboratory Rules

- 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 accident 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.
- 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 only allowed 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.
- Appropriate protective clothing (e.g., aprons, lab coats, safety glasses, etc.) should be kept in the laboratory and worn routinely.
- Leave all protective equipment, including lab coats and protective gloves, in the lab when exiting. Wash areas of exposed skin well before leaving the laboratory.
- Avoid practical jokes or other behavior that might confuse, startle, or distract other workers.
- 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; OPEN TOED SHOES ARE NOT PERMITTED TO BE WORN IN THE LABORATORY.
- Be alert to unsafe conditions and see that they are corrected when detected.
- Do not leave hazardous experiments unattended. When there are plans to leave an experiment unattended, Standard Operating Procedure must be submitted and approved by the laboratory Principal Investigator or his/her designee.
- Avoid wearing earbuds in lab, although Principal Investigators have the final say on permission. One ear should be left free to hear laboratory equipment alerts, safety equipment alarms, and building fire and emergency alarm system.
- All new procedures should be evaluated for potential hazards associated with the work. The following resources are available for this evaluation:
  - EHS
  - SDSs for the materials in question

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 (PHS). 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 Hazardous 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/ehs---particularly-hazardous-substances-table.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 Carcinogen is any substance that meets *at least one* of the following criteria:

- Regulated by OSHA as a carcinogen;
- Listed under the category "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP);
- Listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer (IARC) Monographs;
- 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 the following values:

(1) 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;

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

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

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 PI 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 should be described in detail in the form. Safety precautions must also 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 PI or Laboratory manager shall approve all PHS Safety Protocol Forms where applicable. Consultation with EHS is recommended to ensure that procedures and safety precautions are adequate. The approved protocols shall be uploaded to the laboratory's document section within SciShield (readily accessible for use in an emergency), and be made available to EHS upon request. A copy of a blank PHS Safety Protocol Form is located at: https://www.cmu.edu/ehs/Laboratory-Safety/chemical-safety/documents/ehs---particuarly-hazardous-substances-procedure-protocol-form.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 PI or Laboratory manager for accuracy. These procedures shall be reviewed and changed any time when any part of the protocol or a process is modified.

Particularly Hazardous Substance (PHS) Safety Protocol Forms

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 PI 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 Form and Employee information sheets should be kept on file 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 EHS 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 should be used with particularly hazardous substances. It is recommended that glove manufacturers and/or EHS 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. When handling Pyrophoric Material, specially rated fire protective equipment must be worn.

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 (EHS 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. 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. 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. All PHS compounds shall be 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, must be attached. 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 SDS). Know how a particular chemical can enter the body and symptoms of exposure. Notify your supervisor and EHS 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

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

Animal Work with Chemicals of High Chronic Toxicity

Access
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's Disaster Recovery and Business Continuity Services has prepared and has made available programs and plans for the campus community. Details of these programs and plans are found at https://www.cmu.edu/drbc/em/index.html. Questions about the content of any response activity should be addressed to EHS (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 periodic testing of their eyewashes. A minimum of monthly documented testing is required. FMCS performs annual testing of eyewashes and filter replacements.

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. FMCS 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. Individual laboratories are responsible for the periodic inspection of their fire extinguishers. A minimum of monthly documented inspection is required.

Spill Response
A spill response kit must be present in or near each laboratory are 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. EHS can be called to assist in hazardous spills cleanups, and should be contacted for large, and highly hazardous spills (412-268-8182).

Emergency Response Guide for Labs

Planning and Preparation
A written Laboratory Emergency Response Guide has been prepared for and is circulated throughout Carnegie Mellon University. A summary document, Emergency Response Guide for Laboratories, is available from EHS and should be posted in each laboratory. This document identifies procedures for medical assistance, evacuation, responding to fires, spills, 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 must 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 EHS.

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/hr/assets/workers-comp/workers-comp-forms.pdf and distributed as indicated in the form.

All other accidents and near-miss accidents (minor injuries, spills, incidents) shall be reported to EHS (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 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.
   - Results of the examination to the employee
   - 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
   - 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 for waste generators, is presented in the Carnegie Mellon University Hazardous Waste written program. This document includes procedures for hazard identification, hazardous waste accumulation, rules for requesting removal of hazardous waste, and the disposal process. Also included is information on waste minimization activities. 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 of this document).

Non-Hazardous Waste

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

- All "chemical sharps" or needles must be disposed of in "chemical sharps" containers. They are available from the Mellon Institute Store Room or preferred suppliers. 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 addressed below. Sharps that are contaminated with biological agents and/or radioactive materials are disposed separately from chemically contaminated sharps. Check the EHS web page for further details in the Biological and Radiation Safety Plans.

- 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 containers. Boxes 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. Visit the EHS website or contact EHS for information about these wastes.

Sink Disposal

Do not discharge any waste to the sewer that is known or suspected to be:

- 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

Compressed gases present hazards due to their compressed nature, in additional to any hazard presented by the gas itself (for example, flammable, corrosive or oxidizing gases). Please refer to the EHS "Compressed Gases Cylinders Guideline" for additional information and requirements, such a use of gas cabinets, detection and warning systems and special controls, for certain high hazard compressed gases.

1. Compressed gas cylinders shall be stored and secured in an upright position.
2. In areas of gas cylinder storage, cylinders should be segregated according to their properties. Cylinders need to be kept tightly nested and secured with straps or chains. Additionally, signs shall be posted identifying type of cylinders permitted and identifying any potential hazard.
3. In cases when cylinders are not equipped with a valve shutoff, a wrench should be provided and kept on the valve at all times to permit rapid emergency shutoff.
4. Cylinders must 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. Use only 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.
11. Wherever hydrogen is present, all tubing must be of braided stainless steel hose. Alternative tubing materials will be approved by EHS on a case-by-case basis, to ensure that the alternative meets fire protection requirements.

Electrical Safety

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.

Trip Hazards

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.

Pressure and Vacuum

Pressurized and vacuum operations (including use of compressed gas cylinders)
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.

Cryogens

Low temperature procedures (cold traps and cryogenic hazards)
Cryogenic liquids are:

a. Refrigerated, liquefied gases having a boiling point colder than a temperature of minus 130°F at a pressure of one atmosphere absolute;
b. 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).

Before working with cryogens, please refer to the EHS Cryogens Guideline for additional information and handling instructions when there is a potential exposure to the cryogen.

High Temperature Applications

High Temperature Equipment Safety
High temperature equipment in a laboratory, such as furnaces and ovens, present hazards due to their elevated temperatures.

Ergonomics	Laboratories present special challenges in the prevention of repetitive stress injuries. EHS offers consultations for Ergonomic evaluations of the workspace. To request an evaluation, please write to safety@andrew.cmu.edu Subject: Ergonomics.
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 EHS Guidelines: 3D Printing Safety: https://www.cmu.edu/ehs/Guidelines/ehs-guideline---3d-printers1.pdf

Recordkeeping

Records	**Records Retention** 1. Carnegie Mellon Department of Human Resources (HR) maintains illness and accident reports. 2. EHS maintains documentation of the annual review of the Chemical Hygiene Plan. 3. EHS oversees the University's chemical inventory program, CHEMTRACKER. For additional information about CHEMTRACKER please visit: https://www.cmu.edu/ehs/BioRAFT/. 4. HR maintains all medical records relating to chemical exposure and potential chemical exposures. **Internal Program Evaluations** Records of EHS laboratory inspections and hood evaluations will be maintained in the EHS office for a minimum of three years. Laboratory inspections are maintained through SciShield. For additional information about SciShield please visit: https://www.cmu.edu/ehs/BioRAFT/index.html. **External Program Evaluations** Reports of external (regulatory) inspections will be retained by EHS.