University of Maryland Center for Environmental Science - Appalachian Laboratory

Chemical Hygiene Plan (CHP)

Responsible Administrator: Chemical Safety & Hygiene Officer
Revised: April 2024

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Chapter 1: Introduction

Purpose

The University of Maryland Center for Environmental Science - Appalachian Laboratory (UMCES-AL) is committed to providing a healthy and safe working environment for the campus community that is free from recognized hazards in accordance with the Occupational Safety and Health Administration's (OSHA) standard titled, "Occupational Exposure to Hazardous Chemicals in Laboratories" (29 CFR 1910.1450), which is commonly referred to as the "Laboratory Standard". The Chemical Hygiene Plan (CHP) establishes a formal written program for protecting laboratory personnel against adverse health and safety hazards associated with exposure to potentially hazardous chemicals and must be made available to all employees working with hazardous chemicals. The CHP describes the proper use and handling practices and procedures to be followed by faculty, staff, students, visiting scholars, and all other personnel working with potentially hazardous chemicals in laboratory settings at UMCES-AL. This plan is based on best practices identified in, among other sources, "Prudent Practices for Handling Hazardous Chemicals in Laboratories," published by the National Research Council, and the American Chemical Society's "Safety in Academic Chemistry Laboratories" (www.acs.org/SACL).

Scope

The CHP applies to all work environments affiliated with UMCES-AL that use, store, or handle potentially hazardous chemicals and all personnel who work in these environments. The information presented in the CHP is not intended to be all-inclusive. Departments, research groups, laboratories, or other work units engaged in work with potentially hazardous chemicals that have unusual characteristics, or are otherwise not sufficiently covered in the written CHP, must customize the document by adding additional sections addressing the hazards and how to mitigate their risks, as appropriate. Such customizations must receive prior approval from the Principal Investigator (PI) and the Chemical Safety & Hygiene Officer (CHSO). Consult Appendix D: Safe Use of Particularly Hazardous Substances for additional information on substances that may trigger these additions.

Regulatory Requirements

Implementation of the necessary work practices, procedures, and policies outlined in this CHP is required by the U.S. Department of Labor, including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

Rights and Responsibilities

Employees and other personnel who work in or enter laboratories have the right to be informed about the potential health hazards of the chemicals in their work areas and to be properly trained to work safely with or in proximity to these substances. Employees have the right to file a complaint with OSHA or Maryland Occupational Safety and Health (MOSH) if they feel they are being exposed to unsafe or unhealthy work conditions and cannot be discharged, suspended, or otherwise disciplined by their employer for filing a complaint or exercising these rights. All personnel working with potentially hazardous chemicals are encouraged to report (anonymously, if preferred) any concerns about unsafe work conditions to AL's CHSO by calling (301) 689-7122 or anonymously at https://forms.gle/r3VuwYycBzh48jNr8.

Responsibilities for the health and safety of the campus community extend to the highest administrative levels of UMCES-AL. The Laboratory Director and Associate Director are responsible for the implementation of UMCES-AL's Environmental Safety and Health at all facilities under campus control.

The day-to-day responsibility for the management of laboratory safety and adherence to safe laboratory practices rests with the PI/Laboratory Supervisor within individual research groups, laboratories, and other work units. All personnel, including PIs/Laboratory Supervisors, employees, and students, have a duty to fulfill their obligations with respect to maintaining a safe work environment Safety is everyone's responsibility and should be everyone's priority.

The employees who work with chemicals bear the primary responsibility for safety on the job, not only for themselves but also for fellow employees. They must observe all safety rules; they must report unsafe conditions to AL's CHSO and if they are not certain about proper safety procedures, they must consult their supervisors or AL's CHSO. Those working with chemicals are responsible for staying informed about the chemicals in their work areas, safe work practices, and proper personal protective equipment (PPE) required for the safe performance of their job. Failure to comply with these requirements will result in progressive disciplinary action and may result in a temporary suspension of laboratory activities until corrective action is implemented.

It is the policy of UMCES-AL to do all that is reasonable to prevent injury to persons and damage to property and to protect the employees, facility, patients, the environment, and the public from injury, fire, or other damage. In order to achieve these goals, UMCES has instituted a comprehensive safety program. The administration urges the active cooperation and commitment of all departments and employees. Ongoing dialogue and feedback are encouraged. UMCES Administration supports this program in its promotion of employee safety and health. Aspects of the overall safety program include:

- Safety policies and procedures
- Incident reporting and investigation

- Emergency preparedness
- Hazardous materials and hazardous waste management programs
- Fire protection
- Safety education and training

These facets of the facility safety program are also incorporated by reference into the Chemical Hygiene Plan. The responsibilities of various staff positions are described below.

Responsibilities of Principal Investigator (PI)/Laboratory Supervisor

The PI/Laboratory Supervisor has responsibility for the health and safety of all personnel working in their laboratory who handle hazardous chemicals. The PI/Lab Supervisor may delegate safety duties, but remains ultimately responsible for ensure that delegated safety duties are adequately performed. The PI/Lab Supervisor has the primary responsibility for establishing a strong safety culture within the laboratory they supervise. They are responsible for:

1. Knowing all applicable health and safety rules and regulations, training and reporting requirements, and standard operating procedures associated with chemical safety for regulated substances;
2. Identifying hazardous conditions or operations in the laboratory or other facility containing hazardous chemicals and determining safe procedures and controls, and implementing and enforcing standard safety procedures;
3. Establishing standard operating procedures (general and protocol specific) and performing literature searches relevant to health and safety for laboratory-specific work;
4. Providing prior approval for the use of hazardous chemicals in their laboratory or another facility with hazardous chemicals;
5. Consulting with AL's CHSO on the use of higher-risk materials, such as the use of particularly hazardous substances or conducting higher-risk experimental procedures so that special safety precautions are taken;
6. Maintaining an up-to-date and accurate chemical inventory that includes all hazardous materials and compressed gases for the laboratory facility;
7. Ensuring laboratory or other personnel under their supervision have access to and are familiar with the appropriate Safety Manual(s);
8. Training all laboratory or other personnel they supervise to work safely with hazardous materials and maintain written records of all training (including laboratory-specific or other specialized training) in the Safety Manual;
9. Promptly notifying AL's CHSO or AL's Facilities Manager should they become aware that workplace engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers, etc.) become non-operational;
10. Ensuring the availability of all appropriate personal protective equipment (PPE) (e.g., lab coats, gloves, eye protection, etc.) and ensuring that the PPE is maintained in working order. Ensuring that all employees wear the appropriate PPE every time they enter the laboratory;

11. Conducting self-inspections of the laboratory or facility and maintaining records of inspections annually at a minimum;
12. Promptly reporting accidents and injuries to AL's CHSO or Associate Director.
13. Providing funding for medical surveillance and/or medical consultation and examination for laboratory and other personnel, as required;
14. Informing facilities personnel, other non-laboratory personnel, and any outside contractors of potential laboratory-related hazards when they are required to work in the laboratory environment;
15. Identifying and minimizing potential hazards to provide a safe environment for repairs and renovations.

Responsibilities of All Personnel Who Handle Potentially Hazardous Chemicals

All laboratory staff are expected to observe the safety rules and to report all unsafe conditions and all accidents. Each person working with or around chemicals, having been properly trained, is responsible for remaining aware of the hazards associated with these chemicals and handling them in a safe manner. If there is any doubt as to the specific hazards or a material or to the proper method of handling, the employee is expected to ask their supervisor or their unit's Chemical Hygiene Officer for the appropriate information. All personnel in research or teaching laboratories that use, handle, or store potentially hazardous chemicals are responsible for:

1. Reviewing and following the requirements of the CHP and all appropriate Safety Manuals and Policies;
2. Following all verbal and written laboratory safety rules, regulations, and standard operating procedures required for their assigned tasks;
3. Developing good personal chemical hygiene habits, including but not limited to keeping their work areas safe and uncluttered;
4. Planning, reviewing, and understanding the hazards and processes in their laboratory research or other work procedures prior to conducting work;
5. Properly identifying/labeling, storing, handling, and disposing of hazardous waste;
6. Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls;
7. Understanding the capabilities and limitations of any PPE issued to them;
8. Gaining prior approval from the PI/Lab Supervisor for the use of restricted chemicals and other materials;
9. Consulting with the PI/Lab Supervisor before using any particularly hazardous substances (PHS), pyrophoric chemicals, explosives, and other highly hazardous materials or conducting certain higher-risk experimental procedures;
10. Immediately reporting all accidents, unsafe conditions, and near-misses to AL's CHSO.
11. Completing all required health, safety, and environmental training and providing written documentation to their PI/Lab Supervisor;
12. Participating in the medical surveillance program, when required;

13. Informing the PI/Lab Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury or exposure;
14. When working autonomously or performing independent research or work:
    a. Reviewing the plan or scope of work for their proposed research with the PI/Lab Supervisor
    b. Notifying in writing and consulting with the PI/Lab Supervisor, in advance, if they intend to significantly deviate from previously established procedures
    c. Preparing SOPs and performing literature review relevant to safety and health that are appropriate for their work;
    d. Providing appropriate oversight, training, and safety information to laboratory or other personnel they supervise or direct.

Responsibilities of the Chemical Health & Safety Officer (CHSO)

The CHSO is responsible for administering and overseeing institutional implementation of the Laboratory Safety Program. The CHSO is qualified by training and experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. The CHSO provides technical guidance to personnel at all levels of responsibility on matters pertaining to laboratory use of hazardous materials and is also responsible for the following:

1. Providing assistance, information, or instruction to workers regarding safety issues, identification of hazards or potential hazards, and ensure that adequate supervision is provided;
2. Ensuring that workers comply with the Occupational Health and Safety Act and that they carry out all prescribed safety measures and procedures;
3. Ensuring that all new employees are properly trained, adequately supervised, and familiarized with all aspects of lab safety;
4. Informing PIs/Lab Supervisors of health and safety requirements and assisting with the selection of appropriate safety controls, including laboratory and other workplace practices, personal protective equipment, engineering controls, training, etc.;
5. Ensuring proper facilities, equipment, protective devices, or services are provided and maintained in good order for safe handling, storage, and disposal of chemicals and biological materials or wastes;
6. Maintaining a list of all hazardous materials used in the lab or verifying Safety Data Sheets (SDS) are available for all chemical compounds used;
7. Ensuring that workers are familiar with the Chemical Hygiene Plan and comply with all its requirements;
8. Enforcing proper procedures in chemical handling, storage, dispensing, and transportation within the lab and any bulk chemical storage rooms, as appropriate.
9. Conducting periodic inspections and immediately taking steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
10. Ensure compliance with legislative requirements regarding dangerous drugs, radioactive isotopes, hazardous chemicals or reagents, biological materials, or

wastes;

11. Be involved in the clean-up of significant lab chemical spills and ensure proper procedures and precautions are carried out. Carry out all required reporting of spills or releases;
12. Performing hazard assessments upon request;
13. Helping to develop and implement appropriate chemical hygiene policies and practices;
14. Having working knowledge of current health and safety rules and regulations, training, reporting requirements, and standard operating procedures associated with regulated substances. Such knowledge may be supplemented and developed through research and training materials;
15. Working with research staff to review existing SOPs and assist with the development of new SOPs for working with hazardous chemicals;
16. Providing technical guidance and investigation, as appropriate, for laboratory and other types of accidents and injuries;
17. Helping to determine medical surveillance requirements for potentially exposed personnel;
18. Reviewing plans for the installation of engineering controls and new facility construction/renovation, as needed;
19. Ensuring that waste is disposed of in an appropriate manner;
20. Maintaining inspections and personnel training records;
21. Reviewing and evaluating the effectiveness of the CHP at least annually and updating it as needed.

Chapter 2: Chemical Hazard Communication

Regulatory Requirements

UMCES-AL is responsible for providing information about the hazardous substances in our workplace, the associated hazards, and the control of these hazards, through a comprehensive hazard communication program that is summarized briefly below. UMCES-AL has an established Hazard Communication Program that complies with the OSHA Hazard Communication Standard (CFR 1910.1200). The purpose of this program is to ensure that all employees and, upon request, their personal physicians, have the right to receive information regarding the hazardous substances to which they may have been exposed at work. The requirements of the Hazard Communication Program apply to laboratory environments at UMCES-AL due to the potential for large-scale experiments and for activities that may occur outside of areas where engineering controls are available. Proper hazard communication involves the active participation of the PI/Lab Supervisor and AL's CHSO, who are each responsible for providing consultation and safety information to employees working with hazardous chemicals.

Lists of Hazardous Substances

AL's CHSO maintains a list of hazardous substances used in the facility through AL's chemical inventory system. For each hazardous substance on the inventory, specific information on any associated health or safety hazards must be made readily available to all laboratory personnel.

Hazard Determination

The term "hazardous substance" refers to any chemical for which there is statistically significant evidence from at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed individuals.

Any novel chemical produced should be presumed hazardous. Chemical derivatives of known materials should be assumed at least as hazardous as their known parent compound. Novel compounds should be treated with extreme caution to prevent exposure.

Safety Data Sheets (SDS)

A Safety Data Sheet (SDS), formerly known as a Material Safety Data Sheet (MSDS) must be available for each hazardous substance in AL's chemical inventory. SDSs are available through AL's online SDS library located at the following URL: https://login.ehs.com. The username is ALViewer. The password is 301Braddock!. Hard copies are also provided in

individual laboratories specific to each lab's current chemical inventory.

SDSs are standardized with the following minimum sections:

1. Identification of the substance or mixture and of the supplier
    a. GHS product identifier
    b. Other means of identification
    c. Recommended use of the chemical and restrictions on use
    d. Supplier's details
    e. Emergency phone number
2. Hazards identification
    a. GHS classification of the substance/mixture and any national or regional information
    b. GHS label elements, including precautionary statements and hazard symbols
    c. Other hazards that do not result in a GHS classification or are not covered by the GHS
3. Composition/information on ingredients
    a. Substance
        i. Chemical identity
        ii. Common name, synonyms, etc.
        iii. CAS number, EC number, etc.
        iv. Impurities and stabilizing additives that contribute to the classification of the substance
    b. Mixture
        i. The chemical identity and concentration ranges of all ingredients considered to be hazardous under GHS and are present at or above their cutoff levels
4. First aid measures
    a. Description of necessary measures, subdivided according to the different routes of exposure, e.g., inhalation, skin and eye contact, and ingestion
    b. Most important symptoms/effects, acute and delayed
    c. Indication of immediate medical attention and special treatment needed, if necessary
5. Firefighting measures
    a. Suitable (and unsuitable) extinguishing media
    b. Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products)
    c. Special protective equipment and precautions for firefighters
6. Accidental release measures
    a. Personal precautions, protective equipment, and emergency procedures
    b. Environmental precautions
    c. Methods and materials for containment and cleaning up
7. Handling and storage

a. Precautions for safe handling
b. Conditions for safe storage, including any incompatibilities

8. Exposure controls/personal protection
    a. Control parameters (e.g., occupational exposure limit values or biological limit values
    b. Appropriate engineering controls
    c. Individual protection measures, such as personal protective equipment (PPE)
9. Physical and chemical properties
    a. Appearance (physical state, color, etc.)
    b. Odor
    c. Odor threshold
    d. pH
    e. Melting point/freezing point
    f. Initial boiling point and boiling range
    g. Flash point
    h. Evaporation rate
    i. Flammability (solid, gas)
    j. Upper/lower flammability or explosive limits
    k. Vapor pressure
    l. Vapor density
    m. Relative density
    n. Solubility
    o. Partition coefficient
    p. Auto-ignition temperature
    q. Decomposition temperature
10. Stability and reactivity
    a. Chemical stability
    b. Possibility of hazardous reactions
    c. Conditions to avoid (e.g., static discharge, shock or vibration)
    d. Incompatible materials
    e. Hazardous decomposition products
11. Toxicological information
    a. Concise, but complete and comprehensible description of the various toxicological (health) effects and the available data used to identify those effects, including:
    b. Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact);
    c. Symptoms related to the physical, chemical, and toxicological characteristics;
    d. Delayed and immediate effects and also chronic effects from short- and long-term exposure;
    e. Numerical measures of toxicity (such as acute toxicity estimates).

12. Ecological information
    a. Eco-toxicity (aquatic and terrestrial, where available)
    b. Persistence and degradability
    c. Bio-accumulative potential
    d. Mobility in soil
    e. Other adverse effects
13. Disposal considerations
    a. Description of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging
14. Transport information
    a. UN number
    b. UN proper shipping name
    c. Transport hazard class(es)
    d. Packing group, if applicable
    e. Marine pollutant (Yes/No)
    f. Special precautions of which a user needs to be aware or with which to comply in connection with transport or conveyance either within or outside their premises
15. Regulatory information
    a. Safety, health, and environmental regulations specific to the product in question
16. Other information including information on preparation and revision of the SDS

Labels and Other Forms of Warning

Every chemical in the laboratory (including nonhazardous materials, like water) must be labeled properly. Unlabeled containers of chemicals are a violation of Maryland State regulations and a serious hazard for laboratory personnel. Disposal of unlabeled chemicals is time-consuming and expensive.

Labeling requirements for all hazardous substances are summarized as follows:

- All containers of purchased hazardous materials or materials intended for distribution must be labeled with the identity of the hazardous substance;
- The label must contain all applicable hazard warning statements;
- The name and address of the chemical manufacturer, generator, or other responsible party must be present;
- Manufacturer's product labels must remain on all containers and must not be defaced in any way. Appropriate hazard warning statements must be present, if not that information must be added;
    - If a container is going to be reused, ensure that all the material has been

removed and that the label has been completely removed. Never put a new label over an old label.

- Labels must be legible, in English, and prominently displayed;
- Symbols and/or other languages are required for non-English speaking employees;
- Working containers (such as squirt bottles) must be labeled with the identity of the substance and include appropriate hazard warnings;
- Prepared mixtures and/or buffers must be labeled with the appropriate hazard warnings based on the knowledge of the chemical and physical properties of that substance;
- Newly synthesized compounds must be labeled with the employee's information and the chemical name or structure if known;
- Global Harmonization System symbols should be used when labeling containers.

Laboratory Door Signs

Laboratory hazard warning signs are required at the entrance to every laboratory to alert laboratory personnel, visitors, and first responders to the specific hazards located in that laboratory. Laboratory personnel can request updated door signs through AL's CHSO. These warning signs must be updated whenever there are changes to the hazards or emergency contact personnel.

Employee Information and Training

Employee training on specific workplace hazards must be provided at the time of initial assignment, whenever a new hazard is introduced into the workplace, and whenever employees may be exposed to hazards in other work areas. Training is available online at AL's Safety Web (https://safetyweb.al.umces.edu/). In-person training is available for anyone needing additional training or training in a different format. Additional employee training is required whenever a new hazard is introduced into the work environment and must be provided within 30 days of receiving the SDS and before the employee starts work with the new hazard. All training must be in the appropriate langue, educational level, and vocabulary for laboratory personnel. Employees must also be given the opportunity to ask questions.

Global Harmonization System (Hazard Communication Standard Pictograms)

Health Hazard  • Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	**Flame**  • Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • a-Reactives • Organic Peroxides	**Exclamation Mark**  • Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)
Gas Cylinder  • Gases Under Pressure	**Corrosion**  • Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	**Exploding Bomb**  • Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle  • Oxidizers	**Environment** (Non-Mandatory)  • Aquatic Toxicity	**Skull and Crossbones**  • Acute Toxicity (fatal or toxic)

Chapter 3: Classes of Hazardous Chemicals

Regulatory Requirements

Implementation of the necessary work practices, procedures, and policies outlined in this chapter is required by OSHA's Hazard Communication Standard (CFR 1910.1200) and Laboratory Standard ((29 CFR 1910.1450).

Identification & Classification of Hazardous Chemicals

Chemicals can be divided into several different hazard classes. The hazard class will determine how a chemical should be stored and handled and what special equipment and procedures are needed to use it safely.

Each chemical container, whether supplied by a vendor or produced in the laboratory, must include labels that clearly identify the hazards associated with that chemical, using the GHS. In additional to specific chemical labels, hazard information for specific chemicals can be found referencing the Safety Data Sheet (SDS) for that chemical.

It is essential that all laboratory workers understand the types of hazards, recognize the routes of exposure, and are familiar with the major hazard classes of chemicals. In many cases, the specific hazards associated with new compounds and mixtures will not be known, so it is recommended that all chemical compounds be treated as if they were potentially harmful and to use appropriate eye, inhalation, and body protection equipment at all times.

Flammability Hazards

A number of highly flammable substances are common in university laboratories. Flammable liquids include those chemicals that have a flashpoint of less than 200 degrees Fahrenheit. These materials must be stored in self-closing flammable storage cabinets in aggregate quantities of 10 gallons or more per room. If less than 10 gallons, flammables may be stored in regular cabinets. Flame-resistant lab coats must be worn when working with any amount of pyrophoric materials, when working with large quantities (1 Liter or more) of flammable materials, and/or with procedures where a significant fire risk is present (e.g., when working with open flame, etc.). Even though the use of these materials is fairly common in the lab setting, they can constitute a significant immediate threat and should be treated with particular care. Particular attention should be given to preventing static electricty and sparks when handling flammable liquids. For example, a metal dispensing container should always be bonded and grounded when pouring or dispensing liquid to prevent the buildup of static

electricity and prevent the formation of sparks, which will cause a fire.

Reactivity Hazards

Reactive and explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release large volumes of gases and heat. Some materials, such as peroxide formers, may not be explosive, but may form explosive substances over time. These substances pose and immediate potential hazard and procedures that use or produce them must be carefully reviewed. These materials must also be stored in a separate flame-resistant cabinet or in a laboratory-grade refrigerator or freezer that is designed for flammable and reactive chemicals. Peroxide-formers can only be stored in refrigerators when unopened. Never store opened peroxide-formers (e.g., ether) in a refrigerator or freezer. Opened containers must be stored in a dry environment.

Pyrophoric chemicals are a special classification of reactive materials that spontaneously combust when in contact with air and require hazard-specific training. Flame-resistant lab coats must always be worn at all times when working with reactive chemicals. These reactive chemicals have the potential to cause highly energetic reactions that may result in a fire or explosion. Materials that pose a reactivity hazard should be purchased in the smallest practical size.

Health Hazards

The term "health hazard" includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

The major classes of "hazardous" and "particlarly hazardous substances" and their related health and safety risks are detailed below. A particularly hazardous substance (PHS) is a select carcinogen, reproductive toxin, and/or a substance that has a high degree of acute toxicity. Extreme care should be taken to prevent exposure to these types of substances and immediate treatment be sought upon possible exposure to chemicals that are considered to be health hazards. Particularly hazardous substances require additional planning and considerations.

Corrosive Substances

As a health hazard, corrosive substances cause destruction of, or alterations in, living tissue by chemical action at the site of contact.

Major classes of corrosive substances include:

- Strong acids (e.g., sulfuric, nitric, hydrochloric, and hydrofluoric acids)
- Strong bases (e.g., sodium hydroxide, potassium hydroxide, and ammonium hydroxide)
- Dehydrating agents (e.g., sulfuric acid, sodium hydroxide, phosphorus pentoxide, and calcium oxide)
- Oxidizing Agents (e.g, hydrogen peroxide, chloride, and bromine)

Corrosive materials should always be stored below eye level to reduce the probability of splashing the chemical into the eyes. Symptoms of inhalation exposure include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting. For eye exposures, symptoms may include redness, pain, inflammation, bleeding, irritation, blistering, and burns. As a physical hazard, corrosive substances may corrode materials with which they come in contact and may be highly reactive with other substances. It is important to review information regarding the materials they mar corrode, and their reactivity with other substances, as well as information on health effects. In most cases, these materials should be segregated from other chemicals and require secondary containment when in storage.

Irritants

Irritants are defined as non-corrosive chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are irritants. The most common example of an irritant may be ordinary smoke, which can irritate the nasal passages and respiratory system. Consequently, eye and skin contact with all laboratory chemicals should always be avoided. Symptoms of exposure can include reddening or discomfort and irritation to the respiratory system.

Sensitizers

A sensitizer (allergan) is a substance that causes exposed persons to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of sensitizers include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic

halides, and many phenol derivatives. Sensitizer exposure can lead to all of the symptoms associated with allergic reactions, or can increase an individual's existing allergies. Caution should be taken when using these chemicals, eye and skin contact with all laboratory chemicals should always be avoided. However, inhalation of sensitizers can also lead to an allergic response; therefore, it is recommended that sensitizers always be used in a fume hood or with adequate ventilation. The material should be weighed in a balance that is located in a hood or in a location with adequate ventilation to prevent inhalation. Never have an open container of a sensitizer outside of a fume hood or in a space without adequate ventilation.

Hazardous Substances with Toxic Effects on Specific Organs

Substances in this category include the following:

- Hepatotoxins - substances that produce liver damage (e.g., nitrosamines and carbon tetrachloride)
- Nephrotoxins - agents causing damage to the kidneys (e.g., halogenated hydrocarbons)
- Neurotoxins - substances which produce their primary toxic effects on the nervous system (e.g., mercury, acrylamide, carbon disulfide)
- Hematopoietic agents - decrease hemoglobin function and deprive the tissues of oxygen (e.g., carbon monoxide, cyanides)
- Pulmonary agents - result in negative impacts to the lungs (e.g., asbestos, silica)

Symptoms of exposure to these materials can vary. Staff working with these materials should review the SDS for the specific material being used and should take note of the associated symptoms of exposure.

Particularly Hazardous Substances

OSHA recognizes that some classes of chemical substances pose a greater health and safety risk than others. To differentiate this elevated risk characteristic, OSHA identifies two categories of hazardous chemicals:

1. Hazardous chemicals; and
2. Particulary hazardous substances.

Substances that pose such significant threats to human health are classified as "particularly hazardous substances" (PHSs)

Particularly hazardous substances are divided into three primary types:

1. Acutely Toxic Chemicals
2. Reproductive Toxins
3. Carcinogens

Acutely Toxic Chemicals

Substances that have a high degree of acute toxicity are interpreted by OSHA as being substances that "may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration". These chemicals, associated chemical waste, and their storage containers must be handled with care to prevent cross-contamination of work areas and unexpected contact. Extreme care should be taken to avoid any route of exposure (e.g., inhalation, skin contact, ingestion, or injection). These chemicals must be labeled as "Toxic". Empty containers of these substances must be packaged and disposed of as hazardous waste without rinsing trace amounts into the sanitary sewer system. The SDS should be reviewed and understood prior to working with or handling toxic chemicals in the lab. Where applicable antidotes to a toxic substance must be on hand and easily accessible (e.g., calcium gluconate for labs using hydrofluoric acid), every member of the lab must be aware of first aid measures in case of exposure.

Reproductive Toxins

Reproductive toxins include any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Reproductive toxins can affect the reproductive health of both men and women if appropriate procedures and controls are not employed. For women, exposure to reproductive toxons during pregnancy can cause adverse effects on the fetus; these effects include embrolethality (death of the fertilized egg, embryo, or fetus), malformations (teratogenic effects), and postnatal functional effects. For men, exposure can lead to sterility, in addition to mutagenesis that can affect future generations.

Examples of embryotoxins include thalidomide and certain antibiotics, like tetracycline. Persons with childbearing potential should note that embryotoxins have the greatest impact during the first trimester of pregnancy. Because someone often may not know that they are pregnant during this period of high susceptibility, special caution is advised when working with all chemicals at all times, especially those that can be rapidly absorbed through the skin (e.g., formamide). Pregnant persons and those intending to become pregnant should consult with their lab supervisor and AL's CHSO before working with substances that are suspected to be reproductive toxins.

Carcinogens

Carcinogens are chemical or physical agents that cause cancer. Generally, they are chronically toxic substances, which means that they cause damage after repeated or long-duration exposure. Their effects may only become evident after an extended period of latency. Chronic Toxins are particularly insidious because they may have no immediately apparent harmful effects. Following is the definition OSHA provides for carcinogen in its Use of Hazardous Chemicals in the Laboratory Standard.

OSHA Definition: Select carcinogen means any substance that meets one of the following criteria:

I. It is regulated by OSHA as a carcinogen; or
II. It is listed under the category "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); (https://ntp.niehs.nih.gov/whatwestudy/assessments/cancer/index.html) or
III. It is listed in either Group 2A or 2B by the International Agency for Research on Cancer (IARC) or under the category "reasonably anticipated to be carcinogens" by NTP (https://monographs.iarc.who.int/monographs-available/) , and causes statistically significant tumor incidence in experimental animals in accordace with any of the following criteria:
    A. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);
    B. After repeated skin application of less than 300 mg/kg of body weight per week; or
    C. After oral dosages of less than 50 mg/kg of body weight per day.

Chapter 4: How to Reduce Exposures to Hazardous Chemicals

Regulatory Requirements

Implementation of the necessary work practices, procedures, and policies outlined in this chapter is required by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard"; https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450).

Introduction

Hazardous chemicals require a carefully considered, muti-tiered approach to ensure safety. There are four primary routes of exposure to chemicals:

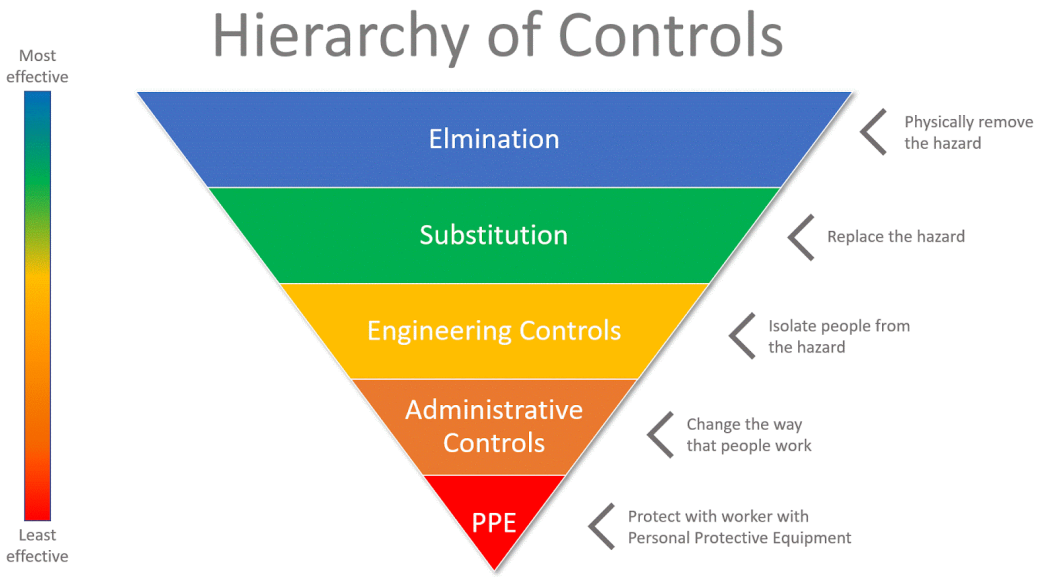
1. Inhalation;
2. Absorption (through the skin or eyes);
3. Ingestion; and
4. Injection (skin being punctured by a contaminated sharp object or uptake through an existing open wound).

Of these, the most likely route of exposure in the lab is by inhalation. Inhalation can provide some materials with direct access to the bloodstream and/or central nervous system. Inhalation can also lead to ingestion if the inhaled materials become entrapped in mucous or saliva that gets swallowed. Many hazardous chemicals may affect people through more than one of these exposure modes, therefore it is critical that protective measures are established for each of these possible uptake mechanisms.

Safety Controls

Controlling exposures to hazards in the workplace is vital to protecting workers. The hierarchy of controls is a way of determining which actions will best control exposures. The hierarchy of controls has five levels of actions to reduce or remove hazards. The preferred order of action based on general effectiveness is:

1. Elimination;
2. Substitution;
3. Engineering Controls;
4. Administrative Conrols; and
5. Protective Apparel and Equipment.



Elements of these five controls are used in a layered approach to help create a safe working environment. Each element is detailed below:

Elimination

Elimination removes the hazard at the source. This could include changing the work process to stop using a toxic chemical, heavy object, or sharp tool. It is the preferred solution to protect workers because no exposure can occur.

Substitution

Substitution employs a safer alternative to the source of the hazard. An example might be using ethanol to preserve biological specimens instead of formaldehyde.

When considering a substitute, it's important to compare the potential new risks of the substitute to the original risks. This review should consider how the substitute will combine with other agents in the workplace. Effective substitutes reduce the potential for harmful effects and do not create new risks.

Elimination and substitution can be the most difficult actions to adopt into an existing process. These methods are best used at the design or development stage of a work process, place, or tool. At the development stage, elimination and substitution may be the simplest and cheapest option. Another good opportunity to use elimination and substitution is when selecting new equipment or procedures.

Engineering Controls

Engineering controls include all "built in" safety systems. They reduce or prevent hazards from coming into contact with workers. Engineering controls can include modifying equipment or the workspace, using protective barriers, ventilation, and more. They generally require minimal special procedures or actions on the part of the user except in emergency situations. A fundamental and very common example is the laboratory fume hood, which is very effective at containing chemical hazards and protecting users from inhalation hazards. Other examples include general room ventilation, flammable material storage units, and secondary containment.

Ventilation Controls

Ventilation controls are controls intended to minimize employee exposure to hazardous chemicals by removing air contaminants from the work area. There are two main types of ventilation controls:

- General (dilution) exhaust - a building-wide system that brings in air from outside and ventilates within. Lab air is continually replaced, preventing the increase of air concentration of toxic substances.
- Local exhaust - a ventilated, enclosed workspace intended to capture, contain, and exhaust harmful or dangerous fumes, vapors, or particulate matter generated by procedures conducted with hazardsous chemicals (e.g., fume hood, snorkel hood to exhaust lab equipment)

To determine ventilation requirements, assess the SDS. Some SDS terminology, as provided below, may indicate a need for special ventilation considerations beyond general exhaust ventilation:

- Use with adequate ventilation
- Avoid vapor inhalation
- Use in a fume hood
- Provide local exhaust ventilation

Fume Hoods

It is strongly recommended to use a laboratory fume hood when working with hazardous substances. Conduct all operations that may generate air contaminants at or above the appropriate PEL or TLV inside a fume hood. Additionally, a laboratory fume hood or other suitable containment device must be used for all work with PHSs. Fume hoods are evaluated for operation and certified annually. Data on annual fume hood monitoring is maintained by AL's CHSO.

Each fume hood is equipped with a continuous quantitative monitoring device designed to provide the user with current information on the operational status of the hood. Most hoods have motion sensors to determine when they are not in active ue. These sensors will reduce the fume hood's air flow to save energy when labs are unoccupied. When hazardous materials are in a fume hood, but it is not under active use, the sash should be kept closed. Never store hazardous materials in a fume hood. Some particularly hazardous chemicals or corrosive substances will corrode the fume hood and the duct work.

General Rules for Fume Hood Use

Observe the following general rules when using laboratory fume hoods:

1. Fume hoods must not be used for work involving hazardous substances unless they have a label that confirms certification within the past year.
2. Do not use the hood as a waste disposal mechanism (e.g., evaporating organic solvents).
3. Minimize foot traffic and other forms of potential air disturbances past the face of the hood.
4. Always keep hazardous materials more than 6 inches beyond the plane of the sash.
5. Never put your head inside an operating fume hood.
6. Work with the sash in the lowest practicable position to use it as a safety shield. Do not clutter the hood with unnecessary equipment or containers that can impede air circulation. Only materials actively in use should be inside the hood.
7. Never make any modifications to hoods, duct work, or the exhaust system. If you suspect a problem with your fume hood, contact AL's CHSO.
8. Do not use large equipment in a fume hood unless it has been dedicated for this purpose because large obstructions can change airflow patterns and render the hood unsafe.
9. Keep the sash closed when not actively using the fume hood. It will save energy and also help maintain containment.
10. Never work with hazardous chemicals if the required ventilation system is not working.

Other Engineering Controls

Consideration must be given to providing engineering controls for the storage and handling of hazardous materials. No more than 10 gallons of flammable chemicals may be stored outside of an approved flammable storage cabinet. For refrigerated or frozen storage, flammable and explosive materials must be kept in explosion-proof refrigeration units specifically designed for storing these materials. Generally, these units do not have

internal lights or electronic systems that could spark and trigger an ignition; additionally, the cooling elements are external to the unit. These units should be labled with a rating from Underwriters Laboratory (UL) or another certifying organization.

Secondary containment must be employed for corrosive and reactive chemicals and is strongly recommended for all other hazardous chemicals. Secondary containment should be made of chemically resistant materials and should be sufficient to hold 100% of the largest container's volume or 10% of the aggregate volumes of all containers, whichever is greater.

Laboratories that use hazardous materials must contain a sink, kept clear for handwashing to remove any final residual contamination. This sink must have soap present to allow for effective hand washing. Hand washing with soap is recommended whenever a staff member who has been working with hazardous materials plans to exit the laboratory or work on a project that does not involve hazardous materials.

Administrative Controls

Administrative controls establish work practices that reduce the duration, frequency, or intensity of exposure to hazards. These types of controls are generally not as reliable as engineering controls because the user typically must follow appropriate procedures and must be fully trained and aware in order to do so. Each laboratory must have safety procedures that include safety practices for any work that involves hazardous materials. These safety procedures should be laboratory-specific and communicated by lab-specific trainings, SOPs, or Job Safety Analyses and be properly documented. An example of an administrative control is developing an SOP for the safe use of hydrofluoric acid in the laboratory.

Standard Operating Procedures

Standard Operating Procedures (SOPs) that include safe work practices and hazard controls are required for all hazardous laboratory tasks, including those involving hazardous chemicals and processes. A risk assessment should be performed prior to development of an SOP so that appropriate controls can be selected to mitigate the identified risks.

SOPs should include:

- Summary of hazards inherent to the materials, equipment, and processes
- Safe work practices, including the use of the Hierarchy of Controls (elmination, substitution, engineering controls, administrative controls, and personal protective equipment)

- Identification of any required procedure-specific training
- Identification of designated areas for storage and use of particularly hazardous substances
- Waste handling procedures that satisfy regulatory requirements
- Procedures for site and personal decontamination, both for routine experiments and in the event of an accident or emergency

AL's CHSO maintains tools and resources that may be referenced while developing SOPs and is also available to assist with SOP development.

Protective Apparel and Equipment

PPE is equipment worn to minimize exposure to hazards. Examples of PPE include gloves, safety glasses, hearing protection, hard hats, and respirators. In some situations, additional or more protective PPE must be used. For example, if an activity involves a chemical splash hazard, chemical splash goggles are required and face shields may also be required when working with chemicals that could cause immediate skin damage. Furthermore, heavy gloves and protective aprons/sleeves may also be needed.

PPE must be provided to employees under the appropriate circumstances. Employees must be trained on the proper use of any PPE issued to them and employees have the responsibility of properly using such equipment.

The SDS may be consulted for information on recommended PPE and safety procedures recommended for a given chemical, although the SDS may not provide adequate information concerning the specific type of safety equipment to use. AL's CHSO should be consulted for additional information on the use and selection of personal protective equipment.

Personal protective equipment (PPE) serves as a researcher's last line of defense against chemical exposures and is required by everyone entering a laboratory containing hazardous chemicals. PPE requirements for labs include but are not limited to the following:

- Full length pants and closed-toe shoes, or equivalent
- Confining of any loose clothing and long hair
- Protective gloves, lab coats, and eye protection when working with, or adjacent to, hazardous chemicals
- Flame-resistant lab coats should be used when working with materials that pose a fire hazard
- Anyone using pyrophoric materials must use Nomex gloves that provide a fire resistant liner with a chemical resistant outer layer.

Eye Protection

Eye protection must be made available to all employees or visitors to labs where hazardous chemicals are used and stored. Protective eye and face equipment must be used where there is a reasonable probability of injury from hazardous chemicals that can be prevented from such equipment. The minimum acceptable requirements are for hardened glass or plastic safety spectacles. The PI/Lab Supervisor should establish the level of eye protection needed per lab activity. Specialized types of eye protection, such as ultraviolet light restricting safety glasses, are also available. The following types of eye protection are recommended for use in the laboratory by the American National Standards Institute (ANSI):

- All eye protective devices must be stamped with "Z87" by the manufacturer to indicate that they meet ANSI standards.
- Safety glasses with side shields offer minimal protection from flying fragments, chips, particles, sand, and dirt. When a splash hazard exists, other protective eye equipment, like impact goggles, must be worn.
- Safety, or impact, goggles only offer protection against flying particles. These need to be worn when working with glassware under reduced or elevated pressure or with shop tools and equipment, like drill presses. They do NOT provide protection against liquid splashes.
- Chemical splash goggles provide indirect venting to provide adequate protection from splashes. Chemical splash goggles offer the best eye protection from splashes.
- Face shields protect the face and neck from both flying particles and splashes. Always were additional eye protection under face shields. Ultraviolet-light face shields should be worn when working around unshielded UV light sources.

Protection of Skin and Body

Skin and body protection involves the use of protective clothing to protect individuals from chemical exposure. Consider the properties of the chemical(s) being used to determine the clothing needed because protective garments are not equally effective for every hazardous chemical. Some chemicals will permeate a garment in a very short time, whereas others will not. The basic and most effective forms of skin and body protection are gloves and lab coats.

Protect exposed skin surfaces whenever there is a reasonable expectation of a possible splash. Open-toed shoes, sandals, shorts, etc., are not permitted when working in chemical laboratories.

Even when there is minimal danger of skin contact with an extremely hazardous

substance, lab coats, coveralls, aprons, protective sleeves, and protective suits should be utilized. These garments should not leave the work area.

Exposures to strong acids and acid gases, organic chemicals, strong oxidizing agents, carcinogens, and mutagens require the use of specialized protective equipment that prevents skin contamination. Impervious protective equipment, like heavy dute, resistant gloves, aprons, boots, and protective suits, must be utilized.

In cases where spills or splashes of hazardous chemicals on clothing or PPE occur, the cloting/PPE should be removed immediately and placed in a container or bag that prevents release of the chemical. Heavily contaminated clothing and PPE resulting from an accidental spill and PPE that is contaminated with PHSs should be disposed of as hazardous waste. Laboratory personnel should never take contaminated items home for cleaning or laundering. Any laundry that is contaminated with potentially infectious materials must be bagged at the location where it was used and should be placed in containers labeled with the universal biohazard symbol until it can be laundered off-site by a professional laundry service. Persons or companies hired to clean contaminated items must be informed of potentially harmful effects of exposure to hazardous chemicals.

Respirators

The use of respirators in labs to protect from chemical exposure is strongly discouraged. Engineering controls, like fume hoods, should always be used in preference to respirators. The use of respirators is only permitted in cases where engineering controls are not feasible. Any individuals that need to use a respirator must be enrolled in AL's respirator program, which will include physician approval, training, and fit-testing.

Laboratory Safety Equipment

New personnel must be instructed on the location of fire extinguishers, safety showers, eye washes, and other safety equipment before they begin work in the laboratory.

Safety Showers

Safety showers provide an immediate water drench of an affected person. AL recommends the following ANSI standards for location, design, and maintenance of safety showers:

- Showers shall be located within 25 feet of areas where chemicals with a pH < 2.0 and > 12.5 are used.
- Showers shall be located within 100 feet of areas where chemicals with a pH > 2 and < 4 or > 9 and < 12.5 are used.

- The location of the shower should be clearly marked, well-lit, and free from obstacles.
- Safety showers are inspected annually.

Eyewash Facilities

Eyewash stations should be within 25 feet or 10 seconds of travel for laboratories where injurious or corrosive chemicals are used or stored. Additional considerations for eyewash stations are recommended:

- Ideally, anyone affected must have both hands available to hold open the eye to ensure an effective wash behind the lids, which means providing eyewash facilities that are operated by a quick release system and simultaneously drench both eyes.
- Eyewash facilities must provide a minimum of a 15-minute water supply at no less than 0.4 gallons per minute.
- Eyewash facilities must not exceed 25 pouds per square inch (PSI) pressure.
- Eyewash facilities must be activated/flushed for at least 10 to 15 minutes once per week to ensure clean water flow.

In the event of an emergency, individuals using the safety shower/eyewash should be assisted by an uninjured person to aid in decontamination and should be encouraged to stay in the shower or eyewash for at least 15 minutes to remove all hazardous material.

Fire Extinguishers

All laboratories must be outfitted with appropriate fire extinguishers. All extinguishers should be wall-mounted in an area free of clutter. Research personnel should be familiar with the location, use, and classification of the fire extinguishers in their work area.

Lab personnel are NOT required to extinguish fires that occur in their work areas and should not attempt to do so unless:

- It is a small fire (e.g., small trash can sized or a small, contained fire in a fume hood)
- Appropriate fire extinguisher training has been received
- It is safe to do so

Any time that a fire extinguisher is discharged, regardless of how little, the PI/Lab Supervisor, or most senior lab personnel present at the time of the incident, must immediately report the incident to AL's CHSO because the fire extinguisher will need to be recharged as soon as possible. In the case of an emergency, dial 911 and pull the building-wide fire alarm.

Safe Laboratory Habits

As detailed above, a safety program must include multiple layers of policies and protective equipment to provide for the safest possible working environment. To achieve and maintain effectiveness, a number of fundamental elements must become basic working habits for the research community. Some of these elements are detailed below:

Personal Protective Equipment

- Wear closed-toe and closed-heel shoes, full length pants or equivalent at all times when in the lab
- Utilize appropriate PPE while in the lab and while performing procedures that involve the use of hazardous chemicals or materials
- Confine long hair, loose clothing, and accessories
- Remove lab coats and gloves immediately upon significant contamination AND before leaving the lab
- If you wear contact lenses, be aware that fumes from concentrated acids and solvents can cause eye irritation and damage to lenses. If eye irritation occurs, immediately remove lenses and rinse eyes with clean water.
- Use any protective and emergency apparel and equipment as appropriate.
- Make yourself aware of the locations of first aid kits, the emergency eyewash, and the shower station
- Change gloves frequently. Rinse re-usable gloves following each use.
- Wear the appropriate gloves for the hazardous material or process.
- Never touch your gloves to any surface that should not be contaminated (e.g., your face, your phone, your computer, lab phone). Always remove your gloves before touching a surface that others may touch with bare hands.
- Keep your lab coat buttoned when working in the laboratory.
- Remove your lab coat when leaving the lab and wash your hands with soap and water.
- Don't wear or store your lab coat in a non-laboratory area.

Chemical Handling

- Use the smallest amount of chemical needed for your procedure or experiment. Only use the amount of chemical that is appropriate for the available ventilation system.
- Any apparatus that may contain or discharge toxic chemicals must exhaust into local exhaust systems (e.g., fume or snorkel hood) and not into the lab
- Properly label and store all chemicals. Always read all labels and warning signs.
- Use secondary containment at all times.
- Deposit chemical waste in appropriately labeled receptacles and follow all other

waste disposal procedures of the Chemical Hygiene Plan.

- Do not allow release of toxic substances or fumes into rooms that re-circulate the atmosphere (e.g., cold rooms or freezers).
- Do not smell or taste chemicals.
- Never use mouth suction for pipetting or starting a syphon.
- Do not dispose of any hazardous chemicals through the sewer system. These substances might interfere with the biological activity of wastewater treatment plants, create fire or explosion hazards, cause structural damage, obstruct flow, or harm the environment.
- Be prepared for an accident, spill, or power outage. Refer to the emergency response procedures for the specific material.

Equipment Storage and Handling

- Use equipment only for its intended/designated purpose
- Store lab glassware with care to avoid damage. Use extra care with Dewar flasks and other evacuated glass apparatuses.
- Use certified fume hoods, glove boxes, or other ventilation devices for operations which might result in release of toxic chemical vapors or dust.
- Keep fume hood sashes closed when you are not using the hood.
- Do not used damaged glassware or equipment
- Avoid storing materials in hoods
- Do not use uncertified fume hoods or glove boxes for hazardous chemical handling
- Do not allow vents or air flow to be blocked
- All electrical equipment should be grounded and kept in good condition.

Lab Operations

- Keep work areas clean and uncluttered. Never keep unnecessary materials or equipment in the work area.
- Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before starting any new lab activity.
- If unattended operations are unavoidable and have been approved by the PI/Lab Supervisor, place an appropriate sign on the door, leave lights on, and provide for containment of toxic substances in the event of an equipment or utility failure.
- Be alert to unsafe conditions and ensure that they are corrected as soon as they are detected.
- Research staff and students must participate in both general training and lab-specific training.
- Research staff and students should never work alone on procedures involving hazardous chemicals, biological agens, or physical hazards.
- Do not engage in distracting behavior such as practical jokes in the lab.

- Cover all cuts, abrasions, open sores, and bruises with waterproof tape and/or a bandage and disposable gloves. Always report all injuries to your supervisor.
- Keep all corridors, doorways, and emergency exits clear and accessible. Three feet of egress is required by Maryland state fire code.
- Understand the procedures in case of an emergency (e.g., fire, earthquake, lab accident, chemical spill, etc.)
- Promptly report all injuries, spills, releases of hazardous materisl, and near-misses to AL's CHSO.

Food/Drink

- Never eat, drink, smoke, chew gum, or apply cosmetics (including lip balm) in areas where hazardous chemicals are handled or stored; wash hands before conducting any of these activities.
- Do not store, handle, or consume food or beverages in storage areas, refrigerators, glassware, or utensils that are also used for lab operations.
- Wash areas of exposed skin well with soap and water before leaving the lab.
- Do not put any objects (e.g., pencils, pens, fingers, swabs, etc.) in the mouth, ears, nose, etc. when working in a lab.

Mobile Devices

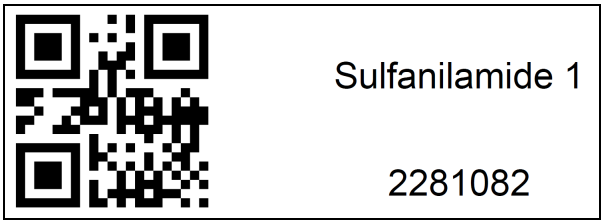
- Never touch your mobile device while wearing gloves.
- Never place your mobile device on any laboratory surface that may be contaminated with chemicals.
- Mobile devices can act as an ignition source. Do not use a mobile device when handling flammable materials.

Chapter 5: Inventory, Labeling, Storage, and Transport

Regulatory Requirements

Implementation of the necessary work practices, procedures, and policies outlined in this chapter is required by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

Chemical Inventories



AL maintains laboratory chemical inventories from the point of purchase through AL's Online Purchasing System. Following order submittal, AL's CHSO adds the new chemical container(s) to the lab's inventory in the online SDS library, which is located at the following URL: https://login.ehs.com. The username is ALViewer. The password is 301Braddock!. QR codes labels are generated for each container that has been assigned a unique inventory control number and is provided to the PI/Lab Supervisor or technician who ordered the chemical. Upon arrival, the researcher adds the QR code label to the appropriate container. AL's CHSO will also confirm whether a copy of the SDS exists in the laboratory-specific binder. If not, a copy will be provided to the relevant laboratory. Where practical, each chemical should be dated so that expired chemicals can be easily identified for disposal. Peroxide forming chemicals should be dated when received to determine proper disposal date. Inventory the materials in your laboratory frequently (at least annually) and reconcile disposed containers and new chemical containers to avoid overcrowding with materials that are no longer useful and note the items that should be replaced, have deteriorated, or show container deterioration. Unneeded and compromised items should be discarded as chemical waste. Indications for disposal include:

- Cloudiness in liquids
- Color change
- Evidence of liquids in solids, or solids in liquids
- "Puddling" of material around the outside of containers
- Pressure build-up within containers
- Obvious deterioration of containers

When containers are consumed, researchers should rinse the container 6 times or more with tap water and reserve the container for removal from the inventory. On termination or transfer of laboratory personnel, all related hazardous materials should be properly

disposed of, or transferred to the laboratory supervisor or a designee.

Access to hazardous chemicals, including toxic and corrosive substances, should be restricted at all times. These materials must be stored in laboratories or storerooms that are kept locked when laboratory personnel are not present.

Chemical Labeling

Every chemical found in the laboratory must be properly labeled. Most chemicals come with a manufacturer's label that contains the necessary information, so care should be taken to not damage or remove these labels. Each chemical bottle, including diluted chemical solutions, must be labeled with its contents and the hazards associated with this chemical. It is recommended that each bottle also be dated when received and when opened to assist in determining which chemicals are expired and require disposal. When new chemicals and compounds are generated by laboratory operations, these new chemical bottles must be labeled with the name of the chemical or compound, date of generation, hazard information and the name of the generator or other party responsible for this chemical so that they may be contacted if questions arise about the container's contents.

Peroxide forming chemicals (e.g., ethers) must be labeled with the date the chemical was received and the date the bottle was first opened. Do not store chemicals past their discard date and make sure a regular peroxide testing regiment is followed. These chemicals can degrade to form heat sensitive, shock sensitive, highly reactive compounds and should be stored and labeled very carefully. If you find a suspicious container, DO NOT move it or try to dispose of it on your own, notify coworkers and contact AL's CHSO at 301-689-7122, immediately.

Particularly Hazardous Substances (see Chapter 3) require additional labeling to identify the specific hazard associated with each of these chemicals (carcinogen, reproductive toxin, acutely toxicant). In addition, the storage area where they are kept must be labeled with the type of hazard. These chemicals should be segregated from less hazardous chemicals to help with proper access control and hazard identification.

Chemical Storage and Segregation

Establish and follow safe chemical storage & segregation procedures for your laboratory.

Storage guidelines are included for materials that are flammable, oxidizers, corrosive, water-reactive, explosive and highly toxic. The specific Safety Data Sheet (SDS) should always be consulted when doubts arise concerning chemical properties and associated

hazards. All procedures employed must comply with Cal/OSHA, Fire Code and building code regulations. Always wear appropriate personal protective equipment (e.g., laboratory coat, safety glasses, gloves, safety goggles, apron, etc.) when handling hazardous chemicals. Be aware of the locations of the safety showers and emergency eyewash stations. Each laboratory is required to provide appropriate laboratory-specific training on how to use this equipment and conduct lab specific training on the use/storage of hazardous chemicals prior to working with hazardous chemicals.

General Recommendations

Each chemical in the laboratory must be stored in a specific location and returned there after each use. Acceptable chemical storage locations may include corrosive cabinets, flammable cabinets, laboratory shelves, or appropriate refrigerators or freezers designed for the storage of hazardous chemicals. Fume hoods should not be used as general storage areas for chemicals, as this will seriously impair the ventilating capacity of the hood. Chemicals should not be routinely stored on bench tops or stored on the floor. Chemicals should be returned to their appropriate storage containers when not in use. Additionally, bulk quantities of chemicals (i.e., larger than one-gallon) should be stored in a separate storage area, such as a stockroom or supply room.

Hazardous liquids or corrosive chemicals should not be stored on shelves above eye-level and chemicals which are highly toxic or corrosive should be in unbreakable secondary containers.

Chemicals must be stored at an appropriate temperature and humidity level and should never be stored in direct sunlight or near heat sources, such as laboratory ovens. Incompatible materials should be stored in separate cabinets, whenever possible. If these chemicals must be stored in one cabinet, due to space limitations, adequate segregation and secondary containment must be ensured to prevent adverse reactions. All stored containers and research samples must be appropriately labeled and tightly capped to prevent vapor interactions and to alleviate possible inhalation hazards. Flasks with cork, rubber or glass stoppers should be avoided because of the potential for leaking.

Laboratory refrigerators and freezers must be labeled appropriately with “No Food/Drink” and must never be used for the storage of consumable materials. Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations. Never store opened peroxide formers (e.g., ether) in a refrigerator or freezer!

Flammable and Combustible Liquids

Flammables should not be stored alongside combustible materials like paper and packaging nylon bags. Large quantities of flammable or combustible chemicals should not be stored in the laboratory. The maximum total quantity of flammable and combustible liquids must not exceed 60 gallons within a flammable storage cabinet. The maximum quantity allowed to be kept outside a flammable storage cabinet, safety can, or approved refrigerator/freezer is 10 gallons per room. The maximum total quantity of flammable and combustible liquids allowed in one fire control area is 120 gallons this includes flammables kept within a flame cabinet. Only the amounts needed for the current procedure should be kept on bench tops or fume hoods and the remainder should be kept in flammable storage cabinets, explosion-proof refrigerators/freezers that are approved for the storage of flammable substances, or approved safety cans or drums that are grounded. Always segregate flammable or combustible liquids from oxidizing acids and oxidizers. Flammable materials must never be stored in domestic-type refrigerators/freezers and should not be stored in a refrigerator/freezer if the chemical has a flash point below the temperature of the equipment. Flammable or combustible liquids must not be stored on the floor or in any exit access.

Handle flammable and combustible substances only in areas free of ignition sources and use the chemical in a fume hood whenever practical. Only the amount of material required for the experiment or procedure should be stored in the work area. Always transfer flammable and combustible chemicals from glass containers to glassware or from glass container/glassware to plastic. Transferring these types of chemicals between metal containers may lead to a fire hazard due to static electricity. If you must transfer a Class 1A flammable chemical (e.g., diethyl ether, pentane) from a metal container make sure that the equipment is bonded and grounded.

Pyrophoric and Water-Reactive Substances

Because pyrophoric substances can spontaneously ignite on contact with air and/or water, they must be handled under an inert atmosphere and in such a way that rigorously excludes air and moisture. Some pyrophoric materials are also toxic and many are dissolved or immersed in a flammable solvent. Other common hazards include corrosivity, teratogenicity, or peroxide formation.

Only minimal amounts of reactive chemicals should be used in experiments or stored in the laboratory. These chemicals must be stored as recommended in the SDS. Reactive materials containers must be clearly labeled with the correct chemical name, in English, along with a hazard warning.

Suitable storage locations may include inert gas-filled desiccators or glove boxes; however, some pyrophoric materials must be stored in a flammable substance approved freezer. If pyrophoric or water reactive reagents are received in a specially designed shipping, storage or dispensing container (such as the Aldrich Sure/Seal packaging system), ensure that the integrity of that container is maintained. Ensure that sufficient protective solvent, oil, kerosene, or inert gas remains in the container while pyrophoric materials are stored. Never store reactive chemicals with flammable materials or in a flammable liquids storage cabinet.

Oxidizers

Oxidizers (e.g., hydrogen peroxide, ferric chloride, potassium dichromate, sodium nitrate) are substances that cause or contribute to combustion of other materials. They should be stored in a cool, dry place and kept away from flammable and combustible materials (e.g., wood, paper, Styrofoam, plastics, flammable organic chemicals), and away from reducing agents (e.g., zinc, alkaline metals, and formic acid).

Peroxide Forming Chemicals

Peroxide forming chemicals (e.g., diethyl ether, cyclohexene, tetrahydrofuran) should be stored in airtight containers in a dark, cool, and dry place and must be segregated from other classes of chemicals that could create a serious hazard to life or property should an accident occur (e.g., acids, bases, oxidizers). The containers should be labeled with the date received and the date opened. This information, along with the chemical identity should face forward to minimize container handling. These chemicals should also be tested and documented for the presence of peroxides on a timeline according to their classification. Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation.

Carefully review all cautionary material supplied by the manufacturer prior to use. Avoid evaporation or distillation, as distillation defeats the stabilizer added to the solvents. Ensure that containers are tightly sealed to avoid evaporation and that they are free of exterior contamination or crystallization. Never return unused quantities back to the original container, contamination can cause the formation of peroxides. Make sure to clean all spills immediately.

If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date, if the date of the container is unknown, or if you do not feel comfortable handling the container), do not handle and/or touch the

container. If crystallization is present in or on the exterior of a container, do not handle and/or touch the container. These circumstances indicate the presence of peroxides which are heat, shock, and friction sensitive, even moving the container can lead to a high energy reaction. Secure the bottle, inform lab members not to touch the bottle, and contact AL's CHSO, immediately for pick-up and disposal.

Corrosives

Store corrosive chemicals (e.g., acids, bases) below shoulder level and in secondary containers that are large enough to contain at least 10% of the total volume of liquid stored or the volume of the largest container, whichever is greater. Acids must always be segregated from bases and from active metals (e.g., sodium, potassium, magnesium) at all times and must also be segregated from chemicals which could generate toxic gases upon contact (e.g., sodium cyanide, iron sulfide).

Specific types of acids require additional segregation. Organic acids should be segregated from inorganic acids (mineral acids). Oxidizing acids must be segregated from organic compounds including organic acids, flammable and combustible substances. Perchloric acid and hydrofluoric acid should be stored by themselves, away from all other chemicals. Picric Acid is reactive with metals or metal salts and explosive when dry and must contain at least 10% water to inhibit explosion. Perchloric acid that is heated must be used in a specific fume hood to prevent formation of explosive powder residue, if your lab plans to use perchloric acid inform AL's CHSO immediately.

Special Storage Requirements

Compressed Gases and Toxic Gases

Compressed gas cylinders that are stored in the laboratory must be chained to the wall or cylinder storage rack, with the safety cap in place. The cylinders must be restrained by two chains at all times; one chain must be placed at one third from the top of the cylinder, and the other placed at one third from the bottom of the cylinder. No more than three cylinders may be chained together with one chain. Bolted "clam shells" may be used in instances where gas cylinders must be stored or used away from the wall. Store gas cylinders securely in the upright position. Cylinders containing certain gases are prohibited from being stored in a horizontal position, including those which contain liquefied fuel or a water volume of more than 5 liters. Do not expose cylinders to excessive dampness, corrosive chemicals or fumes.

Certain gas cylinders require additional precautions. Flammable gas cylinders must use

only flame-resistant gas lines and hoses which carry flammable or toxic gases from cylinders and must have all connections wired. Compressed oxygen gas cylinders must be stored at least 20 feet away from combustible materials and flammable gases.

Gas cylinder connections must be inspected frequently for deterioration and must never be used without a regulator. Never use a leaking, corroded or damaged cylinder. Never refill compressed gas cylinders. When stopping a leak between the cylinder and regulator, always close the valve before tightening the union nut. The regulator must be replaced with a safety cap when the cylinder is not in use. When moving gas cylinders, verify first that the safety cap is in place and only use carts designed for this purpose.

On-Campus Distribution of Hazardous Chemicals

Precautions must be taken when transporting hazardous substances between laboratories and between buildings within the campus. Chemicals must be transported between stockrooms and laboratories in break-resistant, secondary containers such as commercially available bottle carriers made of rubber, metal, or plastic, that include carrying handle(s) and which are large enough to hold the contents of the chemical container in the event of breakage. In the case of big quantities or more than one chemicals being transported the appropriate cart with build-in secondary containment should be utilized and high traffic areas need to be avoided. Never use a secondary container that will react with or is incompatible with the chemical that is being transported.

When transporting cylinders of compressed gases, always secure the cylinder with straps or chains onto a suitable hand truck and protect the valve with a cover cap. Avoid dragging, sliding, or rolling cylinders and when an elevator is required for transport to another floor, do not permit passengers on the elevator car with the tank.

Off-Campus Distribution of Hazardous Chemicals

The transportation of hazardous chemicals and compressed gases over public roads, or by air, is strictly governed by international, federal, and state regulatory agencies, including the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA). Any person who prepares and/or ships these types of materials must ensure compliance with pertinent regulations regarding training, quantity, packaging, and labeling. Without proper training, it is illegal to ship hazardous materials. Those who violate the hazardous materials shipment regulations are subject to criminal investigation and penalties. AL personnel who sign hazardous materials manifests, shipping papers, or those who package hazardous material for shipment, must be trained and certified by AL's CHSO. Shipping and receiving chemicals internationally have additionally regulations including the Toxic Substances Control Act (TSCA).

Chapter 6: Training

Regulatory Requirements

Implementation of the necessary work practices, procedures, and policies outlined in this chapter is required by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

Institutional Training

Effective training is critical to facilitate a safe and health work environment and prevent laboratory accidents. All personnel are required to complete the online Right to Know safety training (https://safetyweb.al.umces.edu/) during their initial onboarding process.

Laboratory-Specific Training

Laboratory personnel must also receive training on the specific hazardous materials, equipment, and processes present in the laboratory. Laboratory-specific training must cover:

- General laboratory rules and restrictions
- Physical and health hazards associated with chemicals in the laboratory
- Routine research-related activities (chemical use, storage locations, waste handling, equipment maintenance, etc.)
- Measures that personnel must take to protect themselves from chemical hazards, including engineering controls, personal protective equipment, and emergency safety equipment
- Hazardous materials storage and use locations
- Standard operating procedures
- Methods and observations used to detect the presence or release of a hazardous chemical
- Signs and symptoms of exposure to hazardous chemicals
- Clean-up and decontamination procedures
- Emergency response procedures
- Specialized training for high hazard tasks, including proficiency demonstration prior to independent work

All laboratory personnel must complete general laboratory safety training and lab-specific training before:

- Beginning work in the laboratory;

- Prior to new exposure situations; and
- As work conditions change.

Documentation of Training

Accurate recordkeeping is a critical component of health and safety training. AL's CHSO documents all health and safety training.

Chapter 7: Inspections and Compliance

Regulatory Requirements

Implementation of the necessary work practices, procedures, and policies outlined in this chapter is required by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

Laboratory Safety Inspections

AL has a comprehensive laboratory safety compliance program to assist laboratories and other facilities that use, handle or store hazardous chemicals to maintain a safe work environment. This program helps to ensure compliance with regulations and to fulfill UCI's commitment to protecting the health and safety of the campus community.

As part of this laboratory safety program, AL's CHSO conducts annual safety inspections of laboratories and other facilities with hazardous chemicals to ensure the laboratory is operating in a safe manner and to ensure compliance with all federal, state and university safety requirements. The primary goal of inspection is to identify both existing and potential injury-causing hazards, actions, faulty operations and procedures that can be corrected before an incident occurs.

The laboratory safety inspection is comprehensive in nature and looks into all key aspects of working with hazardous chemicals. While inspections are a snapshot in time and cannot identify every accident-causing mistake, they do provide important information on the overall operation of a particular laboratory. They can also help to identify weaknesses that may require more systematic action across a broader spectrum of laboratories, and strengths that should be fostered in other laboratories.

Chapter 8: Hazardous Waste Management

Federal EPA regulations also govern certain aspects of hazardous waste management, since most of our waste is treated and disposed out of state. These hazardous waste regulations are part of the Resource Conservation and Recovery Act, or RCRA.

AL's Hazardous Waste Program manages the shipment and disposal of all hazardous waste generated on campus. Each laboratory employee must comply with the campus Hazardous Waste Management Program requirements and all applicable regulations. Hazardous waste pick-up service is provided to all UCI hazardous waste generators. Laboratory personnel are responsible for identifying hazardous waste, segregating, labeling, and storing it properly in the laboratory. Laboratory clean-outs and disposal of high hazard compounds must be scheduled in advance. The PI/Laboratory Supervisor is responsible for coordinating the disposal of all chemicals from their laboratories prior to closing down laboratory operations.

Definition of Hazardous Waste

Federal and State regulations define hazardous waste as a substance that poses a hazard to human health or the environment when improperly managed. A chemical waste is considered hazardous if it is either listed on one of the lists of hazardous wastes found in the Federal or State regulations, or exhibits one or more of the four characteristics listed below.

- Ignitability
    - Flashpoint < 140°F
    - Capable of causing fire at standard temperatures and pressure through friction, absorption of moisture, or spontaneous chemical changes
    - Is an ignitable compressed gas
    - Is an oxidizer
- Corrosivity
    - Liquid with pH less than or equal to 2 or greater than or equal to 12.5
    - Solid with pH less than or equal to 2 or greater than or equal to 12.5 when mixed with equal weight of water
- Reactivity
    - Normally unstable and readily undergoes violent change
    - Reacts violently with water or air
    - Forms potentially explosive mixtures with water
    - Is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes
    - Is capable of detonation or explosive decomposition if subjected to a strong initiating source or heated under confinement

    - Is readily capable of detonation or reaction at standard temperature and pressure
- Toxicity
    - Has an acute oral LD50 less than 2,500 mg/kg
    - Has an acute dermal LD50 less than 4,300 mg/kg
    - Has an acute inhalation LC50 less than 10,000 ppm as a gas or vapor
    - Has an acute aquatic 96-hour LC50 less than 500 mg/L
    - Has been shown through experience or testing to pose a hazard to human health or the environment because of its ability to cause cancer or mutations (carcinogen, mutagen, teratogen), acute toxicity, chronic toxicity, bio-accumulative properties, or persistence in the environment.

The EPA definition of hazardous waste also extends to the following items:

- Abandoned chemicals
- Unused or unwanted chemicals
- Chemicals in deteriorating containers (e.g., broken caps, corroded, cracked bottle)
- Empty containers that have visible residues
- Containers with conflicting labels
- Unlabeled or unknown chemicals

Extremely Hazardous Waste

Certain compounds meet an additional definition known as "extremely hazardous waste". This list of compounds includes carcinogens, pesticides, and reactive compounds, among others (e.g., formaldehyde, chloroform, and hydrofluoric acid). The Federal EPA refers to this waste as "acutely hazardous waste". NOTE: While there is some overlap with the list of Particularly Hazardous Substances, such as the examples listed above, the extremely hazardous waste list is specific to the hazardous waste management program.

Waste Management

Training

All personnel who are responsible for handling, managing, or disposing of hazardous waste must participate in training prior to working with these materials. Laboratory specific hazardous waste training should also be conducted prior to working with hazardous materials. Laboratory specific hazardous waste training should include information relevant to handling, managing, or disposing of the specific hazardous waste generated in the laboratory (e.g., waste streams generated in the laboratory, incompatible waste streams, and proper waste labeling).

Waste Identification

All the chemical constituents in each hazardous waste stream must be accurately identified by knowledgeable laboratory personnel. This is a critical safety issue for both laboratory employees and the waste technicians that handle the waste once it is turned over to AL's CHSO. Mixing of incompatible waste streams has the potential to create violent reactions and is a common cause of laboratory accidents. DO NOT mix waste streams and never put incompatible materials in the same waste container. Always check the contents of a waste container before adding waste to the container. If there is uncertainty about the composition of a waste stream resulting from an experimental process, laboratory workers must consult the PI/Laboratory Supervisor or AL's CHSO. In most cases, careful documentation and review of all chemical products used in the experimental protocol will result in accurate waste stream characterization.

The manufacturer's SDS provides detailed information on each hazardous ingredient in laboratory reagents and other chemical products, and the chemical, physical, and toxicological properties of that ingredient. To avoid incompatible mixtures review the stability and reactivity section (section 10) in the SDS which contains a list of incompatible materials.

Labeling

Storage

The hazardous waste storage area in each laboratory is considered a Satellite Accumulation Area (SAA) by the EPA. According to EPA requirements, this area must remain under the control of the persons producing the waste. This means that it should be located in an area that is supervised and is not accessible to the public. Other SAA requirements include:

- Hazardous waste must be disposed of within 6 months of being generated through AL's CHSO
- Hazardous waste containers must be stored with secondary containment adequately sized to contain all the contents of the primary container
- Hazardous waste containers must be kept closed except when adding waste
- Dispose of damaged containers immediately through AL's CHSO
- Do not dispose of chemicals by pouring them down the drain or placing them in the trash
- Do not evaporate chemicals; always cap waste containers to prevent unintended evaporation

- Hazardous waste streams must have compatible constituents and must be compatible with the containers in which they are stored (e.g., never use glass containers for hydrofluoric waste)
- To avoid accidental exposure, never open waste containers outside of the fume hood
- Hazardous waste containers must be appropriately labeled at all times
- Only fill hazardous waste containers three quarters full

Segregation

All hazardous waste must be segregated to prevent mixing incompatible chemicals Proper segregation is essential to avoid uncontrolled hazardous reactions. Segregation should be by hazard class (e.g., flammables, oxidizers, pyrophoris, inorganic acid, organic acid, base, toxic, etc.). Mixing incompatibles can lead to accidents and emergencies, so it is important to avoid mixing incompatible materials.

Examples of appropriate segregation include:

- Segregating acids from bases
- Segregating oxidizers from organic compounds
- Segregation of cyanides from acids
- Keeping flammables away from oxidizers

Section 10 of the SDS can provide information about specific chemical incompatibility.

Incompatible Waste Streams

Mixing incompatible waste streams or selecting a container that is not compatible with its contents are common causes of accidents in labs and waste storage facilities. Reactive mixutres can rupture containers and explode, resulting in serious injury and property damage. All chemical constituents and their waste by-products must be compatible for each waste container generated. Waste labels must be immediately updated when a new constituent is added to a mixed waste container so that others in the lab are aware. Never add to a waste container if you are not fully aware of its contents. Never mix waste streams and always keep incompatible materials separated.

A common incompatible waste stream is oxidizers added to any fuel. This can trigger an exothermic reaction and result in an explosion. The most frequently encountered reaction is acids oxidizing flammable liquids. All flammable liquids must be pH tested before they are consolidated.

Wastes That Require Special Handling

Unlabeled chemical containers and unknown/unlabeled wastes are considered to be unknowns. Disposable of unknowns incur additional disposal cots because the materials need to be analyzed and identified. Therefore, it is critically important to maintain accurate waste stream labels. Unknowns must be labeled with the word "unknown". Never mix unknown materials for any reason. Inform AL's CHSO immediately if you find an unknown container or waste bottle.

Peroxide Forming Chemicals

Peroxide forming chemicals (PFCs) include a number of substances that can react with air, moisture, or product impurities that triggers a change in their chemical composition during under normal storage conditions to form peroxides. They are highly reactive and can explode upon friction, shock, or spark. It is particularly dangerous to allow a container of PFCs evaporate to dryness, which leaves peroxide crystals on the surfaces of the container. PFCs must always be kept tightly capped and regularly inspected for degradation. Containers of PFCs should be dated with the date received AND the date it was first opened. PFC containers must be disposed of prior to their expiration date.

If old containers of PFCs are discovered in the lab, DO NOT handle, touch, or move the container. Even small movements of a bottle containing peroxides can result in an explosion. Secure it and contact AL's CHSO for pick-up and disposal.

Particularly Hazardous Substances

Waste containers containing particularly hazardous substances (PHS) must be stored within designated areas. Waste containers with PHSs should only be opened within a designated fume hood. Funnels for PHS waste should be dedicated for that purpose.

Managing Empty Containers

Most empty containers do not have to be managed as hazardous waste with the exception of containers that once held acutely or extremely hazardous materials. To be considered empty:

- Any remaining material cannot be poured or scraped from its container, or
- An aerosol container must have its contents and pressure completely dispensed with the spray mechanism in place and functional, and
- Less than five gallons in size

Transportation

It is a violation of Department of Transportation (DOT) regulations to transport hazardous waste in personal vehicles or to carry hazardous waste across campus streets that are open to the public.

Disposal

How to request a disposal pick up?

Hazardous Waste Minimization

In order to reduce the amount of chemicals that become waste, administrative and operational waste minimization controls should be considered.

Purchasing Control

Inventory Control

Operational Controls

It is the policy of UMCES to comply with all federal, state, and local regulations regarding the proper storage, handling, labeling, transportation, and disposal of all regulated wastes, including hazardous (chemical), infectious, and radiological materials. The UMCES Hazardous Waste Management Plan is administered by each unit's Chemical Hygiene Officer. The plan addresses the management of chemical and residual wastes, and is incorporated by reference into this Chemical Hygiene Plan. Specific aspects of the plan as they affect waste management generated by the laboratory are summarized in this section.

Chapter 9: Emergency/Medical Procedures

Overview

Laboratory emergencies may result from a variety of factors, including serious injuries, fires, explosions, spills, exposures, and natural disasters. All laboratory employees should be familiar with and aware of the location of their lab's emergency response procedures. Before beginning any laboratory task, it is critical to know what to do in the event of an emergency situation. Identify the location of safety equipment, including first aid kits, eye washes, safety showers, fire extinguishers, fire alarm pull stations, and spill kits. Plan ahead and know the location of the closest fire alarms, emergency exits, and telephones in your work areas. AL's Emergency Guide flip chart posted at all phones and at most common areas provides an overview of emergency response procedures.

Basic Steps for Emergency and Spill Response

Releases of hazardous substances that pose a significant threat to health and safety or that, by their very nature, require an emergency response regardless of the circumstances surrounding the release or the mitigating factors are emergency situations. The following definitions designate emergency situations:

- The situation is unclear to the person causing or discovering the spill.
- The release requires evacuation of persons.
- The release involves or poses a threat of fire, suspected fire, explosion or other imminent danger; conditions that are Immediately Dangerous to Life and Health (IDLH); high levels of exposure to toxic substances.
- The person(s) in the work area is uncertain they can handle the severity of the hazard with the available personal protective equipment (PPE) and response equipment and/or the exposure limit could easily be exceeded.

Conversely, releases that do not pose a significant safety or health hazards to person(s) in the immediate vicinity or to the person(s) cleaning up the material and do not have the potential to become emergencies within a short time frame are not emergency situations. The following situations are non-emergency situations:

- The person causing or discovering the release understands the properties and can make an informed decision as to the exposure level.
- The release can be appropriately cleaned by lab personnel.
- The materials are limited in quantity, exposure potential, or toxicity and present minor safety or health hazards to persons in the immediate work area or to those assigned to clean up the activity.

General Handling of Spills

All spills should be promptly evaluated to determine the following:

1. What is the material and approximately how much has spilled?
2. What are the hazards associated with the spilled material?
3. Does the employee have appropriate training and PPE to handle the problem?
4. Is there a risk to other employees?

For any spill, regardless of its size or type of chemical involved, first alert fellow employees and visitors that a spill has occured. If it is determined that extreme danger is present due to flammability and/or noxious fumes, evacuate all personnel from the affected area. Secure the area if necessary.

Before attempting to contain or clean up a chemical spill, determine and don the appropriate level of personal protective equipment. Appropriate protection might include safety goggles, apron, lab coat, resistant gloves, and/or respiratory protection. Next, determine the appropriate method of handling by reviewing the Safety Data Sheet, label, or other sources of information.

Spillages of organic solvents, acids, or alkali are effectively cleaned up with "Spill Control Pillows". These pillows contain highly absorptive silica which is capable of retaining up to 1 liter of liquid. Be aware that these pillows do not reduce the toxicity or flammability hazard of the material. Their purpose is to absorb the material and prevent further spreading. Strong oxidizing acids will destroy the pillow fabric. Some chemicals will have to be neutralized or diluted before they can be absorbed onto the pillow.

Clean Up Procedure

1. Initiate any appropriate action to prevent a larger problem. If the liquid is flammable, all sources of ignition (electrical, open flame) must be shut off. To reduce irritant vapors, the area of the spill should be well ventilated.
2. Alert all staff to avoid area of spill.
3. Wear protective clothing when cleaning up spill (chemical resistant gloves, eye protection, respirator, etc. based on the specific hazards of the material).
4. Determine the volume of the spill. For each liter of liquid spilled use one Spill Control Pillow or comparable absorbent. Large spills with flowing liquid should be diked with booms to prevent further spread. Small spills (less than 100 mL) can be easily handled with absorbent paper towels and copious rinsing with water.
5. Clean up the spill by pressing the pillow into the spill or applying an alternative absorbent to the spill area. Allow the absorptive action of the pillow to absorb the spill. Do not use a "wiping" actions to clean-up the spill.

6. Disposal. Spill Control Pillows and absorbents cannot be re-used or used to clean up spills of different type of material because violent chemical reactions can occur. Used pillows should be bagged (or containerized), labeled, and reserved for disposal.
7. Decontamination. Rinse the area with water and dry. Check yourself to determine whether or not you have spilled any chemical on yourself or your clothing. If so, discard clothing or clean as appropriate. After the area is clean and fumes have dissipated, evacuated personnel may return to the room and normal operations may resume.

Note the following special precautions:

- Acid and Alkalis - Spill Control Pillows do not neutralize acid or alkali. It is important to first neutralize acid spills with dry sodium carbonate (or bicarbonate) or a commercial acid neutralizing solution. Neutralize alkali spills with boric acid or commercial caustic spill neutralizing compound. Add until bubbling ceases. Flush with copious amounts of water.
- Organic Solvents - As the Spill Control Pillow does not eliminate the fire hazard associated with organic solvents it is recommended that the Pillows be placed in a fume hood until they can be properly containerized prior to disposal.
- Mercury - Accidental spills of mercury must be cleaned up immediately to prevent toxic vapors from entering the air and to prevent contamination of surface or water systems by large or microscopic droplets. If traces of mercury are left in laboratories as the result of mercury spills, worker health can be affected over a period of time. In areas of spills, mercury vapor in the air can exceed 20 mg/m3 (T.L.V. is 0.05 mg/m3) depending on the conditions in the lab and the amount spilled. It is recommended that each laboratory that uses equipment containing mercury stock a Mercury Spill Control Kit. Other locations should stock Mercury Absorbent Sponges to handle small spills.
- Large Spills (>½ lb.) - Wear protective plastic gloves, respirator and chemical resistant clothing. Use the suction pump to pick up puddles and droplets of mercury. For efficient operation of the pump, keep the reservoir at about the same level as the spill. The stainless steel adapter tube is useful for picking up mercury droplets in crevices. Transfer all mercury in the reservoir to a plastic container with a screw cap. Seal tightly and label "Waste Mercury". After removal of large mercury droplets with the suction pump, use either the sponges or the powder to complete clean-up (see below).
- Small Spills - On flat surfaces use the mercury absorbent sponges. Dampen the sponge and slowly wipe the contaminated area. Allow for complete absorption of all free mercury. Return the used sponge in its plastic bag, seal tightly and label "Mercury Waste". Waste material should be held for disposal according to the facility Waste Disposal Plan. For spills that are difficult to access, sprinkle the

contaminated area with a fine layer of the mercury absorbent powder. Overlay the powder with wet paper towels to moisten the powder. Allow 10 to 15 minutes for the mercury to react with the powder and form an amalgam. As the amalgam lowers the vapor pressure of mercury, it can then be cleaned up by conventional means (eg. a vacuum cleaner) and disposed with the routine waste.

Chemical Exposures

Chemical Splash

If you witness or are made aware of an accident where an individual is the victim of a chemical splash:

1. Remove the individual from contact as promptly and completely as possible. Contaminated clothing should be removed immediately.
2. The affected area should be flushed with water by emergency shower, face flush, or whatever means is quickly available. If the individual is wearing safety goggles, do not remove them until the face area has been flushed. When chemical is splashed in the eyes, the lids should be forcibly held apart so that the entire surface of the eye is flushed.
3. Do not use neutralizing agents, buffering agents, or chemical antidotes.
4. When the affected area has been flushed extensively, the employee should seek immediate medical attention. If a stretcher is necessary to transport the employee, call 911 for an ambulance.
5. The Lab Supervisor and CHSO, if not present, should be contacted immediately.

Chemical Inhalation

When an individual inhales chemical gases, vapors, fumes, or mists and exhibits any symptoms of adverse exposure:

1. Remove the victim from exposure immediately. If victim is located in a confined space or the chemical is toxic, do not risk additional victims and dial 911 for emergency assistance.
2. Dilute the concentration of the material in air by opening nearby fume hoods and pressing the “Emergency” button.
3. Keep the victim warm and lying down.
4. If the victim has stopped breathing, begin artificial respiration and send someone to retrieve the Automated External Defibrillator (AED). CARDIOPULMONARY RESUSCITATION (CPR) SHOULD ONLY BE ADMINISTERED BY CERTIFIED PERSONNEL. Select someone to dial 911 for an ambulance.

5. If the victim has not stopped breathing, they should seek immediate medical attention. If a stretcher is needed, call 911.
6. The source of the chemical gas or vapor should be cut off. Depending on the type of chemical, respiratory protection equipment may be required.
7. Contact the Lab Supervisor and CHSO immediately.

Injury and Illness

The Employee's First Report of Injury form must be completed on all work-related employee injuries. The Supervisor's Report of Injury and the Accident Witness Statement should also be completed.

Medical Consultations and Examinations

Health assessments prior to work assignment for new employees may be required under certain circumstances.

UMCES must provide employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations that the examining physician determines to be necessary, under the following circumstances:

- When an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee must be provided an opportunity to receive an appropriate examination.
- Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) for an OSHA-regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
- Whenever an event takes place in the work area, such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultations shall be for the purpose of determining the need for a medical examination.
- All medical consultations and examinations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

The CHSO or PI shall provide the following information to the physician:

- The identity of the hazardous chemical(s) to which the employee may have been exposed.
- A description of the conditions surrounding the exposure, including available quantitative exposure data.
- A description of the signs and symptoms of exposure that the employee is experiencing if any.
- A copy of the SDS(s).

The department shall obtain a written opinion from the examining physician that shall include the following:

- Any recommendations for further medical follow-up.
- The results of the medical examination and any associated tests.
- Any medical condition that may be revealed in the course of the examination that may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace.
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
- The written opinion of the physician shall not reveal the specific finding of diagnoses unrelated to occupational exposure.