



Chemical Hygiene Plan

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Notice and Disclaimer

The following information is believed to be accurate and represents the best information currently available to the Department of Environmental Health and Safety (EHS) and Occupation Safety and Environmental Health (EHS). The University of Michigan – Dearborn (UM-Dearborn) and The University of Michigan and its employees make no warranty of merchantability of fitness for purpose intended, or any other warranty, expressed or implied with respect to such information, and we assume no liability resulting from its use or from any inaccuracy or incompleteness. Users should make their own investigations to determine the suitability of the information for their particular use. This Chemical Hygiene Plan is not to be sold, distributed, or marketed for profit. This Chemical Hygiene Plan contains a compilation of information gathered from copyrighted materials and is not to be distributed outside of the University of Michigan.

1.0 LABORATORY SAFETY MANAGEMENT POLICY

1.1 POLICY STATEMENT

This Chemical Hygiene Plan (CHP) establishes a written program in accordance with the requirements of the Michigan Occupational Safety and Health Act (MIOSHA) Part 431 Hazardous Work in Laboratories Standard R 325-70100. The CHP is available on the [EHS website](#). The plan will be reviewed annually by EHS and updated as necessary.

The intent of this CHP is to protect University of Michigan - Dearborn employees and all personnel working in UM-Dearborn laboratories from hazardous chemicals and promote a healthy and safe work environment. The CHP includes information to ensure that all laboratory personnel have working knowledge about the hazardous chemicals they use. The CHP is also intended to provide information on best practices in laboratory health and safety.

1.2 SCOPE

The UM-Dearborn CHP applies to all research, teaching, student and other laboratories at the University of Michigan - Dearborn covered by the [Hazardous Work in Laboratories Standard](#). The standard applies to all facilities where the “laboratory use of hazardous chemicals” occurs. A “hazardous chemical” is defined as a chemical for which there is evidence that acute or chronic health effects may occur in exposed personnel. “Laboratory use of hazardous chemicals” is defined as handling or use of such chemicals in which all of the following conditions are met:

- A. Chemical manipulations are carried out on a “laboratory scale”, or work with substances in which the containers used are designed to be easily and safely manipulated by one person;
- B. Multiple chemical procedures or chemicals are used;
- C. The procedures involved are not part of a production process, nor in any way simulate a production process;
- D. “Protective laboratory equipment” is available and in common use to minimize the potential for exposure to hazardous chemicals.

This CHP does not address in detail work with radioactive materials, biological agents or bloodborne pathogens. Procedures for work with these materials are addressed via the University’s [Radiation Safety webpage](#), [Biosafety Manual](#), and [Exposure Control Plan](#) respectively.

1.3 RESPONSIBILITIES

Everyone working at the University of Michigan - Dearborn has the right to expect a safe and healthy work environment. They also have a responsibility to help assure a safe and healthy environment for themselves and others. Everyone has an important role.

According to U-M [Standard Practice Guide \(SPG\) 605.01](#) “Every faculty member and person in a supervisory position is responsible for maintaining conditions which will provide for the safety, well-being and safe conduct of all people who report to him/her or who frequent his/her area.” In the research laboratory it is the responsibility of the Principal Investigator (PI) to provide a healthy and safe work environment and to comply with applicable regulations. Other non-research laboratories, teaching laboratories, clinical laboratories or core facilities may instead have a laboratory director. For the purpose of this CHP the terms PI and Lab director may be used interchangeably and are meant to

indicate the person with the highest level of authority within the lab. The following section designates areas of responsibility for safety at the University of Michigan - Dearborn.

The Departmental Unit is responsible to support safety in departmental laboratories and off-site research, and to help provide resources as needed to ensure student, staff, and faculty safety.

The Principal Investigator (PI) is responsible for determining, implementing, and documenting appropriate safety policies and procedures in accordance with the UM-Dearborn Chemical Hygiene Plan. The PI, by default, is the CHO of their lab. The PI may delegate the safety duties for which he/she is responsible, but must make sure that any delegated safety duties are carried out. The following is a detailed list of PI responsibilities:

- Complete and maintain the laboratory-specific CHP Blue Binder (Document Binder).
- Develop written Standard Operating Procedures (SOP) for hazards beyond those identified in the CHP such as Particularly Hazardous Chemicals or highly reactive chemicals or higher risk experimental procedures.
- Enforce safe work practices and adherence to the CHP and Standard Operating Procedures.
- Complete and update a list of hazardous chemicals in the lab annually.
- Perform routine periodic inspections of their research operations as noted in this CHP. Confirm engineering controls and safety equipment is functional. Promptly correct problem areas and document all inspections and follow-up actions.
- Identify hazardous conditions or operations in the lab; determine safe procedures and controls.
- Provide an approval process for the use of PI restricted chemicals or procedures.
- Provide laboratory personnel access to the CHP and CHP Blue Binder.
- Train laboratory personnel to work safely with hazardous chemicals and operations, and maintain records of training provided.
- Maintain appropriate and functional personal protective equipment (e.g., gloves, goggles).
- Report laboratory accidents and injuries to [WorkConnections](#) and EHS.
- Make available required medical surveillance or medical consultation/examination for laboratory personnel.
- Inform non-laboratory personnel and outside contractors of potential lab-related hazards when they are required to work in the laboratory. Minimize potential hazards to provide a safe environment for the work.
- Continuously evaluate the efficacy and applicability of the SOP in the CHP Blue Binder.

Lab Director/Manager are responsible for assisting in the development and enforcement of safe policies and procedures in the laboratories. The following is a detailed list of responsibilities:

- Assist the PI in the creation of a CHP Blue Binder.
- Assist the PI in the selection of appropriate safety controls, laboratory practices, personal protective equipment, engineering controls, and training.
- Perform hazard assessments, upon request.

All Personnel in Laboratories are responsible for learning and following safe work practices. This includes employees, volunteers, students, and visitors in UM-Dearborn laboratories. The following is a detailed list of responsibilities:

- Read and follow the CHP and the CHP Blue Binder.
- Follow oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- Keep the work areas safe and uncluttered.
- Review and understand the hazards of materials and processes in their laboratory research prior to conducting work.
- Utilize appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls.
- Understand the capabilities and limitations of personal protective equipment issued to them.
- Gain prior approval from the PI for the use of restricted chemicals.
- Consult with the PI before using higher risk chemicals or conducting certain higher risk experimental procedures. Examples of higher risk procedures include procedures that may involve: high temperature, high pressure, high energy, explosives, toxic gases, high volumes of flammable liquids, or pyrophoric materials.
- Promptly report accidents and unsafe conditions to the PI.
- Complete all required health, safety and environmental training.
- Participate in the medical surveillance program, when required.
- Inform the PI of any work modifications ordered by a physician as a result of medical surveillance, an occupational injury or exposure.

The Department of Environmental Health and Safety (EHS) is responsible for administering and overseeing institutional implementation of this Plan. EHS also provides technical guidance to personnel at all levels of responsibility on matters pertaining to the laboratory use of hazardous chemicals. The following are EHS responsibilities:

- Review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as appropriate.
- Maintain area and personnel exposure-monitoring records, upon request.
- Provide technical consultation and investigation, as appropriate, for laboratory accidents and injuries.
- Help to determine medical surveillance requirements for laboratory personnel.
- Manage the Engineering Control Certification program for fume hoods, biological safety cabinets (certified by EHS), and other local exhaust points.
- Audit laboratory facilities on a periodic basis.

EHS also supports the CHP by providing management oversight or assistance in chemical compliance, hazardous waste management, chemical inventory, training, and hazardous materials spill/release response.

Department of Public Safety (DPS) is responsible for emergency efforts within the University, including the dispatch of officers for response, communications between public safety agencies, and incident command of emergencies.

Facility Management in each laboratory building is responsible for coordinating maintenance, repair, or renovation procedures with other UM-Dearborn entities.

1.4 AUTHORITY TO SUSPEND/STOP WORK

Authority to Suspend Work

Laboratory personnel covered by the UM-Dearborn Chemical Hygiene Plan are authorized to temporarily cease, or suspend, their own work to immediately correct a deficiency or unsafe condition that poses an immediate danger to themselves, other personnel, the public, or the environment. Examples of circumstances under which laboratory personnel may suspend work include, but are not limited to: damage to personal protective equipment during the course of work, housekeeping issues, minor facility deficiencies, or minor chemical spills. Laboratory personnel may also suspend work if something unusual or unanticipated occurs and they need to take time to evaluate the situation and decide what to do (this scenario may result in a decision that no change or correction is required). Laboratory personnel may restart suspended work without seeking their supervisor's authorization.

Authority to Stop Work

Laboratory personnel covered by the UM-Dearborn Chemical Hygiene Plan are empowered and obligated to stop any activity that they deem to pose an immediate danger to themselves, other personnel, visitors, users, or contractors, the public, or the environment. This authority is referred to as "stop-work authority." Individuals who exercise stop-work authority also are obligated to immediately report their action to the Principal Investigator (PI), department head or other line supervisor of the relevant organization.

After an individual has stopped work as described above, work may not resume until the responsible PI, department head or other line supervisor of the relevant organization has verified that appropriate hazard control measures are in place and that the individual who stopped the work has had the opportunity to concur with the corrective action. (Other more specific policies and procedures established for complex facilities take precedence and may require a readiness assessment or review before work is resumed after an individual has exercised stop-work authority.)

1.5 REGULATORY INTRODUCTION

In January 1991, the Occupational Safety and Health Administration (OSHA) promulgated a final rule for occupational exposure to hazardous chemicals in laboratories (29 CFR 1910.1450). Included in the standard is the requirement that all employees covered by the standard must carry out the provisions of a Chemical Hygiene Plan (CHP). The equivalent standard in Michigan is [MIOSHA Hazardous Work in Laboratories \(Part 431 R325.70101\)](#).

A CHP is a written program which sets forth policies and procedures for protecting employees from the health hazards presented by potentially hazardous chemicals (and other agents) used in workplaces. Components of a CHP must include:

- Standard Operating Procedures (SOP) relevant to safety and health to be followed whenever laboratory work includes the use of hazardous chemicals and other agents.
- Criteria used to determine and implement control measures to reduce worker exposure to hazardous chemicals including engineering controls, the use of PPE and hygiene practices.
- Requirements that fume hoods and other protective equipment are functioning properly and for maintaining adequate performance of such equipment.
- Provisions for employee information and training

- Circumstances under which a particular laboratory operation, procedure, or activity would require special approval from the PI prior to implementation.
- Provisions for medical consultation and medical examinations.
- Determination and implementation of control measures to reduce employee exposures to hazardous chemicals.
- Provisions for additional employee protection for work involving particularly hazardous substances and conditions.
- Availability of Safety Data Sheets (SDS) and other sources of information, to describe potential hazards and safety precautions.

For additional information on health and safety regulations impacting laboratory safety see [Appendix 2](#).

1.6 EXPECTATIONS TO PLAN SAFE RESEARCH

In the laboratory the Principal Investigator (PI) is responsible for the planning and conduct of research. They are expected to be fully aware of the risks posed by their research materials/methods and effectively communicate this awareness to their staff and students. The expected method for instilling this awareness is through written standard operating procedures (SOP) and training to identify necessary precautions. Written records of this instruction must be maintained by the lab. Equally important to communication is direct involvement of the PI in observing the behavior of their staff and enforcing safety procedures. The following paragraphs detail the University of Michigan – Dearborn’s expectations for Principal Investigators:

PLAN FOR SAFETY - Some of the first considerations for an experiment design or method change are the hazardous chemicals to be used, potentially dangerous equipment to be purchased, and the potential injury they may cause. The PI must be fully aware of the risks and have a good working knowledge about the hazards. This will drive decisions to: minimize experimental quantities; mandate protective equipment; enclose processes in fume hoods, provide other ventilation; place guards, screens, or barriers between the hazard and the researcher; and other prudent practices.

COMMUNICATE AWARENESS - Staff and students must be knowledgeable about the hazards of their work and what action to take in the event something goes wrong. The PI must ensure that students and staff working with hazardous materials and equipment have been fully trained on the risks to which they are exposed.

WRITE STANDARD OPERATING PROCEDURES (SOP) - The PI must write SOP’s that include precautions and warnings that address protective equipment, chemical storage, use of engineering controls, emergencies, and waste disposal. These precautionary instructions should be written into the protocol at points where the risks appear. Staff and students must be familiar with and follow prepared and approved SOP.

ASSURE EQUIPMENT SAFETY FEATURES - Hazardous equipment must have safety features that prevent injury and are difficult to defeat. Most modern scientific instruments contain features that reduce or eliminate the potential for accidental exposure and injury to the user. Older equipment may not have such features and the PI is responsible for identifying and addressing hazard points.

ENFORCE SAFETY PROCEDURES - The PI's instructions must be followed in practice and on a daily basis. The PI is responsible for personally verifying that approved methods and precautions are being followed. The Principal Investigator may assign a laboratory manager or designee to assist in meeting these expectations. In the event laboratory personnel are not following standard safety precautions, or ignoring good lab practices, firm action must be taken to clarify safety expectations in the lab.

1.7 LABORATORY SAFETY COMPLIANCE

The safety performance of each laboratory will be reviewed by EHS through compliance audits which comprise comprehensive physical inspections, checks of relevant documentation, reviews of self-inspection reports, and interviews with laboratory personnel. Each laboratory will be audited on a periodic basis based on the Lab Hazard Rank (LHR) assigned to the space. The LHR provides a framework to rank the potential hazards found within each lab and prioritize audits based on: type of hazardous materials present and quantities, hazardous operations and equipment, engineering controls and procedures, and facility history. Deficiencies identified in the audits will be reported to the PI to rectify. Standard deficiencies identified during the audit require correction within 60 days. Critical deficiencies identified during the audit require immediate action and full resolution within two business days. A critical deficiency is defined as a situation that creates an unsafe condition where there is reasonable probability that if allowed to continue, will result in serious physical harm, fire, or significant environmental impact. An imminent danger situation will result in immediate stoppage of work related to the process. Imminent danger means there is high probability that immediate serious physical harm would result if the situation is allowed to continue.

Failure of a PI to submit verification of deficiency abatement will impact their ability to obtain approvals for permits and grant certifications requiring validation of compliance with applicable state and federal regulations.

1.8 RESOURCES

The University of Michigan-Dearborn provides health, safety, and environmental resources to the research community through EHS. Technical assistance regarding research material risks, method refinement, equipment specifications and training, hazard containment, protective equipment, and hazardous waste disposal is available from EHS. The [EHS web page](#) is a readily available resource for initial query into these areas.

Templates for SOP, safety plans, and recommended methods are all easily accessible from this on-line site. EHS representatives are a phone call away and will provide personalized service for specific challenges.

1.9 EXCLUSIONS

This CHP does not cover work with radioactive materials, biological agents or bloodborne pathogens. Procedures for work with these materials are addressed via the University's [Radiation Safety webpage](#), [Biosafety Manual](#), and [Exposure Control Plan](#) respectively.

2.0 IDENTIFICATION AND EVALUATION OF CHEMICAL AND PHYSICAL HAZARDS

Research laboratories work with chemicals, materials, and processes that have recognized hazards. It is critical for all laboratory personnel to understand the nature of these hazards and have a good understanding of the inherent physical, chemical and toxicological properties. The following sections in this chapter describe the main categories of

recognized chemical risks to provide a basic understanding of the hazards. Additional chemical specific hazard information can be found in **Safety Data Sheets (SDS)**. All manufacturers and vendors of hazardous chemicals provide SDS for their products. At UM-Dearborn, SDS are available to all laboratory personnel through the [EHS Safety Data Sheet webpage](#) and the ChemWatch database. The ChemWatch (Gold FFX) program contains over 13 million SDS for chemicals and chemical mixtures in multiple languages. The program can also be used to print safety labels and view molecular structures. In addition to locating a particular vendor SDS, departmental SDS folders can be created within the Gold FFX program. All SDS specific for that department can then be added to allow for easier SDS retrieval. SDS location posters should be conspicuously posted on departmental bulletin boards and in each laboratory. These posters are available online at the [State of Michigan](#). Location of laboratory SDS must be indicated on the poster.

2.1 FLAMMABLE AND COMBUSTIBLE LIQUIDS

Flammable and combustible liquids are classified according to their flash point, with flammable liquids having a flash point of less than 100 °F and combustible liquids having a flash point between 100-200 °F. Both flammable and combustible liquids are considered fire hazards. Flammable/combustible liquids include: alcohols, ketones, xylenes and carboxylic acids. Most organic chemicals are also flammable or combustible. A flammable liquid fire can spread very quickly and intensely. Some general rules of handling include the following:

- Keep flammables/combustible materials away from sources of ignition, open flames, hot surfaces, electrical equipment and static electricity.
- Never heat flammable substances with an open flame.
- Store flammable liquids in National Fire Protection Administration (NFPA) approved cabinets or storage rooms designed for flammable materials.
- Keep containers closed and only transfer chemicals in fume hoods.
- Keep no more than 5 gallons of flammables per room outside of flammable liquid storage cabinets at any time.

See the [Flammable and Combustible Liquids SOP](#) for additional information.

2.2 CORROSIVE MATERIALS

Corrosive chemicals can cause irreversible and visible tissue damage through chemical action at the point of contact. Corrosive chemicals can be liquids, solids, or gases and can affect the skin, eyes, and respiratory tract. The damage will be acute, i.e. within 24 hours. Chemicals with a low or high pH are considered corrosive. Therefore, acids and bases are corrosive. Examples of corrosive chemicals include: ammonium hydroxide, hydrochloric acid, nitric acid, phenol, sodium hydroxide and sulfuric acid. Some general rules of handling include the following:

- **Do not** store acids and bases, which are incompatible, together.
- **Do not** mix an acid and base together and put into a sealed container. The chemical reaction can generate heat and pressure which could result in an explosion.
- **Do** protect your eyes with safety goggles when working with corrosives. Hand protection and body protection are also necessary and should be chosen based on volumes used and specific corrosive attributes. Consult a glove compatibility chart for specific guidance.

See the [Corrosive Materials SOP](#) for additional information.

2.3 OXIDIZERS

Oxidizers are materials that can react with other substances and promote combustion by giving off electrons and undergoing reduction. Reactions with easily oxidizable materials like metal powders, organic materials (paper, wood), and organic compounds can result in vigorous reaction, fire or an explosion. Examples of common oxidizers are chlorates, perchlorates, peroxides, nitric acid, nitrites and permanganates. Bromine, chlorine, fluorine, and iodine gases act similarly. Some general rules of handling include the following:

- Store oxidizers separate from organics and flammable materials.
- Use oxidizers with extreme care and do not combine oxidizer waste materials with organic compounds. If waste is comingled during the research project do not allow pressure to build in containers.

See the [Oxidizing Chemicals SOP](#) for additional information.

2.4 HIGHLY REACTIVE/ UNSTABLE MATERIALS

Highly reactive or unstable materials are those that have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. They can release heat, toxic gas, or flammable gas upon contact with water or air, or moisture in air. Water reactive materials react violently in contact with water. Examples: lithium, sodium, potassium, organometallic compounds, aluminum bromide, calcium oxide and phosphorus pentachloride. Pyrophoric materials can react with air and ignite spontaneously at or below 113°F (45°C). Pyrophoric materials should be handled and stored in inert environments. Examples: chlorine trifluoride, phosphine, tert-butyl lithium, silane, white or yellow phosphorous and many finely divided metals. Safe handling of these materials depends on the specific material and the conditions in which it's handled. The lab must develop specific procedures (SOP) that include hazards, personal protective equipment and engineering controls. Persons working with these materials must receive training and approval from the PI or lab manager.

For additional information see the SOP for [Reactive Chemicals](#), [Water Sensitive Chemicals](#), and [Pyrophorics Materials](#), etc.

2.5 PEROXIDE FORMING

Peroxidizable chemicals can undergo auto oxidation to form organic peroxides that can become explosive with impact, heat or friction. These chemicals will become more hazardous as they age; peroxides may form even when the container has not been opened. Peroxide forming chemical examples include: isopropyl ether, divinyl acetylene, vinylidene chloride, dioxane, cyclohexene, furan, tetrahydrofuran, sodium amide, methyl i-butyl ketone, ethyl ether, vinyl ethers, styrene, butadiene, vinyl acetate and tetrafluoroethylene. Some general rules of handling include the following:

- **Date** all peroxide formers upon receipt and again after opening.
- Store away from heat and light.
- Use proper antioxidant inhibitors.

- Test for peroxide formation according to the [Peroxide Forming Chemicals SOP](#) or 18 months if the container has not been opened.
- If the test is positive, treat to remove peroxides or call EHS Hazardous Material Management for disposal.
- Never open a bottle that has solid formation around the lid. Friction from removing the cap can cause an explosion.

See [the Peroxide Forming Chemicals SOP](#) for additional information.

2.6 EXPLOSIVES (Highly Energetic Compounds)

Explosives are chemicals (or combinations thereof) that may cause a sudden release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. Some common functional groups for explosive compounds include: organic azides, metal cyanides, diazo compounds, alkyl or acyl peroxides and metal fulminates, etc. Safe handling of these materials depends on the specific material and the conditions under which it's handled. The lab must develop specific procedures (SOP) that include hazards, personal protective equipment and engineering controls. Persons working with these materials must receive training and approval from the PI or lab manager. Some general rules of handling include the following:

- Use small quantities of reactants to minimize hazards.
- Use safety shielding for any operation having the potential for explosion. Shields must be placed so that all personnel in the area are protected from the hazard.
- Wear appropriate PPE eyewear, face shield, and hand protection.
- A special facility design may be required for larger quantities.

Special approval is required to work with an explosive that falls within the scope of Title 18, United States Code, Chapter 40 "Importation, Manufacture, Distribution, and Storage of Explosive Materials" and materials classified as explosive by Title 49 CFR, Parts 100-199.

2.7 CRYOGENIC LIQUIDS

Cryogenic liquids have boiling points below minus 130°F (minus 90°C) and are used in research to provide extremely low temperatures for frozen storage and experimentation. Common cryogenic liquids of concern include nitrogen, helium, hydrogen, and argon. Cryogenic liquids undergo substantial volume expansion when released to air, potentially depleting workplace oxygen content to hazardous levels. Other concerns with cryogenic liquids are extreme cold and potentially hazardous gases. Some general rules of handling include the following:

- Avoid contact with components or liquid, or exposure to its gases.
- Store dewars in well-ventilated areas.
- Read the SDS and safety precautions for all cryogenics used, and incorporate these precautions into Standard Operating Procedures.

Additional information on the use and handling of cryogenic liquids can be found on the EHS [Cryogenic Liquids Use Webpage](#).

2.8 COMPRESSED GASES

A compressed gas is any gas or mixture of gases exerting in a container, a pressure exceeding 40.6 psia (280 kPa, abs) at 68°F (20°C). Generally, the term "compressed gas"

also refers to liquefied and dissolved gases meeting these criteria and also include cryogenic gases. Currently, there are more than 200 different substances commonly shipped in compressed gas containers that can be considered compressed gases. The primary hazards with compressed gas cylinders are the incredible amount of stored energy due to the high pressure, the large volume of gas present, and properties of the gas itself. All compressed gases are dangerous and must be handled using the basic safety rules found on the EHS [Compressed Gas Use Webpage](#). A rupture can result in a powerful release of gas that can propel the heavy steel cylinder in a deadly manner.

Toxic gases pose additional potentially acute health hazards to laboratory personnel and the public, and as such, are considered “Restricted Gases” that require prior approval by EHS to purchase. This approval process also applies to oxidizing and flammable gases.

EHS rules for the use, handling, distribution and dispensing of toxic gases are in the [EHS Compressed Gas Use Guideline](#). The guideline contains specific provisions mandating facility permitting, engineering controls, protective equipment, storage requirements, emergency response plans, warning systems and personnel training based on the type and quantity of toxic gas used.

The following are general rules for the handling and use of compressed gases:

- Compressed gas cylinders must be secured in an upright position away from excessive heat, highly combustible materials and areas where they might be damaged or knocked over. A chain, bracket or other restraining device shall be used at all times to prevent cylinders from falling. Securing devices can be purchased from various laboratory supply companies, or the Sheet Metal Shop can develop a restraining system to meet the laboratory's needs.
- Cylinders of oxygen and other oxidizers must be stored at least 20-feet from fuel-gas or other combustible materials unless separated by a noncombustible wall, not less than 5-feet high, having a fire-resistance rating of ½-hour.
- Cylinders must have valve protection caps on at all times except when containers are secured and connected to dispensing equipment. Empty gas cylinders must also be stored securely with the valve protection cap in place.
- All hazardous materials must be labeled with the name of the chemical and the primary hazard associated with that chemical (flammable, oxidizer, etc.).
- The cylinder status as to “full”, “in-use”, or “empty” must be indicated on the cylinder.
- Flash arrestors should be used to prevent a flash-back, should it occur, in a line containing a flammable gas.
- All tubing and fittings should be checked for integrity when used. If tubing is damaged, cracked or missing, it should be removed from service until properly repaired or replaced.
- Cylinders must be stored in dry, well-ventilated areas. Closets and lockers are not acceptable storage locations.
- Cylinders must not be stored in hallways, corridors, stairwells or near elevators.
- Unobstructed access must be maintained around the cylinders.

2.9 PARTICULARLY HAZARDOUS SUBSTANCES

Select carcinogens (known and potential human carcinogens identified by [IARC](#) or [NTP](#)), reproductive toxins, and chemicals with high acute or chronic toxicity are considered to be high-risk materials, also known as “Particularly Hazardous Substances”.

Carcinogens are chemicals or physical agents that cause cancer or tumor development, typically after repeated or chronic exposure. Their effects may only become evident after a long latency period and may cause no immediate harmful effects. Common lab carcinogens are benzene, formaldehyde, and carbon tetrachloride.

Reproductive toxins are typically grouped into two classes; mutagen or teratogen. Mutagens can cause genetic changes/mutations to the genes, causing heritable mutations and abnormalities in the offspring. Teratogens cause physical defects to the fetus or embryo during pregnancy, but the mother does not show signs of toxicity. Many reproductive toxins cause damage after repeated low-level exposures. Effects become evident after long latency periods. See the [EHS Reproductive Health Awareness Guideline](#).

Highly Toxic chemicals have the ability to cause harmful local and systemic effects after a single or brief exposure. The toxicity of a chemical is determined from studies that identify the Lethal Dose (LD) and/or Lethal Concentration (LC) for a given exposure dosage, route and population. Many of these chemicals may also be characterized as a toxic gas, corrosive, irritant or sensitizer. See the [Highly Toxic Chemicals SOP](#) for additional information.

An increased level protection is required for laboratory personnel working with Particularly Hazardous Substances. These increased protections must be specified in written procedures that when followed will reduce the potential exposure to these compounds. The procedures must include: written approval from the PI, a secure storage area, a designated area to perform the work, use of engineering controls such as fume hoods or glove boxes, appropriate PPE, minimized quantities, limited aerosol generation, medical surveillance if applicable, signage, labeling, decontamination of the work area, and documentation of training. EHS [SOP Template](#) is provided to assist the PI in creation of SOP for Particularly Hazardous Substances.

2.10 SENSITIZERS

A sensitizer is a substance that causes most people to develop an allergic reaction after repeated exposure. The first exposure may cause little or no reaction but repeated exposure may cause a marked allergic response not necessarily limited to the contact site. Both skin and respiratory sensitization are possible. Once sensitization occurs, allergic reactions can result from exposure to extremely low doses of the chemical. Allergic reactions can be immediate and result in death if not treated. Examples of sensitizers used in laboratories include: diazomethane, formaldehyde, various isocyanates, certain phenol derivatives, and proteins (e.g. latex, commonly found in natural rubber latex lab gloves).

See the [Sensitizer SOP](#) for additional information

2.11 IRRITANTS

Irritants are non-corrosive chemicals that cause reversible inflammatory effects by chemical action at the site of contact (skin, eyes, nose or respiratory tract). Higher concentrations of some irritants could cause permanent health effects or even death. A wide variety of organic and inorganic compounds are irritants; thus, skin contact with all laboratory chemicals should be avoided. Examples include: chlorine and ammonia containing products, halogens, nitrogen dioxide, ozone and phosgene.

See the [Irritants SOP](#) for additional information.

2.12 NANOMATERIALS

A nanoparticle is a collection of atoms with one dimension less than 100 nanometers. Nanoparticles that are naturally occurring (e.g., volcanic ash) or incidental byproducts of combustion processes (e.g., welding, diesel engines) are often termed ultrafine particles. Engineered nanoparticles are intentionally produced and designed with very specific properties related to shape, size, surface properties and chemistry. They may be bought from commercial vendors or generated via experimental procedures by researchers in the laboratory. Examples of engineered nanomaterials include: fullerenes, carbon nanotubes, metal oxide nanoparticles, and quantum dots, among many others. The health effects of exposures to nanomaterials are not fully understood at this time. Until more definitive findings are made regarding the potential health risks of handling nanomaterials, researchers planning to work with nanomaterials must implement a combination of engineering controls, work practices, and personal protective equipment to minimize potential exposures. The EHS [Guideline for Engineered Nanomaterials](#) addresses procedures for overseeing the safe use, storage, transportation, and disposal of these materials. It is designed to provide reasonable and consistent guidance for managing the potential risks associated with nanomaterials whose hazards have not been fully characterized.

2.13 RADIOACTIVE MATERIALS AND RADIATION-PRODUCING DEVICES

Radioactive material compounds, radiation-producing devices, radioactive sealed or plated sources, and devices that contain a radioactive source require special authorization, training, and adherence to University of Michigan policies and procedures. In addition, there are mandatory regulatory requirements specified by the State & Federal agencies that apply to the procurement, use, and disposal of radioactive materials and radiation-producing devices. The failure to comply with these requirements can result in serious consequences including temporary suspension of radioactive material or radiation-producing device use and financial fines. The U-M [Radiation Safety Service](#) (RSS) manages all aspects of radiological health and safety and can be contacted at (734) 764-6200.

In addition, all x-ray machines and other radiation-producing devices are REQUIRED to be registered with the State of Michigan. It is the responsibility of each UM-Dearborn department or individual user to contact EHS RSS when x-ray machines or other radiation-producing devices are purchased.

2.14 BIOLOGICAL AGENTS AND TOXINS

Etiologic agents are hazardous biologic agents (viable microorganism) or its toxin which may cause severe, disabling, or fatal human disease. The Centers for Disease Control and Prevention (CDC) regulates and permits the use and transfer of these agents. The agent risk group classifications are assigned into the appropriate biosafety level with associated

safe practices and controls. These are detailed in the CDC publication [Biosafety in Microbiological and Biomedical Laboratories \(BMBL\)](#). At UM-Dearborn, the Biological Safety Officer resides within EHS and is responsible for all related health and safety programs which can be found on the [EHS Biological Safety](#) webpage.

2.15 CONTROLLED SUBSTANCES

The purchase, storage and use of many drugs are regulated under Title 21 CFR Part 1300 and the State of Michigan Act 368 Article 7 as controlled substances. Every person who engages in research with controlled substances must acquire a State of Michigan controlled substance research license and a DEA researcher registration to receive, distribute, store, and administer controlled substances for research purposes at the University. The research use of these controlled substances can be hazardous based on the specific chemical properties and planned use. Health, safety, security and licensing concerns must be addressed prior to doing this work. The [Institutional Animal Care & Use Committee \(IACUC\)](#) administers this program for all use of controlled substances involving animal research.

2.16 ANESTHETIC GASES

Anesthetic gases, used during research involving animals, must be properly controlled to avoid overexposure of the researcher to the chemical. Workers acutely exposed to excess amounts of anesthetic gas can experience symptoms of drowsiness, headache, nausea, poor judgment and loss of coordination. Chronic symptoms of over-exposure can include liver, kidney and reproductive effects. Anesthetics of concern include ether, nitrous oxide, and halogenated agents including: chloroform, enflurane, halothane, isoflurane, methoxyflurane and trichloroethylene. Use of anesthetic gases requires engineering controls (typically ventilation) to remove chemicals from the workplace and prevent overexposure.

3.0 CONTROLS TO REDUCE EXPOSURES TO HAZARDOUS MATERIALS

As a general principle, all use of hazardous materials in the research lab must be controlled to reduce exposures below permissible limits. The nature of a hazardous substance and its route of absorption into the body determine the types of controls used to reduce exposures. Airborne hazards must be removed from the air and barriers must be provided to prevent contact hazards. Ingestion hazards are prevented by good clean lab practices and hand washing facilities.

There are three types of controls that are utilized: engineering, administrative and personal protective equipment (PPE). Engineering controls are those that actually remove the hazardous material from the work environment. Administrative controls are procedures that reduce the amount of material, duration or extent of exposure to the material. PPE provides a barrier between the user and the material. In UM-Dearborn labs engineering controls will be used as the primary method to reduce exposures. Administrative and PPE will be used as secondary controls in most cases.

3.1 Engineering Controls

The laboratory is designed with features and equipment to control and reduce exposures. Experiments must be designed to use these controls to reduce exposures to hazardous materials. The primary engineering controls include fume hoods, glove boxes, and other local exhaust ventilation (LEV) systems. Other engineering controls may include drop down flexible ducts, paint booths, canopies, biological safety cabinets, slot hoods, or ventilated gas cabinets.

In addition, laboratories are designed with a one pass general exhaust system with air change rates based on an assessment of the potential airborne hazards. The laboratory is also maintained under negative pressure compared to adjacent non-lab space.

If any engineering control is malfunctioning or in an alarm condition it shall not be used and must immediately be reported to Facilities Operations at (313) 593-5270 during business hours and Public Safety at (313) 593-5333 after hours. It shall also be reported to the Principal Investigator/Laboratory Director.

Additional engineering controls for minimizing exposures to hazardous chemicals may include:

- Substituting a less hazardous chemical (e.g., using isoflurane for animal anesthesia instead of ether, or using toluene instead of benzene.)
- Isolating or enclosing an experiment within a closed system (i.e., glove box, sealed chamber).
- Micro scaling the size of the experiment to reduce the amount of chemical usage.

Exhaust ventilation is the most common engineering control and is provided in almost every lab setting. These ventilation systems protect users from various airborne hazards by exhausting the material at the point of generation. Proper use of these systems is critical to reducing potential exposures.

Please observe the following general rules when working with exhaust ventilation engineering controls:

- Check for a current EHS certification (EHS certification for Biosafety Cabinets) date of less than one year.
- Confirm all engineering controls are operating properly before use
- Seek training on the proper operation.
- Use the engineering control as it was designed.
- Re-evaluate the use of the engineering controls if the research protocol changes.
- Contact Facilities Operations (313) 593-5270 for assistance in determining the correct engineering control your research needs
- Do not use a fume hood, biological safety cabinet (BSC), or LEV that has been posted "out of service".
- Call Facilities Operations (313) 593-5270 for repair of fume hoods, LEVs, and BSCs.
- Contact EHS at (313) 593-5061 to arrange certifications for fume hoods, LEVs, and BSCs.

Fume Hoods, Biological Safety Cabinet (BSC), and Glove Box

Chemical fume hoods are sometimes mistakenly used as a BSC or glove box. The following chart and section provides guidance on which engineering control to use for various hazardous materials.

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| Fume Hood | Glove Box/Isolator | BSC |
|---------------------|---------------------------|---|
| Volatile chemicals | Air reactive compounds | Biological aerosols including human blood |
| Flammable liquids | Highly toxic compounds | Biosafety Level 2 and 3 agents |
| Toxic materials | Controlled environment | Tissue culture |
| Hot processes | | Sterile field |
| Open flames | | Necropsy (Not Perfused) |
| Acids and bases | | Non-volatile drugs |
| Gases | | |
| Necropsy (Perfused) | | |

Fume Hoods (Laboratory Hoods, Chemical Hoods)

A fume hood is typically the primary engineering control for working with hazardous chemicals in the lab. It's used to contain chemical vapors, powders, and gases. An exhaust fan on the roof draws air into the fume hood, through an exhaust duct and out of the building through the roof stack. An average face velocity of 100 feet per minute is considered optimal for containment of contaminants. 100% of the air drawn into the fume hood is exhausted out the roof stack.

All chemicals should be handled in a fume hood whenever possible. Chemicals that have high acute toxicity, are carcinogenic, or are reproductive toxins must be handled in a laboratory fume hood except where there is only a very low risk of exposure (e.g., use of minimal quantities in a closed system). As a general rule, use a fume hood or other local exhaust ventilation device when working with any appreciably volatile substance or material easily dispersible in air.

Follow these rules for proper use of fume hoods:

- Maintain fume hood sash at or below the certification mark indicated by an arrow on the side of the fume hood. The sash is the glass window that slides up and down and/or left to right.
- Use the sash to protect yourself – when using the fume hood the sash will protect you from splashes inside the hood. When not using the fume hood keep the sash closed to increase safety in the lab
- Avoid rapid movements at the face of the fume hood, as they tend to create competing air currents and reduce the ability of the fume hood to contain air contaminants.
- Minimize equipment and chemical storage placed in the fume hood to avoid dead air spaces or eddies and to prevent blocking back baffles all of which disrupt the airflow into the fume hood and reduce its overall effectiveness of controlling air contaminants.
- Elevate equipment that disturbs airflow to prevent turbulence.
- Keep chemical sources and equipment at least six inches away from the face or rear of the fume hood.
- Be aware of flammables when using a burner or other potential ignition source. When there are multiple users of a fume hood you need to be especially vigilant in determining if your experiment will react with other materials left in the fume hood.
- Keep the work surface neat and return bulk chemicals to proper storage areas when done.

Perchloric acid fume hoods are designed specifically for the use of perchloric acid. These hoods contain water spray systems to wash down the interior of the hood, duct, fan, and stack to prevent accumulation of explosive perchlorate crystalline material. You must receive lab-specific training before performing any work in a perchloric acid fume hood. We currently do not have any perchloric acid fume hoods on the UM-Dearborn campus.

Glovebox (Sometimes referred to as an isolator or isolation chamber)

A glovebox can be used for chemicals, pharmaceuticals, nuclear materials, and in some instances biological materials. The glovebox must be specifically designed for the type of materials used. The glovebox can have several types of positive pressure atmospheres like inert gases (argon, nitrogen) or negative pressure atmospheres (vacuum). The basic elements of a glovebox include a frame for the containment area, a look-through area to observe the work performed inside the glovebox, the gloves in which the operator will place their hands to work inside the glovebox, and the pass through chamber for placing materials either in or out of the glovebox. Contact the manufacturer's representative or the Lab Director/Supervisor for advice on the appropriate type or proper installation of a glovebox.

Glovebox safety starts with the installation per the manufacturers' specifications. Once in place, the PI is responsible for maintenance, inspection, and proper use. The PI can hire an external vendor or train and designate laboratory personnel to carry out these tasks. The lab is also responsible for writing a SOP for the use of the glovebox and training of operators. The SOP and training records must be maintained in the CHP Blue Binder. The PI will also keep maintenance and inspection records for each glovebox within their responsible area.

Basic glovebox safety requirements include an inspection by the user before each use. The inspection must cover the following:

- Confirm the atmosphere is correct for the type of work the operator will perform
- Clear the work space to help prevent accidents or spills
- Check gloves for tears, degradation, or bubbling
- Confirm appropriate chemical resistant gloves are available inside the glovebox
- Check glass for cracks or fogging
- Check that O-rings and seals are not compromised
- Confirm atmospheric gauges are working properly
- Confirm airlocks are working properly and sealing
- Clean and clear work surfaces

A guidance document by the American Glovebox Society has detailed information on the proper selection, maintenance, and use of gloveboxes.

Biological Safety Cabinet (BSC)

A BSC is the primary engineering control for working with hazardous biological materials. Class II BSCs protect users and the environment from biological aerosols while protecting the product from the environment. EHS coordinates all BSC related work with U-M EHS. BSC Manufacturers currently supported by EHS include: Baker, Labconco, Nuair, ESCO, and Thermo. Additional information on the proper use of BSCs is found in the [BSC Guideline](#).

Class III BSC

A Class III BSC is a totally enclosed, air-tight, negatively pressured, ventilated cabinet. All operations are performed through rubber gloves, and the supply and exhaust air are filtered with HEPA filters. The exhaust air is discharged to the outdoor environment. A Class III BSC is NOT a glove box and does not provide a moisture and/or oxygen-free atmosphere. Pyrophorics or other highly reactive chemicals CANNOT be used in a Class III BSC.

Snorkel Exhaust

A snorkel, also called an elephant trunk, is a piece of flexible duct or hose connected to an exhaust system, designed to give the user some degree of mobility in placing it where ventilation is needed. Snorkels are commonly used to capture exhaust from gas chromatographs, vacuum pumps, and from other equipment and processes. Snorkels CANNOT effectively or safely capture airborne contaminants beyond the distance at which it was certified for, which is typically one-half diameter from the end of hose. Please refer to the EHS certification sticker on the snorkel and use it in accordance with the specified capture distance.

Canopy Hood Exhaust

Canopy hoods are ventilated horizontal enclosures suspended above a bench or work area, similar to a kitchen range hood. The drawbacks of canopy hoods are that a relatively large amount of air is required to be exhausted to remove contaminants, increasing operational costs, and may pass contaminated air through the breathing zone of the user. Canopy hoods work best when there are thermal or evaporative forces that direct contaminants into the capture zone of the hood. Canopies are used when a larger working space is needed and when air contaminants are relatively low in toxicity. The capture ability of the hood may be compromised by competing air currents occurring near the canopy hood.

Slot Hoods

Slot hoods are ventilation hoods that are specially designed to capture airborne contaminants for a specific process or operation. There are many types of slot hoods and are typically used to exhaust open surface tanks like acids baths and work benches. Slot hoods are suited when a larger working space is needed and when air contaminants are relatively low in toxicity. Slot hoods are much more effective and use less airflow than snorkels or canopy hoods. To perform effectively, the geometry, flow rate, and velocity of the slot hood must be appropriate for the air contaminant being captured.

Ductless Hoods

The use of ductless hoods is not recommended. Ductless hoods do not exhaust contaminated air to the outside environment but rather pull air in through the hood inlet and into a filtration system which is recirculated back into the room. Contaminants are removed by a variety of filters such as activated carbon filters, HEPA filters, or catalyst reaction filters. The appropriate filter MUST be used for the contaminant being exhausted. It is critical that the filters are replaced regularly and that the hood is functioning properly because exhausted air is recirculated back into the ambient environment. Any failure of the hood can result in exposure. The difficulty in determining whether filters are providing adequate protection and the constant potential for exposure makes ductless hoods much less protective than other LEV options. The use of ductless hoods at UM-Dearborn will be restricted to very specific procedures, nuisance chemicals or small quantities that could be used safely on an open bench.

Ventilated Compressed Gas Cabinets

Gas cabinets are enclosures designed to house and/or dispense toxic and flammable compressed gas cylinders. These are not intended for cryogenic gases. The gas cabinet prevents escaping gas, due to leaks or other failures, from entering the laboratory space and provides fire protection. Gas cabinets may have features that monitor for leaks and excessive flow and that automatically shut off gas flow. Toxic compressed gases in cylinders larger than a lecture bottle must be contained in a gas cabinet. See the [Compressed Gas Use Guideline](#) document for more information.

Wet Benches

Wet benches or wet station hoods are ventilated workstations that may be free-standing or enclosed used to house various chemical baths which may contain flammable, corrosive, oxidizing, and toxic liquids. Wet benches are often used in semiconductor fabrication processes. Typically, a slot-type hood is placed over and around the deck surface of the bath sink or is designed with slotted sink exhausts. Splash shields are often equipped to alter the direction of air flow and provide limited splash protection. These may have plumbing or heating systems in the baths. Baths of incompatible chemicals should not be used within the same wet bench.

Grossing Stations

Grossing stations, also called downdraft hoods or necropsy tables, are designed with ventilation slots along the sides of the work area to capture air contaminants. The air is pulled down through the slots and then exhausted to the outside environment. These are effective when chemicals with vapor densities heavier than air are used.

Paint Booths

Paint booths, also called spray booths, are ventilated and fire protected booths that range in size from bench top-sized booths to walk-in booths. Along with ventilation, filters are used to capture paint and glaze contaminants and must be regularly replaced. Paint, dust, and pigment accumulation may prevent the hood from performing effectively. Often times, the user must be standing laterally with the direction of airflow in order for the hood to work properly.

Horizontal Laminar Flow Hoods (clean bench, vertical laminar flow hood)

Laminar flow hoods are designed to protect processes and products from contamination by flowing HEPA filtered air onto the work area. Laminar flow hoods **do not** provide personal protection and cannot be used with hazardous materials.

Bench Top Vented Enclosures

Bench top enclosures are relatively small enclosures that may or may not be exhausted by the building exhaust system. These enclosures are designed to contain and remove low-to-moderately toxic air contaminants. Most enclosures are made of acrylic, so the material compatibility of the air contaminants and the acrylic must be evaluated.

Inspection of Fume Hoods, BSC, and other Local Exhaust Systems

All Fume Hoods, BSC, and other Local Exhaust Systems on campus must be certified by annually. If an inspection is needed, notify EHS at (313) 593-5061. If the hood does not perform within required performance limits it will be tagged-out of service and reported for repair. Any system tagged out of service will not be allowed to be used.

3.2 ADMINISTRATIVE CONTROLS

Administrative controls are other measures, beyond engineering controls, aimed at reducing exposure to hazards. They typically involve the use of written procedures, policy, and training designed to reduce the quantity of hazardous materials used and length of time spent using the material. These types of controls are normally used in conjunction with other controls that more directly prevent or control exposure to the hazard. Some administrative controls include continual review of the work environment and safe work practices, regular equipment maintenance, hazard correction procedures, and a medical surveillance program when needed to help prevent workplace hazards and exposures.

Safe work practices include general workplace rules and other operation-specific rules. For example, even when a hazard is enclosed, exposure can occur when maintenance is necessary. Through established safe work practices, exposure to hazards can be further reduced. This document, as well as the written SOP, include many safe work practices for the various work completed in labs.

3.3 PERSONAL PROTECTIVE EQUIPMENT

When exposure to hazards cannot be engineered completely out of normal operations or maintenance work, and when safe work practices and other forms of administrative controls cannot provide sufficient additional protection, the use of protective clothing or equipment provides a supplementary means of control. This is collectively called personal protective equipment, or PPE. PPE is not a substitute for engineering controls, work practices, and/or administrative controls. PPE should always be used in conjunction with permanent protective measures, such as engineered guards, substitution of less hazardous chemicals, and prudent work practices.

The basic element of any PPE program is an evaluation of the equipment needed to protect against the hazards in the workplace. The evaluation should be used to create a standard operating procedure for personnel, and then to train laboratory personnel on the proper use, maintenance and limitations of PPE. Using PPE requires hazard awareness and training on the part of the user. Laboratory personnel must be aware that the equipment does not eliminate the hazard. If the equipment fails, exposure will occur. To reduce the possibility of failure, equipment must be properly fitted and maintained in a clean and serviceable condition. The PPE selected must fit laboratory personnel it is intended to protect. Make certain that personnel have the correct size of protective equipment. Whenever possible, select adjustable PPE. Personnel input in the selection process are critical. PPE that fits properly and is comfortable will more likely be worn. Damaged or defective protective equipment shall be immediately taken out of service to be repaired or replaced.

PPE must be provided at no cost to employees, including temporary and part time staff. See the [EHS PPE Guideline](#) for details.

Appropriate Lab Attire

Although not technically PPE, personal attire in the laboratory that covers the torso, legs, and feet can impact your risk of exposure to hazardous agents and the potential of physical injury. Appropriate clothing provides an extra layer of protection against spills or splashes of hazardous materials but must not exacerbate a potentially hazardous situation. The following attire and practices **shall** be adhered to in all wet bench laboratories:

- Personnel working in laboratories conducting work with chemical, biological, and/or radiological materials must wear at minimum: safety glasses, lab coats, and appropriate gloves.
- Shirts or tops must cover the upper torso. Layered clothing is a benefit to safety and provides an extra layer of protection. Natural, tightly woven materials are recommended.
- Shorts, skirts or pants that leave any part of the leg exposed are not allowed. Natural, tightly woven materials are recommended. Panty hose are not recommended due to an increased risk of injury from chemicals or heat melting the nylon to the skin.
- Shoes must completely cover the feet. Sandals, open toe, open weave, or shoes with holes are not allowed. Shoe material should not be readily absorbent. Leather that is easily cleanable is recommended. Good shoes will be slip resistant, protect the wearer from chemical splashes, hot liquids, and sharp objects.
- Hair must be kept away from the eyes and long hair must be tied in the back. Hair must not impede vision or come in contact with chemicals, biologicals, other work materials, equipment or open flames.
- Ties and scarves must not hang loose outside the lab coat or come in contact with chemicals, biologicals, other work materials, equipment or open flames.
- Caps or other head gear must not impede vision, interfere with protective eyewear, hang loose or come in contact with chemicals, biologicals, other work materials, equipment or open flames.
- For your protection, jewelry should not be worn in the laboratory. Dangling jewelry can become entangled in equipment and can conduct electricity. Chemicals can seep under the jewelry and cause injuries to the skin. Chemicals can ruin jewelry and change its composition.
- Use of iPods, MP3 players or other electronic devices with headphones is not allowed in laboratories. Laboratorians must be aware of their surroundings and able to hear alarms, sirens, other incidents or people calling for help.

Hazard Assessment and PPE Selection

The MIOSHA standard regarding PPE requires a workplace hazard assessment and training. A Hazard Assessment is a determination of hazards in the workplace for a particular job classification, such as Research Assistant. When a hazard cannot be eliminated through engineering controls or administrative controls, PPE is often required. These assessments are part of the CHP and are located in [Appendix 1](#).

The PI or their designee is responsible to review the PPE assessments in this CHP and determine if they fully cover the hazards in the lab. If not, additional hazard assessments and PPE requirements for specific hazards not covered in the general assessments must have a written SOP that details PPE for the procedure. The individual conducting the hazard assessment must be developed. PPE must be selected to protect against any hazard that is likely to occur or has a serious injury impact if it does occur.

It is important to become familiar with the potential hazards, the type of protective equipment that is available, and the level of protection that is provided by that equipment, i.e., splash protection, impact protection, etc. The following hazard sources should be considered:

- High or low temperatures
- Chemical exposures (Review SDS and other hazard information to determine appropriate PPE to wear based on chemical hazards encountered)
- Flying particles, molten metal or other eye, face, or skin hazards
- Light radiation, e.g., welding, arc lamps, heat treatment, lasers
- Falling objects or potential for dropping objects
- Sharp objects
- Rolling or pinching that could crush the hands or feet
- Electrical hazards
- Infectious agents

Where these hazards could cause injury to employees, PPE must be selected to substantially eliminate the injury potential.

Eye Protection

The use of eye and face protection shall be used where a hazard exists due to flying objects or particles, molten metal, liquid chemicals, gases, vapors, or injurious light radiation. These types of hazards are considered to exist in any laboratory working with hazardous materials or processes and safety glasses are required as the minimum level of protection. Select eye and face protection based on Tables I and II in [Appendix 1](#). If the appropriate protection is not listed in the tables, such as laser eyewear, contact EHS for further assistance. All protective eye and face protection must comply with ANSI Z87.1.

The following general guidance applies to eye protection:

- Safety glasses must have side shields and meet ANSI Z87.1 standards. Standard prescription glasses are not considered a form of eye protection.
- Safety glasses should be chosen to conform to the wearers face and minimize gaps around the glasses. Chemical goggles may be required for certain processes where safety glasses are deemed inadequate. Safety glasses do not provide protection from chemical vapors, liquids, or caustic dust hazards which may bypass safety glasses. When exposure to these hazards cannot be avoided by use of engineering controls, chemical goggles shall be worn.
- Safety glasses or goggles must be worn over prescription glasses and must be of a type intended to be worn over prescription glasses.
- Prescription ANSI Z87.1 protective eyewear can be obtained through the EHS Prescription Safety Glasses Program with the approval of your Supervisor and EHS. Contact EHS for more information (313)593-4914.
- Contact lenses may be worn if appropriate protective eyewear is also worn. Contact lenses ARE NOT considered a form of eye protection and do not provide protection against chemicals or particulates.
- MIOSHA recommends against wearing contact lenses when working with acrylonitrile, 1,2 dibromo-3-chloropropane, ethylene oxide, methylene chloride, and 4,4' - methylene dianiline.
- ANSI Z87.1 chemical goggles must be worn during chemical transfer/ handling operations or during any other operations having any likelihood for chemical splash or spray (i.e., processes above or below ambient pressure).
- In addition to safety eyewear, an ANSI Z87.1 face shield is to be worn when working with highly corrosive chemicals, where there is any likelihood for chemical splash/spray, or where flying fragments/particles are generated.

- Laser safety eyewear must be specific for the lasers present. EHS can be contacted to help determine appropriate laser eyewear.
- Face shields should be worn when the potential exists for chemical splashes or flying particles to come into contact with the face. Appropriate safety glasses or goggles are required for eye protection beneath face shields.

Face Protection

Face protection shall be used where a hazard exists to the face due to flying objects or particles, molten metal, liquid chemicals, gases, vapors, or injurious light radiation. Face shields worn over safety glasses is required for certain processes as determined by the Principal Investigator (PI) and/or the PPE hazard assessment table in [Appendix 1](#). Face shields must always be worn over safety glasses or goggles, *not instead of* safety glasses or goggles. The use of face shields over safety glasses is required with processes involving high pressure (>30 PSI), pneumatic lines (>30 PSI), or machining operations.

Head Protection (Hard Hats)

Protective headwear is not typically required in laboratories. Helmets are required to shield the head from the impact and penetration of falling objects, working in low clearance areas, and in some cases high voltage electric shock and burns. They should be worn whenever the potential exists for injuries to the head due to falling objects or when head clearance is restricted. Contact EHS if additional information is needed.

Foot Protection

The minimum level of protective footwear required in laboratories is a closed toe shoe. No sandals, flip flops, etc. are allowed.

Additional protective footwear is required when employees work in areas where there is a danger of foot injuries due to falling and rolling objects, objects piercing the sole, and where employees' feet are exposed to electrical hazards. Safety shoes will be provided by your Department if you meet the criteria.

Hand Protection

Protective gloves are required to prevent: skin absorption of harmful substances; severe cuts or lacerations; severe abrasions; punctures; chemical burns; harmful temperature extremes. Appropriately resistant gloves must be worn when handling chemicals, biologicals, or radiologicals.

It is important to select the appropriate glove for a particular application and to determine how long the glove can be worn, and whether it can be reused. Chemically protective gloves should be selected based on tested performance against specific chemicals. [Appendix 1](#) provides guidance on glove selection for certain classes of chemicals and common physical hazards.

Glove manufacturers have developed recommendations for the proper selection and use of chemically-protective gloves.

- No single material can protect against all chemical, physical (e.g., cuts, abrasions, burns, temperature extremes) or biological hazards. It is critical to select the correct glove for the hazard.
- Incorrect selection results in a false sense of security and increased exposure. A Dartmouth researcher died in 1997 from exposure to dimethylmercury, which penetrated her latex gloves.

- See the [EHS Glove Use](#) webpage for links to various glove manufacturers' information for selecting gloves for chemical use.

Proper use of gloves:

- Inspect gloves before and after each use.
- Check for perforations by inflating gloves with air or water.
- Inspect visually for tears or rips.
- Discoloration or stiffness may indicate chemical degradation.
- Torn or damaged gloves should be replaced immediately.
- Gloves should be selected that do not put the user at risk by causing: loss of dexterity, risk of being caught in rotating equipment, or risk of ergonomic injury from gloves that are too heavy or stiff for manipulating small objects.
- For disposable gloves, replace when chemical contact occurs, or when damage is suspected.
- Wash hands after removing gloves (even when double gloving).
- Remove gloves before you leave the lab or handling objects such as doorknobs, telephones, or computer keyboards.
- Disposable gloves are not to be reused.
- For reusable gloves, wash after removal and air dry in lab.
- Store gloves in clean area away from chemicals, temperature extremes, and other hazards.
- Dispose of contaminated gloves in the proper hazardous waste container.

Lab Coats

Lab coats are required before handling chemical, biological or radiological materials. The requirement also applies to working at a lab bench where such materials are handled or working adjacent to areas with such work. They must be maintained in good condition and reasonably clean so as to not create a hazard. Coats shall be selected for proper fit and shall cover the user to the knees. Lab coats made of polyester-cotton blends must be at least 35% cotton. Where open flames are used (such as alcohol burners) lab coats must be made of 100% cotton. Lab coats made of flame resistant (FR) material are required in labs where pyrophoric materials are handled. Persons working with pyrophoric liquids are also required to wear 100% cotton clothing underneath the FR lab coat on days that they handle these materials in the lab.

Clean rooms and other specialty areas are excluded from this requirement provided that personnel are furnished with appropriate alternative protective garments for working with hazards present.

Lab coats and gloves are not to be worn in offices, lunch rooms, break rooms, rest rooms, conference rooms, meeting rooms or other public access areas. Whenever possible, lab coats are to be hung in the lab before exiting.

Lab coats must be laundered by the University. Home laundering of lab coats is not allowed.

Lab coats which are grossly contaminated by over use or because of a spill (on to the lab coat) should not be turned in for laundering if the contaminants include heavy metals, nanomaterials, NFPA health hazard 4 chemicals, biologically hazardous materials, or

flammable solvents. In such a case, the lab coat will be disposed of as hazardous waste or autoclaved if biologically contaminated.

Skin Protection, Other than Gloves

Skin protection should be worn when there is a possibility of chemical splashes to the body, when the atmosphere may contain contaminants that could damage the skin or be absorbed by the skin, or when contaminants could remain on the street clothes of an employee. The amount of coverage is dependent on the area of the body that is likely to be exposed. For small controlled processes, an apron may be sufficient; for work above the head, a full body coverall may be required. The process for selecting chemically resistant clothes is similar to that for gloves. Please check the manufacturer's recommendations for the proper selection of chemically-protective clothing.

Respiratory Protection

Respirators are worn on the face to protect the respiratory system from hazardous air contaminants. Respiratory protection is not normally warranted in laboratory settings where exposures are controlled through the use of various engineering controls designed into the lab. When it is not feasible to conduct operations within a fume hood, or where there otherwise may be a need for respiratory protection, EHS must be contacted for respirator approval. EHS provides employee respirators from dust masks to air purifying respirators as well as all replacement cartridges and parts. Regulations require that all employees complete a medical questionnaire, fit test & training before receiving any type of respiratory protection. Note that the medical questionnaire may prompt the need for a physical examination. EHS will work with your Supervisor to coordinate this effort per the [EHS Respiratory Protection Program](#).

Hearing Protection

Hearing protection is rarely required during laboratory operations. If a laboratory operation generates noise conditions in which researchers have to raise their voices to be heard, contact EHS for an assessment. Hearing protectors such as earmuffs or earplugs may be necessary when sound levels exceed comfortable noise levels (typically at 85 decibels or greater).

Employees who perform tasks where noise may be excessive are in the [EHS Hearing Conservation Program](#), which includes regular audiograms to monitor their hearing as well as mandatory annual training and the use of hearing protection during those tasks.

PPE Training Guidelines

Training must be provided to each employee who is required to use PPE. Each employee must be trained to know at least the following:

- When and why PPE is necessary;
- What PPE is necessary;
- How to properly don, doff, adjust and wear PPE;
- The limitations of the PPE; and
- The proper care, maintenance, useful life and disposal of the PPE.

Laboratory personnel must be instructed to remove gloves and lab coats prior to entering common areas (hallways, elevators, eating areas, rest rooms, offices, etc.).

Each employee shall demonstrate an understanding of the training and the ability to use personal protective equipment properly before being allowed to perform work requiring the use of PPE.

Supervisors are responsible for providing training. This training must be part of the lab safety and SOP training your employees receive. Any training format can be used as long as a hands-on session is included. The length and complexity of training should reflect the complexity of the PPE to be used. For example, training on wearing safety glasses may be an informal hands-on session only. Appendix B in the [EHS PPE Guideline](#) provides PPE employee training information that can be discussed, or distributed to employees.

Reassessment and Retraining

Reassessment of the workplace should be conducted when new equipment, chemicals or processes are introduced that could create new or additional hazards. Incident records should be reviewed and the suitability of previously selected PPE reevaluated, if warranted. When the supervisor has reason to believe that any affected employee who has been trained does not have the understanding or skills required to use the personal protective equipment properly, the supervisor shall retrain such employees. Retraining is also required when there have been changes in the workplace or change in type(s) of PPE that render previous training obsolete.

3.4 GOOD LAB PRACTICE POLICIES

Some actions may be described as basic or fundamental to safety in any laboratory or other situation where potential hazards exist, e.g., wearing appropriate eye protection, closing hood sashes when leaving a hood, not smoking or eating in the vicinity of hazardous chemicals, etc. These simple, somewhat "common sense" rules are important. If basic rules are followed, it is more likely that other, more complex and perhaps less intuitive, safety procedures will also be followed.

Other examples of basic safety rules for chemical laboratories include: restraining long hair, jewelry, or loose clothing; prohibiting sandals and open-toed shoes, requiring laboratory coats at all times when working with hazardous chemicals, prohibiting loose woven, frilly, or flammable synthetic clothing materials when working with open flames, pyrophorics, or flammable liquids.

The weight and weave of a fabric will affect how easily it will ignite and burn. Recommended fabrics are materials with a tight, heavy, weave that will burn more slowly than loose, light, fabrics of the same material. The surface texture of the fabric also affects flammability. Fabrics with long, loose, fluffy pile or "brushed" nap will ignite more readily than fabrics with a hard, tight surface. Most synthetic fabrics, such as nylon, acrylic or polyester resist ignition but should be avoided. Once ignited, the fabrics melt resulting in severe burns from the melted burning substance.

The following Basic Safety Rules are the minimum required and apply to all laboratories where chemical, radiological, and/or biological materials are used or stored. The PIs can and should develop their own more stringent or lab-specific rules and include them in their CHP Blue Binder.

Basic Safety Rules

Consumption, storage and preparation of food and drink are prohibited in research spaces where animals, hazardous chemicals, or human tissues/fluids are located, as well as in all laboratories that have been designated as Biosafety Level 1 or 2. This policy is intended to protect the health of research personnel and ensure compliance with accrediting agency rules, as well as State and Federal regulations. The UM-Dearborn [Exposure Control Plan](#) and [Biological Safety Manual](#) also prohibit eating/drinking in areas where recombinant DNA is handled and/or there is a reasonable likelihood of exposure to blood or other potentially infectious materials. The designation of clean areas within the lab for food storage, preparation and consumption is not allowed as interpreted by accrediting and regulatory agencies.

Food and drink is allowed in Non-laboratory areas that are physically separated from the laboratory by a door or partition which can be closed. Desk areas within the laboratory are not exempt from the restriction on food and drink.

Smoking, applying cosmetics, chewing gum, adjusting contact lenses, taking/storing medicine, and other related activities are not permitted in areas where chemical and/or biological materials are used or stored. Smoking is not permitted on campus.

Glassware used for laboratory operations is prohibited from use to prepare or consume food or beverages.

Laboratory refrigerators, ice chests, cold rooms, ovens, and so forth shall not be used for food storage or preparation.

Laboratory water sources and deionized laboratory water should not be used as drinking water.

Laboratory chemicals should never be tasted.

Mouth pipetting is prohibited. A pipette bulb or aspirator should be used to pipette chemicals or to start a siphon.

Hands should be washed with soap and water immediately after working with any laboratory chemicals, even if gloves have been worn.

Additional guidelines for maintaining a safe laboratory environment:

- To ensure that help is available if needed, do not work alone if using hazardous materials or performing hazardous procedures.
- To ensure that help is available in case of emergencies, laboratory personnel should not deviate from the assigned work schedule without prior authorization from the laboratory supervisor.
- Do not perform unauthorized experiments.
- Plan appropriate protective procedures and the positioning of all equipment before beginning any operation. Follow the appropriate standard operating procedures at all times in the laboratory.
- Always read the SDS and the label before using a chemical in the laboratory.
- Wear appropriate PPE, including a laboratory apron or coat, at all times in the laboratory. Everyone, including visitors, must wear appropriate eye protection in areas where laboratory chemicals are used or stored.

- Wear appropriate gloves when handling hazardous materials. Inspect all gloves for holes and defects before using.
- Use appropriate ventilation such as laboratory chemical hoods when working with hazardous chemicals.
- Contact your PI if you have questions about the adequacy of the safety equipment available or chemical handling procedures.
- Know the location and proper use of the safety equipment (i.e., eyewash unit, safety shower, fire extinguisher, first-aid kit, fire blanket, emergency telephone, and fire alarm stations). Maintain situational awareness. Be aware of the hazards posed by the work of others in the laboratory and any additional hazards that may result from contact between materials and chemicals from different work areas.
- Make others in the laboratory aware of any special hazards associated with your work.
- Notify supervisors of any chemical sensitivities or allergies.
- Report all injuries, accidents, incidents, and near misses.
- For liability, safety, and security reasons, do not allow unauthorized persons in the laboratory.
- Report any unsafe conditions to the laboratory supervisor or PI.
- Properly dispose of all chemical wastes.
- Always protect hands with appropriate gloves when cutting glass tubing. To avoid breakage, do not attempt to dry glassware by inserting a glass rod wrapped with paper towels. Always lubricate glassware with soap or glycerin before inserting rods, tubing, or thermometers into stoppers.
- To reduce the chances of injuries from projectiles, when heating a test tube or other apparatus, never point the apparatus toward yourself or others.
- Be sure that glassware has cooled before touching it. Hot glass looks just like cold glass.
- Dilute concentrated acids and bases by slowly pouring the acid or base into the water while stirring.

Visitors

Visitors, including children, are permitted in laboratories where hazardous substances are stored or are in use, or hazardous activities are in progress, as long as they are properly protected. Unsupervised volunteers and visitors, as well as children and pets, create a risk for injury and additional liability on the University. EHS recommends that a responsible person appointed by the Laboratory Director supervise all visitors or volunteers when they enter a laboratory to work, or for a visit. Departmental policy to this effect will reduce, or eliminate, the risk of personal injury to visitors/volunteers in research laboratories, and the risk of damage to projects and property.

If minors are expected in a laboratory (e.g., as part of an educational or classroom activity), ensure that they are under the direct supervision of qualified adults at all times. Other laboratory personnel and volunteers in the area should be made aware that minors will be present.

Pets

No pets are permitted in laboratories. *Note: service animals are not pets. They are highly trained and may be present in a laboratory after a risk assessment has been conducted. A clean, safe area must be provided where the animal can wait.

Working Alone in the Laboratory

It is not prudent to work alone in a laboratory with hazardous materials or procedures. The American Chemical Society states that one should, “never work alone in the laboratory” (ACS, 2003). The [MIOSHA Hazardous Work in Laboratories Standard](#) states “Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous.” Accidents are unexpected by definition and if a person is working alone when one occurs, his or her ability to respond appropriately could be severely impaired, which could result in personal injury or death. Thus it is imperative that, whenever working in the laboratory, others are actively aware of your activities. If faced with a situation where you feel it is necessary to work alone in a laboratory:

- Reconsider the need. Is the work really that critical?
- Reconsider the timing and setup of the work. Can the task be accomplished another time when others will be present?
- If the timing of the task cannot be changed and you still feel it must be accomplished is there any other person trained in laboratory procedures who can accompany you?
- If not, is there anyone else within the building who could act as a “buddy” to check on you periodically during the time that you feel you must work alone?
- If no one can accompany you and you cannot find a “buddy,” **do not proceed with the work**. Speak to your supervisor to make arrangements to complete the work in a safe manner.

Good Housekeeping Practices in the Laboratory

Good housekeeping practices are those that promote general care, cleanliness, orderliness and maintenance of the laboratory. These practices in the laboratory can reduce potential risks of chemical exposure, fire, slip and fall, etc. Good housekeeping can also help reduce scientific error by reducing the chance of samples becoming confused or contaminated and keeping equipment clean and in good working order.

Laboratory Equipment and Tools

Laboratory staff is responsible for routine inspection of the equipment and tools to check for functionality and damage. If an inspection finds that any equipment or tools are not functioning as expected or are damaged, the laboratory is also responsible for removing that equipment or tool from service and arranging appropriate maintenance by trained and qualified technicians. Laboratory staff shall not conduct their own equipment or tool maintenance. This will usually be conducted by a technician from the manufacturer of the equipment or other specifically trained individual. Laboratory equipment and tools shall not be used after being found to require service.

Equipment or tools that are taken out of service must be decontaminated by the laboratory staff prior to service, for both on-site and off-site service. Laboratories must use the [EHS Equipment Decontamination Form](#).

When using laboratory equipment and tools, manufacturer’s recommendations must be followed. Contact the manufacturer for more information regarding proper use and technical assistance for specific equipment and tools. Procedures involving modified use of equipment or tools require a laboratory-specific Standard Operating Procedure to outline

any special health and safety considerations. See Section 4.0 of the Chemical Hygiene Plan for more information on Standard Operating Procedures.

Electrical Safety

Electrical equipment and connections must be checked regularly and kept clear of high traffic areas. Connections and cords must be insulated and undamaged. Equipment must be grounded when appropriate. Extension cords and daisy chained power strips are not permitted. Contact the facilities manager to arrange for receptacle drops or additional wall receptacles to be installed if more receptacles are required. Installations and electrical work must be done by a licensed electrician. Laboratory staff is not permitted to modify or work with facility electrical equipment or connections. High voltage panels must remain unblocked. Laboratory staff cannot access high voltage panels. Use of these panels presents a serious electrical hazard.

Standard operating procedures outlining electrical safety and general safety must be produced for any field fabricated equipment. Contact the Director/Lab Supervisor when planning to fabricate a new piece of equipment, for assistance in facilitating control measures for any associated hazards. See the [EHS Field Fabricated Equipment Guideline](#) and [EHS Electrical Safety webpage](#) for more information.

3.5 CHEMICAL EXPOSURE ASSESSMENT

Many chemicals routinely used in laboratories present a significant health risk when handled improperly. The Swiss physician Paracelsus (1493-1541) is known as “the father of toxicology.” Paracelsus is famous for his quote, “What is it that is not poison? All things are poison and nothing is without poison. It is the dose alone that makes a thing not a poison”. In that same spirit, trained laboratory personnel are encouraged to reduce personal risk by minimizing exposure to hazardous chemicals and by eliminating unsafe work practices in the laboratory.

The [MIOSHA Hazardous Work in Laboratories Standard](#) defines a hazardous chemical as one “for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed persons.” Note that this definition is not limited to toxic chemicals and includes corrosives, explosives, and other hazard classes. Routes of exposure to hazardous materials include contact with skin and eyes, inhalation, ingestion, and injection.

Overexposure to chemicals can result in adverse acute or chronic health effects. Acute exposure is defined as short durations of exposure to high concentrations of hazardous materials in the workplace. Acute health effects appear rapidly after only one exposure and symptoms include rashes, dizziness, coughing, and burns. Chronic exposure is defined as continual exposure over a long period of time to low concentrations of hazardous materials in the workplace. Chronic health effects may take months or years before they are diagnosed. Symptoms of chronic health effects include joint pain, neurological disorders, and tumors.

Consistent adherence to general safe laboratory practices in conjunction with appropriate use of exposure controls are expected to keep laboratory chemical exposures to a safe level. Exposure risk is more likely to increase when handling hazardous chemicals outside of a fume hood, especially chemicals:

- Having high acute or chronic toxicity or which are carcinogens or reproductive toxins
- Having a permissible exposure limit of less than 50 ppm (or 0.25 mg/m³ for particulate matter)
- That are appreciably volatile or easily dispersible in air
- That are used in large volumes (e.g., greater than 1 liter)

UM-Dearborn [Environmental Health and Safety \(EHS\)](#) has professionals experienced in evaluating laboratory chemical exposures. Employees are encouraged to contact EHS at (313) 593-0921 with concerns or requests for an evaluation. In some instances EHS will conduct exposure monitoring to measure levels of airborne contaminants. Depending on the chemical some measurements can be made directly and potential exposures may be known right away. In other situations, samples of air must be collected in containers or passed through special collection media, with subsequent laboratory analysis.

Exposure monitoring *may* be conducted by EHS or an outside professional industrial hygienist under the following conditions:

- Lab personnel are experiencing strong odors associated with hazardous material usage in the laboratory
- Lab personnel are experiencing any physical symptoms associated with exposure to a particular hazardous material
- The use of engineering controls is not possible with the use of certain hazardous materials
- There is reason to believe that exposure levels for a substance exceeds the [MIOSHA Action Level \(AL\) or Permissible Exposure Limit \(PEL\)](#).
- An employee makes a request

The initiation, frequency, and termination of monitoring are done in accordance with the relevant regulation. Monitoring results are provided to laboratory personnel per the time requirements of the relevant regulation, or within 15 days of receipt of monitoring results. EHS maintains copies of exposure monitoring per the regulatory requirement. A copy of all individual lab exposure monitoring must be maintained by the lab for employee review in their CHP Blue Binder.

Reproductive Health at the University of Michigan

Another aspect of your safety involves your reproductive health. Reproductive success relies on a delicate balance between maternal, paternal and fetal systems. Any disruption of the balance can result in a broad range of effects including infertility, poor pregnancy outcomes, childhood cancers or heritable alterations affecting future generations. Proper use of engineering controls, lab safety procedures and adhering to Standard Operating Procedures (SOP) will greatly reduce your potential risk. If there is a potential risk, review the [EHS Reproductive Health Awareness Guideline](#) and complete the appropriate forms. Contact EHS for review and approval.

4.0 STANDARD OPERATING PROCEDURES (SOP)

The PI/Laboratory Supervisor is responsible for providing written Standard Operating Procedures (SOP) relevant to health and safety for laboratory activities he/she directs involving hazardous chemicals and equipment. Laboratory personnel working autonomously or performing independent research are responsible for developing SOP appropriate for their own work.

Priority for SOP development should be given to any operation involving restricted and higher hazard chemicals, such as Particularly Hazardous Substances and Highly Reactive Chemicals, and specified higher-risk research procedures.

4.1 **Written SOP**

This section contains links to SOP for many specific chemicals and classes of chemicals. The SOP provided are intended to promote the prudent use of hazardous chemicals in laboratory work and will also serve as models for the preparation of additional SOP for chemicals and processes not included in the CHP. Only individuals familiar with the chemicals and process should conduct experiments involving these SOP.

The scope of coverage and degree of detail provided in these SOP should be appropriate for prudent experiment planning in most commonly encountered laboratory situations. Ultimately, the PI is responsible to ensure the SOP is adequate and provides sufficient guidance to laboratory personnel to maintain a safe work place. The information contained in these SOP is believed to be accurate at the time of inclusion in the CHP. A current SDS should be consulted for updated information.

Laboratory workers are required to prepare new SOP for unfamiliar substances as part of the risk assessment they must carry out for each experiment. In addition, substances that meet the MIOSHA criteria for “particularly hazardous substances” such as select carcinogens, reproductive toxins, and substances that have a high degree of acute or chronic toxicity are required to have written SOP.

The following discussion may be helpful in the development of laboratory-specific SOP for handling hazardous chemicals. Some laboratory equipment presents special hazards, which will require a SOP to assure safety. Follow a similar, thorough approach for developing equipment SOP.

Consider the chemical process

List all possible reactions, including side reactions, before beginning. Think through all reactants, intermediates, and products in terms of flammability, toxicity, and reactivity hazards. Consider the following:

- Does it decompose, and if so, how rapidly and to what products?
- What is its stability on exposure to heat, light, water, metals, etc.?
- Is it impact sensitive?
- With what substances is this material incompatible? Are any incompatible materials in the vicinity of the reaction?
- Is it toxic? If so, what type of hazard (inhalation, ingestion, skin contact)? What protective measures are required?
- What is the recommended first aid treatment in case of an accidental exposure?
- Determine the quantity and the rate of the evolution of heat and gases that may be released during the reaction. Use the thermodynamic and kinetic data from the reaction chemistry.
- Follow recognized, safe practices concerning protective equipment, housekeeping, handling hazardous chemicals, and proper use of lab equipment.

Question the process dynamics

- How violent will it be?
- What is the effect of catalysts or inhibitors?
- How will air affect the reaction?
- How are the waste products to be handled and disposed of properly?

Develop contingency plans for:

- Electric power failure
- Cooling system failure
- Exhaust system failure
- Over-pressurization
- Water leaks into system
- Air leaks into system
- Fire (Is the appropriate extinguishing agent nearby?)
- Container breakage
- Chemical spill

During the process

- Provide adequate cooling, ventilation, pressure relief, and gas purging.
- Isolate the reaction vessel, if possible, and make frequent inspections of equipment during reaction.
- Post appropriate warning signs near any dangerous equipment.
- Inform others working in the area of the chemicals being used and the possible hazards involved.
- Always stay in the area and monitor systems that may present unusual hazards.
- Report all incidents and unusual occurrences at once.

The SOP listed below provides standard information and require some customization for each lab. EHS has also created a [SOP Template](#) to use for any chemical or experimental procedure not listed below. SOP applicable to individual labs should be printed and placed in the CHP Blue Binder. Personnel trained to conduct the procedure should sign the training certification.

Equipment

| | |
|--------------------|-------------------------|
| Autoclaves | Environmental rooms |
| Biosafety cabinets | Machinery – Supervisors |
| Centrifuge safety | Machinery – Users |

Health Hazards

| | | |
|-------------------------|-----------------------------|----------------------|
| Acrylamide | Diethyl ether | Pyrophoric materials |
| Acutely toxic chemicals | Ethidium bromide | Rapamycin |
| Animal anesthetics | Fluorouracil | Reproductive toxins |
| Antineoplastic drugs | Formalin & Paraformaldehyde | Sensitizers |
| Aqua regia | Hydrofluoric acid | Sodium azide |
| Asphyxiants | Irritants | Streptozocin |
| Biotoxins | Methylene chloride | Sulfuric acid |
| Bleach | Nanomaterials | Tamoxifen |
| B-mercaptoethanol | Nitric acid | Tetrahydrofuran |
| Carcinogens | Osmium tetroxide | Toxic gases |
| Chloroform | Oxidizers | |
| Controlled substances | Peroxide forming chemicals | |
| Corrosive chemicals | Phenol | |
| Cytotoxins | Piranha solution | |

Physical Hazards

| | | |
|---------------------------|----------------------------|---------------------------|
| Aqua regia | Oxidizing chemicals | Tetrahydrofuran |
| Compressed gases | Peroxide forming chemicals | Ultraviolet radiation |
| Corrosive chemicals | Perchloric acid | Water-sensitive chemicals |
| Diethyl ether | Picric acid | |
| Electrophoresis | Piranha solution | |
| Explosives | Pressure and vacuum | |
| Flammables & Combustibles | Pyrophoric materials | |
| Nitric acid | Reactive chemicals | |

4.2 Restricted Chemicals Requiring Prior Approval

Laboratory personnel shall seek and the PI/Laboratory Supervisor (or his/her delegate) must provide prior approval of any chemical usage involving particularly hazardous materials (defined in section 2.9 of this document) and the following Restricted Chemicals listed below. Those preceded by an asterisk are select carcinogens as defined in the [MIOSHA Carcinogens standard](#).

In addition, the PI/Laboratory Supervisor must also provide prior approval for the use of substances with a hazard ranking of 4 in any [ChemWatch Gold FFX](#) rating for Flammability, Toxicity, Body contact, Reactivity or Chronic.

| | |
|----------------------------------|---------------------------------------|
| *2-Acetylaminofluorene (53-96-3) | Fluorine (7782-41-4) |
| Acrolein (107-02-8) | Hexamethylphosphoramide (680-31-9) |
| *4-Aminodiphenyl (92-67-1) | Hydrazine (302-01-2) |
| Anhydrous ammonia (7664-41-7) | Hydrogen cyanide (74-90-8) |
| Arsine (7784-42-1) | Lithium aluminum hydride (16853-85-3) |
| *Benzidine (92-87-5) | *alpha-Naphthylamine (134-32-7) |
| Boron trifluoride (7637-07-2) | *beta-Naphthylamine (91-59-8) |

| | |
|--|--|
| Butyllithiums (and related alkyl lithium reagents) | Nickel carbonyl (13463-39-3) |
| *Chloromethyl methyl ether (107-30-2) | *4-Nitrobiphenyl (92-93-3) |
| Cyanogen bromide (506-68-3) | N-Nitrosodimethylamine (62759) |
| Diazomethane (334-88-3) | Osmium tetroxide (20816-12-0) |
| Diborane (19287-45-7) | Palladium on carbon (7440-05-3) |
| Diethylnitrosamine (and related nitrosamines) | Phosgene (75-44-5) |
| *4-Dimethylaminoazo-benzene (60-11-7) | Phosphine (7803-51-2) |
| Dimethylmercury (593-74-8) | *beta-Propiolactone (57-57-8) |
| Dimethyl sulfate (77-78-1) | Sodium azide (26628-22-8) |
| Ethylene dibromide (106-93-4) | Toluene diisocyanate (584-84-9) |
| *Ethyleneimine (151-56-4) | Trimethylaluminum (75-24-1) and related organoaluminum compounds |
| Ethylene oxide (75-21-8) | Trimethyltin chloride (1066-45-1) |

4.3 Special Provisions for Other Higher Hazard Chemicals and Operations

The MIOSHA [Hazardous Work in Laboratories Standard](#) has mandated that a special review be conducted in any laboratory in which a “particularly hazardous substance” is being used in order to determine if the hazard potential warrants implementation of special controls or procedures to control employee exposure. Each PI/Laboratory Supervisor will identify those materials and procedures in their lab for which special provisions will be applied. The PI will write a SOP that includes the necessary special provisions.

In developing a SOP for higher hazard chemicals and operations, consideration must be given to:

- Establishment of a designated area
- The conditions of handling
- Skin exposure potential
- Inhalation hazard
- Use of personal protective equipment
- Continuous air monitors
- Alarms
- Need for contamination control devices such as glove boxes
- Decontamination procedures
- Procedures for the handling and safe removal of waste materials

Laboratory personnel must consult with PI/Laboratory Supervisors on the following procedures in their laboratories so that special safety precautions can be taken, where appropriate:

- A procedural change that significantly increases the overall hazard of an existing procedure, such as introduction of a high hazard chemical in a procedure or scale up of an experimental procedure or operation. Careful consideration of scaled up work is critical to plan for the effects caused by an increase in chemical concentration/quantity and differences in dissolution rate and heat transfer.
- Unattended operations that represent significant likelihood of fire, explosion, or exposure to personnel if a malfunction were to occur (such as a utility outage, runaway reaction, broken container or chemical spill).

- Time the work is to be conducted (during normal business hours (i.e., 7 am – 8 pm Monday through Friday) versus at night or on weekends/holidays).

5.0 CHEMICAL PROCUREMENT, LABELING, STORAGE, AND INVENTORY

Prior to procuring a chemical, it is important to consider all cost aspects during the life cycle of the chemical. Close attention must be paid to purchasing, handling and disposal costs to effectively manage chemical inventories and minimize accumulation of unused or unwanted chemicals.

Once in the lab, hazardous chemicals must be stored, labeled and inventoried properly to avoid confusion or mistaken identity of a chemical, to provide separation of incompatible materials, and to provide information for emergency response personnel.

5.1 Chemical Procurement

Anyone who purchases a chemical assumes responsibility for ownership of that chemical. Before purchasing a chemical, the following points must be considered:

- Has the purchase been reviewed to ensure that any special requirements can be met?
- Is the material already available?
- What is the minimum quantity that will suffice for the current use? The potential savings when buying in bulk is often outweighed by the disposal cost for excess chemicals.
- What is the maximum size container or overall quantity allowed in the lab where the chemical will be used and/or stored? Contact EHS for assistance in determining maximum quantities.
- Can the chemical be safely stored when it arrives? Is any special storage such as a dry box or freezer available? Will arrangements need to be made to notify someone as soon as the chemical arrives?
- Is the proper PPE available in the lab to handle the chemical?
- Does the lab fume hood provide proper ventilation?
- Has a SOP been developed that addresses proper handling, storage and disposal for the chemical?
- Are there special containment considerations in the event of a spill, fire or flood?

Chemicals should be delivered to a central location in the building where someone is available to accept the delivery. Chemicals must not be delivered to administrative offices or mail rooms.

Any person accepting delivery of a chemical must be trained to:

- Check for an identifying label
- Be able to identify signs of breakage (e.g. rattling) and leakage (e.g. wet spot or stain)
- Respond appropriately if a cylinder of compressed gas is leaking

Restricted chemical procurement procedures are detailed in section 5.5 of this document.

5.2 Chemical Labeling










The MIOSHA Hazard Communication Standard (HCS) is intended to ensure chemical safety in the workplace by requiring employers to provide information about the identities and hazards of chemicals that employees handle and use. The HCS is now aligned with the Globally Harmonized System (GHS) of classification and labeling of chemicals. GHS

provides a standardized approach to label elements and safety data sheets (SDS).

All hazardous chemical containers will have a primary label from the chemical manufacturer/supplier containing pictograms, signal words, hazard statements and precautionary statements. In addition, the label will have the common product or chemical name and the supplier or manufacturer name, address and telephone number.

The pictogram is a symbol plus other graphic elements, such as a border, background pattern, or color that is intended to convey specific information about the hazards of a chemical. There are eight (8) required (*as applicable*) standardized pictograms and one (1) optional pictogram, under the GHS. Each pictogram consists of a different symbol on a white background within a red square frame set on a point, i.e. a red diamond. All pictograms are diamond shaped with a red border and black image.

HCS Pictograms and Hazards

| | | |
|---|---|---|
| <p>Health Hazard</p>  <ul style="list-style-type: none"> ▪ Carcinogen ▪ Mutagenicity ▪ Reproductive Toxicity ▪ Respiratory Sensitizer ▪ Target Organ Toxicity ▪ Aspiration Toxicity | <p>Flame</p>  <ul style="list-style-type: none"> ▪ Flammables ▪ Pyrophorics ▪ Self-Heating ▪ Emits Flammable Gas ▪ Self-Reactives ▪ Organic Peroxides | <p>Exclamation Mark</p>  <ul style="list-style-type: none"> ▪ Irritant (skin and eye) ▪ Skin Sensitizer ▪ Acute Toxicity ▪ Narcotic Effects ▪ Respiratory Tract Irritant ▪ Hazardous to Ozone Layer (Non-Mandatory) |
| <p>Gas Cylinder</p>  <ul style="list-style-type: none"> ▪ Gases Under Pressure | <p>Corrosion</p>  <ul style="list-style-type: none"> ▪ Skin Corrosion/Burns ▪ Eye Damage ▪ Corrosive to Metals | <p>Exploding Bomb</p>  <ul style="list-style-type: none"> ▪ Explosives ▪ Self-Reactives ▪ Organic Peroxides |
| <p>Flame Over Circle</p>  <ul style="list-style-type: none"> ▪ Oxidizers | <p>Environment (Non-Mandatory)</p>  <ul style="list-style-type: none"> ▪ Aquatic Toxicity | <p>Skull and Crossbones</p>  <ul style="list-style-type: none"> ▪ Acute Toxicity (fatal or toxic) |

Signal words are used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The two signal words to be used are "Danger" and "Warning". "Danger" is used for the more severe hazards, i.e., for hazard categories 1 & 2 while "Warning" is used for less severe hazards. Only one signal word corresponding to the class of the most severe hazard should be used on a label.

A hazard statement is assigned to a hazard class and category that describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard. Examples:

- Flammable liquid and vapor
- Causes skin irritation
- May cause cancer
- May cause liver & kidney damage

A precautionary statement is a phrase that describes recommended measures to be taken to minimize or prevent adverse effects resulting from exposure to a hazardous chemical or improper storage or handling of a hazardous chemical.

Examples:

- Wear eye & face protection
- Avoid breathing fumes or mist
- Keep away from heat, sparks, open flames & other sources of ignition
- Store in well-ventilated space

Secondary containers of chemicals and any in-house dilutions made from stock chemical bottles are required to be labeled with the full chemical name (no abbreviations), concentration, and primary health and/or physical hazard(s). Labels can be hand written or printed. The [Chemwatch Safety Data Sheet program](#), located on the EHS website, has the capability of creating and printing various size labels for use in the lab.

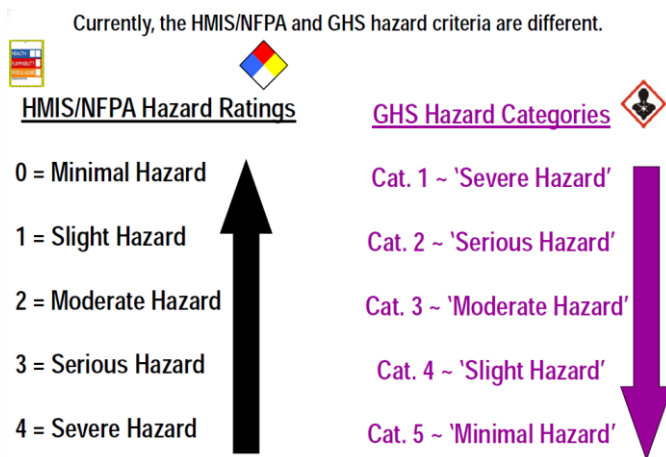
Physical hazards under GHS are:

| | |
|----------------------------|---|
| • Explosives | • Pyrophoric Liquids |
| • Flammable Gases | • Pyrophoric Solids |
| • Flammable Aerosols | • Self-Heating Substances |
| • Oxidizing Gases | • Substances which, in contact with water, emit flammable gases |
| • Gases Under Pressure | • Oxidizing Liquids |
| • Flammable Liquids | • Oxidizing Solids |
| • Flammable Solids | • Organic Peroxides |
| • Self-Reactive Substances | • Corrosive to Metals |

Health hazards under GHS are:

| | |
|-------------------------------------|--|
| • Acute Toxicity | • Reproductive Toxicology |
| • Skin Corrosion/Irritation | • Target Organ Systemic Toxicity – Single Exposure |
| • Serious Eye Damage/Eye Irritation | • Target Organ Systemic Toxicity – Repeated Exposure |
| • Respiratory or Skin Sensitization | • Aspiration Toxicity |
| • Germ Cell Mutagenicity | |
| • Carcinogenicity | |

GHS adds severity rankings to each of the hazard classifications. Categories range from 1 to 4; with “1” indicating the most severe and “4” indicating least severe. Note: This ranking system conflicts with the NFPA and HMIS systems where the number “4” indicates a severe hazard.



5.3 Chemical Storage

To lessen risk of exposure to hazardous chemicals, trained laboratory personnel must separate and store all chemicals according to hazard category and compatibility. In the event of an accident involving a broken container or a chemical spill, incompatible chemicals that are stored in close proximity can mix to produce fires, hazardous fumes, and explosions. Laboratory personnel should read the SDS and heed the precautions regarding the storage requirements of the chemicals in the laboratory.

Incoming chemical shipments should be dated promptly upon receipt, and chemical stock should be rotated to ensure use of older chemicals. Peroxide forming chemicals must be dated upon receipt and again when the container is opened so that the user can dispose of the material according to the recommendations on the SDS. Peroxide formers should be stored away from heat and light in sealed airtight containers with tight-fitting, nonmetal lids. Test regularly for peroxides and discard the material prior to the expiration date. For more information about storage and handling of peroxides, see Chapter 2, Section 2.5 and the [Peroxide Forming Chemicals SOP](#).

Basic Guidelines for Chemical Storage:

- Storage areas should be cool, dry, ventilated, well lit and away from direct heat and sunlight.
- Appropriate chemical spill kits and fire extinguishers should be kept near storage areas.
- Containers must be sealed, capped and in good condition.
- Outside of the containers must be kept clean of chemical residue.
When storing chemicals on open shelves, always use sturdy shelves that are secured to the wall.
- Do not store liquid chemicals above shoulder height.
- Do not store chemicals within 18 inches of sprinkler heads in the laboratory.
- Use secondary containment devices (i.e., chemical-resistant trays) where appropriate.
- Chemical, biological, or radiological materials must be placed in secondary containers to be safely transported between labs or from the chemical stock room.
- Do not store chemicals in the laboratory chemical hood, on the floor, in the aisles, in hallways, in areas of egress, or on the benchtop.
- Store chemicals by compatibility – not alphabetically!
- Reference the compatibility chart below
- Download [NOAA Chemical Reactivity Worksheet](#) to your computer Highly hazardous

chemicals must be stored in a well-ventilated secure area that is designated for this purpose. Cyanides must be stored in a tightly closed container, and placed in a cool dry cabinet to which access is restricted. Protect cyanide containers against physical damage and separate them from incompatibles. When handling cyanides, follow good hygiene practices and regularly inspect your PPE. Use proper disposal techniques.

Rooms that are used specifically for chemical storage and handling (i.e., preparation rooms, storerooms, waste collection rooms, and laboratories) should be controlled-access areas that are identified with appropriate signage. Chemical storage rooms should be designed to provide proper ventilation, two means of access/egress, vents and intakes at both ceiling and floor levels, a diked floor, and a fire suppression system.

Storage Guidelines for General Classes of Chemicals

- Flammable Liquids – Flammable liquids are required to be stored in flammable liquid storage cabinets approved by the [National Fire Protection Association \(NFPA\)](#) or flammable liquid storage rooms meeting [MIOSHA requirements](#). MIOSHA's requirements include ventilation, dikes, explosion proof lighting, intrinsically safe wiring, grounding and bonding. Oxidizers, acids and other incompatible chemicals are prohibited from being stored in these areas. Do not permit sources of ignition in or near storage areas.

Only laboratory-grade flammable liquid storage refrigerators and freezers may be used to store properly sealed and labeled chemicals that require cool storage in the laboratory. Periodically clean and defrost the refrigerator and freezer to ensure maximum efficiency. Domestic refrigerators and freezers must not be used to store chemicals; they possess ignition sources and can cause dangerous and costly laboratory fires and explosions.

- Corrosives – Corrosives can be acidic or basic. Acids and bases should never be stored together. Corrosives should not be stored with flammable or combustible materials. Spill trays should be used to contain leaks.
- Oxidizers – Store in an isolated area away from flammable or combustible materials. These agents may react at room temperature producing fire or explosions. Strong oxidizers – i.e. perchloric acid, chromic acid, and hydrogen peroxide - are even explosive on contact with organic materials.
- Toxic and Poisonous Materials – Store in isolated areas. Do not store with acids or flammable materials.
- Cryogenic Liquefied Gases – Store in cool, well-ventilated areas. Cryogenic gases boil off at room temperatures and must be vented to prevent dangerous excessive pressure build up. This vented gas can displace oxygen in enclosed or unventilated areas. The liquid form of cryogenic gases will instantly cause cold-contact burns to living tissue upon contact.
- Water Reactive Compounds – Store in isolated location away from any water sources
- Pyrophoric Compounds – Store in isolated location under nitrogen or other appropriate storage method from the chemical manufacturer.

- Peroxide Forming Compounds – Do not store with organics or solvents. Store in airtight containers in a dark, cool but not freezing, and dry area. Do not permit sources of heat, friction, grinding, or impact near storage areas. For more information about storage and handling of peroxides, see Section 2.5.
- Special Compounds – Follow specific storage instructions from chemical manufacturers. Check for moisture in the bottle of explosive chemicals that must be stored wet or in solution. Date all incoming shock sensitive explosive chemicals and dispose of them immediately upon reaching their expiration date. Both picric acid and benzoyl peroxide must be kept wet. If the solution dries, the crystals form very sensitive explosive compounds. Any shock or friction could set these off.

Some chemicals like diethyl pyrocarbonate must be refrigerated to remain stable. Once unstable, removing the cap could cause an explosion.

Do not mix combustibles with perchlorates. Many perchlorates become explosive when mixed with combustibles. Examples include: silver perchlorate, ammonium perchlorate, sodium perchlorate, and potassium perchlorate. Organic perchlorates like methyl perchlorate are self-contained explosives.

- Compressed Gas Cylinders – Compressed gas cylinders must be secured in an upright position away from excessive heat, highly combustible materials, and areas where they might be damaged or knocked over. A chain, bracket or other restraining device shall be used to secure the cylinder at all times to prevent them from falling. The cylinder status as to “full” or “empty” must be indicated on the cylinder and the valve cap must be in place whenever the cylinder is not connected for use.

Cylinders must be stored in ventilated areas. Closets and lockers are not acceptable storage locations. Hallways, corridors, stairwells or near elevators are also unacceptable. Additionally, cylinders of oxygen and other oxidizers must not be stored within 20-feet of fuel-gas or other combustible materials unless separated by a specific barrier, e.g., a noncombustible wall, not less than 5-feet high, having a fire-resistance rating of ½-hour. Securing devices can be purchased from any laboratory safety supply company, or the Sheet Metal Shop can develop a restraining system.

Additional Safety Procedures – Maintain small inventories of chemicals. Large inventories are more dangerous and usually result in more wastes being generated. When applicable, handling and storage procedures, outlined on the SDS, should be incorporated into your Standard Operating Procedures (SOP). Prior to working with chemicals, training on proper use and storage must be provided. If you are unsure of the correct safe handling procedures for any chemical, please contact EHS for assistance.

Chemical Compatibility Charts: Adapted from the [Fisher Scientific Chemical Stockroom Handbook](#)

Incompatibilities by Hazard Class

| | Acids Inorganic | Acids Oxidizing | Acids Organic | Alkalis Bases | Oxidizers | Poisons Inorganic | Poisons Organic | Water Reactive | Organic Solvents |
|-------------------|-----------------|-----------------|---------------|---------------|-----------|-------------------|-----------------|----------------|------------------|
| Acids Inorganic | | | X | X | | X | X | X | X |
| Acids Oxidizing | | | X | X | | X | X | X | X |
| Acids Organic | X | X | | X | X | X | X | X | |
| Alkalis Bases | X | X | X | | | | X | X | X |
| Oxidizers | | | X | | | | X | X | X |
| Poisons Inorganic | X | X | X | | | | X | X | X |
| Poisons Organic | X | X | X | X | X | X | | | |
| Water Reactive | X | X | X | X | X | X | | | |
| Organic Solvents | X | X | | X | X | X | | | |

X indicates incompatibility between two chemical product groups. Incompatible products should not be stored in close proximity.

Specific Chemical Incompatibilities

| Chemical | Store Separately From |
|----------------------|--|
| Acetic acid | Chromic acid, nitric acid, perchloric acid, peroxides, permanganates and other oxidizers |
| Acetone | Concentrated nitric and sulfuric acid mixtures, and strong bases |
| Acetylene | Chlorine, bromine, copper, fluorine, silver, mercury |
| Alkali metals | Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens |
| Ammonia, anhydrous | Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid |
| Ammonium nitrate | Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials |
| Aniline | Nitric acid, hydrogen peroxide |
| Arsenic materials | Any reducing agent |
| Azides | Acids |
| Bromine | Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals |
| Calcium oxide | Water |
| Carbon (activated) | Calcium hypochlorite, all oxidizing agents |
| Carbon tetrachloride | Sodium |
| Chlorates | Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials |

| | |
|------------------------------------|--|
| Chromic acid and Chromium trioxide | Acetic acid, naphthalene, camphor, glycerol, glycerin, turpentine, alcohol, flammable liquids in general |
| Chlorine | Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals |
| Chlorine dioxide | Ammonia, methane, phosphine, hydrogen sulfide |
| Copper | Acetylene, hydrogen peroxide |
| Cumene hydroperoxide | Acids, organic or inorganic |
| Cyanides | Acids |
| Flammable liquids | Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens |
| Hydrocarbons | Fluorine, chlorine, bromine, chromic acid, sodium peroxide |
| Hydrocyanic acid | Acids |
| Hydrogen peroxide | Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids |
| Hydrogen sulfide | Fuming nitric acid, other acids, oxidizing gases, acetylene, ammonia (aqueous or anhydrous), hydrogen |
| Hypochlorites | Acids, activated carbon |
| Iodine | Acetylene, ammonia (aqueous or anhydrous), hydrogen |
| Mercury | Acetylene, fulminic acid, ammonia |
| Nitrates | Sulfuric acid |
| Nitric acid (concentrated) | Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals |
| Nitrites | Acids |
| Nitroparaffins | Inorganic bases, amines |
| Oxalic acid | Silver, mercury |
| Oxygen | Oils, grease, hydrogen; flammable liquids, solids, or gases |
| Perchloric acid | Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease and oils |
| Peroxides, organic | Acids (organic or mineral), avoid friction, store cold |
| Phosphorus (white) | Air, oxygen, alkalis, reducing agents |
| Potassium | Carbon tetrachloride, carbon dioxide, water |
| Potassium chlorate and perchlorate | Sulfuric and other acids, alkali metals, magnesium and calcium |
| Potassium permanganate | Glycerin, ethylene glycol, benzaldehyde, sulfuric acid |
| Selenides | Reducing agents |
| Silver | Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid |
| Sodium | Carbon tetrachloride, carbon dioxide, water |
| Sodium nitrite | Ammonium nitrate and other ammonium salts |
| Sodium peroxide | Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural |
| Sulfides | Acids |
| Sulfuric Acid | Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals: sodium, lithium, etc.) |
| Tellurides | Reducing agents |

(From Manufacturing Chemists' Association, Guide for Safety in the Chemical Laboratory, pp. 215–217, Van Nostrand)

Additional Incompatible by Chemical Class

| | | | | | | | | | | | | | | | | | | | | | |
|----|-----------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|----|
| 1 | Inorganic Acids | 1 | | | | | | | | | | | | | | | | | | | |
| 2 | Organic Acids | X | 2 | | | | | | | | | | | | | | | | | | |
| 3 | Caustics | X | X | 3 | | | | | | | | | | | | | | | | | |
| 4 | Amines & Alkaholamines | X | X | | 4 | | | | | | | | | | | | | | | | |
| 5 | Halogenated Compounds | X | | X | X | 5 | | | | | | | | | | | | | | | |
| 6 | Alcohols, Glycols & Glycol Ethers | X | | | | | | | | 6 | | | | | | | | | | | |
| 7 | Aldehydes | X | X | X | X | | | | | x | 7 | | | | | | | | | | |
| 8 | Ketones | X | | X | X | | | | | | x | 8 | | | | | | | | | |
| 9 | Saturated Hydrocarbons | | | | | | | | | | | | | | | | | | | 9 | |
| 10 | Aromatic Hydrocarbons | X | | | | | | | | | | | | | | | | | | 10 | |
| 11 | Olefins | X | | | | X | | | | | | | | | | | | | | 11 | |
| 12 | Esters | X | | X | X | | | | | | | | | | | | | | | 12 | |
| 13 | Halogens | | | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X | 13 | |
| 14 | Ethers | X | | | | | | | | | | | | | | | | | | 14 | |
| 15 | Acid Anhydrides | X | | X | X | | X | X | | | | | | | | | | | | X | 15 |
| 16 | Oxidizers | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 16 |

NOTE: Identify class to which a specific compound belongs, read unsafe combinations with other classes both horizontally and vertically.

X = Unsafe Combination

5.4 Chemical Lists

The PI is required to maintain a current list of all potentially hazardous chemicals stored, used, or produced within each laboratory that is under their responsibility. It is the responsibility of the PI to determine if chemicals in use or in storage present a potential hazard which must be identified on the Chemical List.

EHS has a chemical inventory tracking system available to assist laboratories in maintaining their Chemical Lists called the [Environmental Health and Safety Assistant \(EHSA\)](#). The EHSA system is a web-based, online, limited access database that can be used to maintain Chemical Lists as well as inventories of chemicals in UM research laboratories. This system is maintained on a secure internet server and is an easy to use, long-term, convenient way for researchers to maintain their lists or inventories, generate various built-in inventory reports and export data to Excel.

While the EHSA system is the **preferred** way to maintain a laboratory's Chemical List, other systems, e.g., Excel, Access, etc., can be used, as long as this information is updated at least annually. Also note that Chemical Lists already in other systems can be uploaded into the EHSA for subsequent use, by contacting EHS for more information. After a list/inventory has been uploaded in to the EHSA, it can be used exclusively for chemical maintenance and report generation, rather than the previous system used.

There is no specific required format for the information required in the laboratory's Chemical List. It is recommended that the list include the elements below. However, the PI should also consider their particular needs for chemical management.

- Common product or chemical name
- Approximate quantity
- Room number and building name
- Storage area or cabinet
- Department
- Name of person taking inventory
- Date of inventory

The chemical list must be updated on an annual basis, or more often if warranted. Unneeded materials should be discarded through EHS.

There are many benefits of performing annual chemical reviews and list updates:

- ensures that chemicals are stored according to compatibility tables,
- eliminates unneeded or outdated chemicals,
- promotes more efficient use of laboratory space,
- checks expiration dates of peroxide formers,
- ensures integrity of shelving and storage cabinets,
- encourages laboratory supervisors to make "executive decisions" about discarding unnecessary chemicals,
- Provides opportunity to repair/replace torn or missing labels and broken caps on containers,
- ensures compliance with all federal, state, and local record-keeping regulations, e.g., HHS/USDA's Select Agents and Toxins, DHS' Chemicals of Interest, etc.
- promotes good relations and a sense of trust with the community and the emergency responders,
- reduces the risk of exposure to hazardous materials and ensures a clean and safer laboratory environment, and
- may reduce costs by entering chemicals into the chemical reuse program.

Important safety issues to consider when performing a chemical review and list update are:

1. Wear appropriate PPE and have extra gloves available.
2. Use a chemical cart with side rails and secondary containment.
3. Chemicals should not be stored on high shelves
4. Know where the safety shower and emergency eyewash are located.
5. If necessary, cease all other work in the laboratory while performing the review.

5.5 Restricted Chemicals and gas, DEA, DHS

In order to provide a safe working environment in U-M research facilities, EHS has instituted a program with U-M Procurement Services which requires written EHS

approval for a relatively narrow range of hazardous gas purchases (see list below). These gases are of particular concern due to high toxicity, flammability, or reactivity - particularly in quantities that could defeat normal precautions and emergency responses. Under no circumstances should a researcher purchase more than a 1 year supply. See the [Hazardous Gases Purchasing Program](#) for more details.

Departments must complete an [authorization form](#) to purchase restricted gases. EHS must approve the request before the department orders the gas from a Strategic Supplier. A list of the restricted gases, a copy of this policy and procedure, and the authorization form are posted on the U-M Procurement Services web page:

Restricted Hazardous Gases

All of the hazardous gases listed below, in cylinder sizes larger than a lecture bottle (size LB), are included in this policy:

- Carbon Monoxide
- Hydrides (arsine, disilane, diborane, germane, phosphine, silane)
- Hydrogen
- Toxic (NFPA Health Rating of 3 or 4)
- Oxidizers (chlorine, fluorine)
- Oxygen (over 25% volume)

The Following are exempted from this Policy:

- Lecture bottles
- Hydrogen \leq 5% with inert gas balance
- Oxygen cylinder $<$ 30 ft³, no more than 330 ft³ in a single purchase request
- Lurie Nanofabrication Facility (LNF)*
- Plant Operations department*
- University of Michigan Health System and off-site clinics*
- School of Dentistry patient clinics*

* These departments are already under restrictions and audits through separate programs.

Select Agent Toxins

Some biological agents are capable of causing substantial harm to human, animal, or plant health and are high-risk agents for illegitimate use. Hence, the United States Department of Health and Human Services (HHS) and the United States Department of Agriculture (USDA) have established regulatory requirements for the possession, receipt, or transfer of such agents. These organisms are considered *Select Agents and High Consequence Livestock Pathogens and Toxins*. A list of the biological materials regulated as Select Agents are provided below. The University of Michigan and all individuals involved with Select Agents are required to comply with the Select Agent Program. Compliance is required under Federal Law; non-compliance can result in substantial penalties for both an individual and the University.

The Select Agent Regulation requires compliance with the "toxin due diligence" provision which applies to principal investigators, physicians, veterinarians, commercial manufacturers, distributors and all who may currently possess or use these toxins in excluded amounts. This provision was written to address the concern that someone might stockpile toxins by receiving multiple orders below the excluded amount. The provision requires that a person transferring toxins in amounts which would otherwise be excluded

from the regulation must: (1) use due diligence to assure that the recipient has a legitimate need to handle or use such toxins; and (2) report to the Federal Select Agent Program if they detect a known or suspected violation of Federal law or become aware of suspicious activity related to the toxin.

| HHS Toxins | Amount |
|---|---------------|
| Abrin | 100 mg |
| Botulinum neurotoxins | 0.5 mg |
| Short, paralytic alpha conotoxins | 100 mg |
| Diacetoxyscirpenol (DAS) | 1000 mg |
| Ricin | 100 mg |
| Saxitoxin | 100 mg |
| Staphylococcal Enterotoxins (Subtypes A, B, C, D and E) | 5 mg |
| T-2 toxin | 1000 mg |
| Tetrodotoxin | 100 |

UM-Dearborn Principal Investigators who currently possess, use, and/or order these toxins may have to provide documentation to the supplier to confirm the material will be used for a legitimate purpose. If you share any amount of the toxin with a colleague (anyone) at UM or outside of UM, you will be required to document that the material is being used for a legitimate purpose prior to each transfer and document the transfer in your inventory records for that toxin.

EHS will provide assistance on: regulatory requirements, document transfers, confirmation of funded research, federal agency response, and reporting any events that violate federal regulation.

In addition to the requirements detailed above for Select Agent Toxins (in exempt quantities), the laboratory must provide one additional layer of physical security (i.e., toxin secured within locked freezer, or secured within a permanently fixed lock box).

Controlled Substances in Research

Due to the responsibilities associated with the acquisition, administration, and storage of controlled substances, the University of Michigan has established the following policy:

- To conduct animal research with controlled substances, the Principal Investigator of the associated UCUC protocol(s) must always be appropriately licensed by State of Michigan and registered with the Drug Enforcement Administration (DEA).

Key permanent University employees, such as laboratory managers, may also obtain separate individual state controlled substance licenses and DEA registrations if the Principal Investigator on the UCUC protocol(s) travels frequently or is not routinely present at the registered location where controlled substances are administered.

The State of Michigan and DEA can impose administrative, civil, and criminal actions against a controlled substance licensee and DEA registrant for non-compliance, theft, or

loss associated with the storage and administration of controlled substances for research use.

As a result, researchers who hold State of Michigan controlled substance licenses and who are registered with the DEA must have the proper authority and research laboratory infrastructure to design, implement, and maintain necessary security and record keeping controls to maintain compliance.

The Principal Investigator may grant UM-Dearborn employees and students access to controlled substances by designating them as authorized agents under the authority of their state controlled substance license and DEA registration. [MI §338.7303(3a) and 21 C.F.R § 1301.22(a)]

Both State of Michigan (§338.7103) and federal regulations [21 U.S.C § 802(2)] require non-licensed and non-registered authorized agents to administer controlled substances in the presence of the licensee and DEA registrant.

The Principal Investigator of the UCUCA protocol(s) is responsible for the inventory and safe storage of controlled substances at their licensed and registered location.

Only the Principal Investigator of the UCUCA protocol(s) holding the State of Michigan controlled substance license and DEA registration may be authorized to purchase and store controlled substances at their registered laboratory location.

State of Michigan controlled substance licenses and DEA registrations acquired by key permanent staff may only be used for administration purposes when the Principal Investigator is not present. Other employees or students may work as designated authorized agents under the supervision of the licensed and registered laboratory manager.

The UCUCA office provides guidance on the use of Controlled Substances in Research and has [instructions](#) on completing appropriate applications. EHS offers additional guidance for research practices found in the [Controlled Substances Standard Operating Procedure](#).

5.6 Transporting, Transferring, and Shipping Chemicals

Transporting Chemicals

It is prudent practice to use a secondary containment device (i.e., rubber pail) when transporting chemicals from the storeroom to the laboratory or even short distances within the laboratory. When transporting several containers, use carts with attached side rails and trays of single piece construction at least 2 in. deep to contain a spill that may occur. Bottles of liquids should be separated to avoid breakage and spills.

Avoid high-traffic areas when moving chemicals within the building. When possible, use freight elevators when transporting chemicals and do not allow other passengers. If you must use a general traffic elevator, ask other passengers to wait until you have delivered the chemicals.

Transferring Chemicals between Containers

Often, laboratory operations require transferring chemicals from the original labeled container into a secondary container (e.g., beaker, flask, or bottle). Portable containers must comply with all labeling requirements listed in section 5.2 if any of the following events occur:

- The material is not used within the work shift of the individual who makes the transfer
- The worker who made the transfer leaves the work area
- Labels on portable containers are not required if the worker who made the transfer uses all of the contents during the work shift
- Check chemical compatibility with containers to verify that chemical storage is appropriate to the container

Transferring substances, especially when filling small containers from a larger one, can be quite dangerous. Follow these guidelines when transferring chemicals to make sure you do it safely:

- Make sure that the large container is stable and in your control if you are lifting to pour liquid out of it
- Use a funnel and pour slowly to prevent splashing, and airlocks in the funnel
- If the substance is flammable keep it away from any source of heat or ignition
- Use a properly operating chemical fume hood, local exhaust, or adequate ventilation when transferring chemicals
- If the substance is corrosive, wear gloves, safety goggles, a face shield and a rubber apron
- Whenever possible use a hand-pump or siphon to transfer liquids, rather than pouring
- If transferring flammable liquids from a drum, always ground and bond the drum and receiving vessel to prevent static charge buildup

Shipping Hazardous Materials and Dry Ice

Shipment of hazardous research materials is regulated by the Department of Transportation and its branch, The Federal Aviation Administration (FAA). FAA requires that anyone who ships hazardous materials, including dry ice, be trained to properly pack, mark, and manifest hazardous materials in a way that is compliant with the regulations. Serious fines can result if a package of hazardous materials is not declared on the shipping papers and marking/labeling on the parcel.

EHS provides guidance on this area of regulatory compliance and certain training services, mainly geared toward the shipping of biological hazards. If chemically hazardous materials need to be shipped by a research organization on campus, EHS should be contacted to provide a risk assessment and consultative services on the regulatory requirements. Refer to the EHS [Shipping Hazardous Materials and Dry Ice](#) webpage for training and additional information.

6.0 HAZARDOUS WASTE MANAGEMENT

Generators of hazardous waste are required to comply with extensive and complex rules and regulations promulgated by federal, state and local regulatory agencies. These rules regulate chemical waste storage, labeling, packaging and disposal. Management of hazardous waste is both a critical compliance and health & safety responsibility of the lab. Each generator of chemical waste at UM-Dearborn is responsible for the proper management of their wastes.

The Hazardous Waste Disposal Program for UM-Dearborn is coordinated by EHS. The University requires all chemical, biohazardous, and radioactive wastes be disposed through EHS and EHS.

In addition to hazardous waste pickup, EHS assists the University community in maintaining compliance with regulations pertaining to waste management and disposal. Specific services include:

- Technical advice on identification, labeling and manifesting of waste.
- Emergency response to accidental spills.
- Laboratory cleanouts.
- Technical advice and training on emergency response to spills.
- Waste disposal supplies.
- Pollution prevention / waste minimization.

6.1 Chemical Waste

All waste must be properly packaged, labeled and manifested. Evaporation in a chemical fume hood is not an option. Waste must be called in for pickup within 90 days of the accumulation start date on the container waste label. This will ensure that the waste will be sent for disposal prior to the 180-day regulatory limit.

No hazardous wastes may be poured down the drain to the sanitary sewer.

Chemicals must be in a waste container compatible for the specific class of chemicals. Waste containers must be properly labeled and should be the minimum size that is required. There should be at least 10% (of the volume of the container) of headspace in the liquid waste container to avoid a buildup of gas that could cause an explosion or a container rupture.

Container Management – Containers must be:

- In good condition (free of defects, cracks, rust, etc.)
 - Compatible with the waste in them
 - Stored CLOSED (containers can only be open while actively adding or removing waste and cannot be stored open with a funnel)
 - Handled and stored so containers do not rupture or leak
 - Inspected weekly for leaks and defects
 - Stored so incompatible wastes are separated or contained from each other by physical barriers
- Chemical waste containers are available to labs free of charge through EHS. They can be ordered by calling (313) 593-0921.

The following guidelines are provided to assist generators at the UM-Dearborn in complying with essential practices for proper management and disposal of chemical wastes:

Aqueous/Organic – Do not intentionally mix aqueous waste with organic waste after generation if each waste stream is generated separately. If a mixture of aqueous and organic waste is generated in combination as part of a research activity, do not attempt to separate the bi-phase solutions prior to disposal.

Aqueous Solutions – Keep acids separate from bases. List each anion and cation in the solution. Of particular importance are the metals, cyanide, and sulfide. Avoid including organics, if possible.

Cyanides and Sulfides – Keep these materials separate from other wastes; label and manifest thoroughly. These may include pure compounds or aqueous solutions.

EP (Extraction Procedure) Toxic Metals – The following metals (in metallic or compound form) should never be discarded with organics:

| | | |
|----------|---------|----------|
| Arsenic | Copper | Selenium |
| Barium | Lead | Silver |
| Cadmium | Mercury | Thallium |
| Chromium | Nickel | Zinc |

Organics are burned -- both solids and liquids. These metals and their compounds cannot, by law, be incinerated. Keep these materials separate from all other wastes and label thoroughly.

Explosive Materials – Explosive materials, such as picric acid with less than 10% water and its derivatives, or certain azo- compounds or perchlorates, must be separated from all other wastes and packaged individually.

Hazard Classes – Separate hazard classes are required to keep incompatible chemicals apart, which might otherwise react and create an extremely hazardous situation. If placing several bottles or vials of different, partially used chemicals in a bucket or wide mouth jar, or if placing several different liquids in a waste bottle, try to utilize a separate hazard class for each container. Please note that free liquids should not be disposed in buckets.

Separate organics from inorganics, liquids from solids, and if possible, halogenated organics from non-halogenated organics. Also refer to Chapter 5.3 – “Chemical Compatibility Chart.”

Labels – Each different chemical in the container must be listed on the hazardous waste label (include quantity of all waste regardless of class or toxicity). The month, date and year must be placed on the label to indicate when waste was first put into the container. The lab’s contact information, building EPA ID number and the manifest document number must also be put on the label.

Lecture Bottles – Check before ordering that the manufacturer will take the lecture bottle back for disposal. EHS prefers that all lecture bottles are emptied prior to sending for disposal. The lecture bottle must have the word “empty” written on the bottle. Most landfills will not accept lecture bottles unless they are emptied, purged, and cut in two.

Liquids/Solids – DO NOT combine liquid and solid chemical wastes in the same container. Use separate containers. EHS recommends disposing liquids in gallon jugs.

Place solids in wide mouth jars or buckets. Solid wastes contaminated with chemicals may include paper towels, Kimwipes, gloves, weigh boats, capillary tubes, glassware, etc. Non-contaminated glass can be placed in a container for recycling. The container must be labeled as “Non-contaminated Glass,” and will be picked up by Building Services.

Metallic Mercury – Keep metallic mercury and other materials contaminated with metallic mercury separate from all other wastes and label properly.

Organometallics – Organometallic wastes, especially those containing any of the EP toxic metals, must be kept separate from all other wastes and labeled.

Polychlorinated Biphenyls (PCB) – Keep PCB and other PCB-contaminated materials separate from all other wastes.

Pyrophoric Materials – Pyrophoric materials must be separated from all other wastes and packaged individually.

Sharps and Needles – Discarded sharps and needles must be placed in a puncture-proof waste container. Needles must not be bent, sheared, or replaced in the sheath or guard following use. Once the container is $\frac{3}{4}$ -full, seal the container shut so that it is air-tight. Label the container with a “Sharps” label or write “Sharps” on the container exterior. Only chemically contaminated sharps require a hazardous waste label and manifest.

Water-Reactive Chemicals – Keep water reactive chemicals separate from all other wastes.

If questions arise, contact the Lab Director/Supervisor to provide further guidance.

6.2 Biohazardous Waste

Biohazardous waste includes any waste material with the presence or reasonably anticipated presence of blood or infectious material or any waste material containing or contaminated with liquids of human or animal origin, but not including urine.

Proper biohazardous waste management practices are essential in protecting human health and the environment. Lab Directors/Supervisors can assist generators in developing a waste management plan to address collection and disposal of biohazardous solids, liquids, pathological and sharps waste.

6.3 Battery Waste

All battery sizes and types must be disposed of through the EHS. Batteries cannot be disposed of in the general trash. Please contact EHS for proper disposal at (313) 593-0921.

6.4 Proper Segregation and Disposal of Low-Level Radioactive Waste (LLRW)

Disposal of the various forms of low-level radioactive waste (LLRW) is complex, extremely difficult, and very costly. Waste minimization and segregation are critical to reducing costs, ensuring regulatory compliance, maintaining a safe work place, and protecting the environment. EHS will collect and process the various forms of radioactive waste generated at the University of Michigan-Dearborn provided the waste is properly segregated, packaged and identified.

6.5 Environmental Management

Ongoing operations and research activity must employ sound environmental practices to provide environmental stewardship and limit liabilities. EHS works with labs to reduce or eliminate concerns and maintain compliance with the constantly changing regulations.

Examples of the assistance EHS provides to promote environmental stewardship include:

Wastewater/Drain Disposal – Wastewater discharged from inside UM-Dearborn facilities flows into the sanitary sewer system and is treated at the Detroit Waste Water Treatment Plant (DWWTP) prior to discharge into the Detroit River watershed. Pouring other materials (pollutants) down the drain such as chemicals, metals, solids, and oils can interfere with the treatment process.

Mercury Elimination Program – Mercury thermometers are prohibited at The University of Michigan-Dearborn. Any remaining mercury-containing thermometers should be disposed of properly through EHS and shall be replaced with solvent-filled or digital non-mercury containing thermometers.

7.0 CHEMICAL HAZARD INFORMATION AND TRAINING

Information and training on the hazards of chemicals present in their work area must be made available to laboratory personnel. This information and training is provided in a number of formats detailed in this chapter.

7.1 Hazard Information

MIOSHA requires employers to have a written Chemical Hygiene Plan. The PI must inform laboratory personnel of the location and availability of the UM-Dearborn Chemical Hygiene Plan. This CHP fulfills the regulatory requirement and is a resource for information used for planning experiments and laboratory operations. Any hazards beyond those covered in this CHP must be addressed by the Principal Investigator in the form of lab specific SOPs and lab specific training which must be documented in their CHP binder.

Information on chemical hazards can be obtained from the SDS. EHS maintains a [SDS database](#) through ChemWatch, available on the EHS website. [Links to other SDS databases](#) as well as additional sources of chemical hazard communication are also available.

7.2 EHS Training

EHS conducts Lab Safety Training which is a new-hire training program to address requirements outlined in the Bloodborne Pathogen (BBP), Laboratory Safety (LSS) and Personal Protective Equipment (PPE) Standards. The training addresses employee orientation to these standards and provides an overview of employee rights and responsibilities.

7.3 Work Directed by PI

For work directed by a PI, the must provide laboratory personnel information and training at the time of initial assignment to the laboratory, and prior to assignments involving new exposure situations, work with Particularly Hazardous Substances, and hazardous operations.

Laboratory-Specific Training

In addition to the EHS training, each laboratory must set up and implement a laboratory-specific training program. This training must cover necessary work practices, procedures and policies to ensure that employees are protected from all potentially hazardous chemicals, biological pathogens, and dangerous equipment used in the workplace. The training must be conducted by someone thoroughly knowledgeable of all the specific hazards and proper safety techniques.

Documentation of Training

It is the responsibility of the PI to make sure that all employees have received the mandatory lab safety training provided by EHS. The PI must also maintain written verification of employee training. Records should also be maintained for all lab-specific training, inspections, or related activities in the CHP Blue Binder. Documentation of lab specific training is also required on the lab-specific written SOPs for the lab.

Most research groups have regular meetings to discuss research plans and progress. It is suggested that brief, but effective, discussions be conducted on basic safety topics as part of these or other regular meetings.

The following is a list of safety topics with suggestions for discussion. It is presented as a possible guide in conducting lab-specific safety training. EHS can attend meetings to discuss specific safety topics.

- **Introduction:** Read through the entire online CHP and review SOP. Determine lab location for the CHP document binder (Blue Binder) so that it can be used as a reference by any employee at any time.
- **Emergencies:** Review emergency information in the CHP and any specific emergency information in relevant SOP. Discuss any related questions. Do you have the type of fire extinguishers that you need? Do you have spill cleanup capabilities? Do you have first aid supplies? Set a policy for locking doors to maintain security. Plan what to do in a power failure. Draw up an evacuation plan, including what gets turned off and what stays on in an emergency.
- **Responsible Persons:** Are health & safety duties properly assigned within your lab(s)? Are people properly performing their assigned duties in your lab(s)?
- **Basic Safety Rules:** Note rules with special importance for your laboratory. Set up a buddy system for working after hours. Discuss procedures for unattended operations.
- **Chemical Inventories:** Review the Chemical Inventory for your laboratory. Plan next inventory-taking session. Properly dispose of unused or expired chemicals.

Waste Disposal Program: Review the UM-Dearborn's waste handling procedures in chapter 6.0 of the CHP. Discuss and answer any related questions. Are wastes being properly managed in your lab(s)? Do you have unusual waste disposal problems? Are wastes being adequately labeled? For compliance with the training and information requirements for hazardous waste regulations, all laboratory personnel are required to know the following:

- The hazards of the waste chemicals in the lab
- How to properly contain and store the waste in the lab, and
- What to do in an emergency involving the lab waste
- **Chemical Procurement, Distribution, and Storage:** Discuss current chemical

storage practices. Develop lab-specific procedures for chemical procurement, distribution, and storage.

- **Particularly Hazardous Procedures or Substances:** Discuss the use of toxic materials in the lab or how to get rid of old peroxide formers. Set aside a specific area for use of highly toxic materials. Develop any related, lab-specific procedures. Review procedures for storage and use of any explosive or pyrophoric materials.
- **Procedures Requiring Special Prior Approval:** What additional safety concerns need to be addressed? Develop any lab-specific procedures requiring special prior approval or any lab-specific procedures not covered in earlier sections.
- **Working with Special Equipment:** Discuss electrical safety. Are electrical cords damaged? Are gas cylinders chained up, valve protection caps on, empty or unused cylinders set for pickup? Schedule a refrigerator/freezer clean out. Develop procedures for any lab-specific equipment. Review previous incidents using the equipment and develop ways to prevent another incident.
- **Protective Apparel and Equipment:** Discuss when safety glasses, goggles, or face shields are required. Discuss any need for respirators. Discuss fume hood and glove box use. Develop any related, lab-specific procedures.
- **Housekeeping, Maintenance, and Inspections:** Discuss materials stored or frequently present on the floor. Identify emergency exits. Discuss maintenance items. Develop any related, lab-specific procedures.
- **Environmental Monitoring:** Discuss [MIOSHA PELs](#) for chemicals in use and how to reduce employee exposure. Discuss building ventilation and proper use of hoods, biosafety cabinets and other types of local exhaust ventilation. Develop any lab-specific procedures for environmental monitoring as needed.
- **Working with Biologically Hazardous Materials** Review applicable materials in the [Exposure Control Plan](#) or [Biosafety Manual](#) and discuss any related questions. Is a labeled area set aside for work with biohazardous materials? Are cold/warm rooms, refrigerators/freezers properly labeled? Develop any related, lab-specific procedures.
- **Working with Radioisotopes:** Review materials in the CHP and discuss any related questions. Ensure that all workers are properly badged and trained. Ensure that all inventories of radioisotopes are up-to-date. Is a specific location set aside for radioisotope use? Are all signs and postings up? Develop any related, lab-specific procedures.
- **Medical Program:** Discuss need for any exposure monitoring. Discuss lab-specific injuries. Is the health of each employee working with hazardous materials being adequately monitored?
- **Training Program:** Have employees attended appropriate Departmental and EHS training sessions? Develop and document internal training. Are workers reading, understanding, and following SDS precautions? Are signs and labels properly posted? Are adequate safety supplies, including spill cleanup materials, available? Are official records up-to-date?
- **Additional Safety Session Topics:**
 - Recent incidents/accidents/injuries and how to prevent reoccurrence
 - New equipment and corresponding SOP and training
 - New procedure and corresponding SOP and training
 - Results of recent inspections and how to correct problem areas
 - New chemicals in the laboratory

7.4 Work Conducted Autonomously or Independently

The PI shall provide access to the online CHP and lab specific CHP document binder to persons working autonomously or performing independent research before they undertake work in UM-Dearborn laboratories. Anyone working in UM-Dearborn laboratories, regardless of employment status, is required to take all general and lab-specific training applicable to their work. Persons working autonomously are responsible for ensuring they have any other training that is appropriate to the work they conduct in UM-Dearborn laboratories.

7.5 Other Sources of Chemical Hazard Information

Other sources of chemical data are available from various resources, including the following:

- [ToxNet](#)
- [HazMap](#)

Various reference materials on the hazards, signs & symptoms of exposure, safe handling, storage & disposal of hazardous chemicals:

- [National Library of Medicine, National Institutes of Health](#)
- Safety Data Sheets (SDS): SDS copies can be obtained from chemical suppliers or from the [EHS SDS database](#).
- A SDS location poster must be posted in the laboratory and may be obtained directly from the [MIOSHA website](#).
- [Pocket Guide to Chemical Hazards](#) distributed by the [National Institute of Occupational Safety and Health](#) (NIOSH).

7.6 EHS Hazard Guidelines

EHS provides hazard guidelines on various chemical and physical hazards. These guidelines can be accessed on the [EHS website](#).

8.0 LABORATORY INSPECTIONS

A program of periodic laboratory inspections helps keep laboratory facilities and equipment in a safe operating condition by identifying and addressing potential health and safety deficiencies. Periodic inspections will also help to ensure all regulatory compliance requirements are being met. Inspections safeguard the quality of the institution's laboratory safety program.

The goals of the inspection program are to:

- Maintain laboratory facilities and equipment in a safe, code-compliant operating condition.
- Provide a comfortable and safe working environment for all personnel and the public.
- Ensure that all laboratory activities are conducted in a manner to prevent employee exposure to hazardous chemicals.
- Ensure that trained laboratory personnel follow the CHP.

EHS Safety Inspections

UM-Dearborn EHS conducts laboratory inspections on a routine basis. These inspections may be comprehensive, targeted to certain operations or experiments, focused on a particular type of inspection such as safety equipment and systems, or audits to check the

work of other inspectors. More information on EHS inspections follows in section 8.1, below.

Routine Self-Inspections

Each PI or designee is required to conduct an annual self-inspection of their lab space. The self-inspection should be conducted by knowledgeable and trained laboratory personnel with PI oversight. The focus is on the facility, equipment, operating procedures, training and documentation. This is an excellent opportunity to promote a culture of safety. The supervisor should take a close look at the facilities and operations. They can discuss with workers, issues of interest or concern that may fall outside the scope of the actual inspection. More information on self-inspections follows in section 8.2, below.

Inspections by External Entities

Many types of inspections or audits can be conducted by outside experts, regulatory agencies, emergency responders, or other organizations. They may inspect a particular facility, equipment, or procedure either during the pre-experiment design phase or during operations. As a matter of safety and security, if someone requests entry to a laboratory for the purpose of an audit without a recognized escort, ask to see his or her credentials and contact EHS at (313) 593-4914, (313) 593-0921, or (313) 593-5061.

Regulatory agencies may conduct announced or unannounced inspections on a routine or sporadic basis. Laboratories must keep their programs and records up-to-date at all times to be prepared for such inspections. Any significant incident or accident within a lab may trigger one or more inspections or investigations by outside agencies. Evidence that the underlying safety programs are sound may help limit negative findings and potential penalties. All such inspections by regulatory agencies must be reported to EHS at (313) 593-4914, (313) 593-0921, or (313) 593-5061 as soon as possible.

8.1 EHS Inspection Frequency and Recordkeeping

EHS has developed a Lab Hazard Ranking (LHR) system for inspections, which provides a framework to rank the potential hazards found within each lab. The LHR presents an objective approach to prioritize labs for audit based on: type of hazardous materials present and quantities, hazardous operations and equipment, engineering controls and procedures, and facility history. The purpose is to cyclically audit labs based on the LHR.

There are five LHR classes ranging from the least hazardous (LHR 0) to the most potentially hazardous (LHR 4). The frequency of audit is noted within each LHR. Laboratories must be inspected as indicated. Completed inspection checklists and the actions taken to correct identified unsafe conditions must be maintained by the PI or their designee in the CHP Blue Binder.

LHR 4 High Hazard (6 month inspection program)

LHR4 has the highest potential severity of hazards present. LHR 4 labs typically work with large or production volumes of solvent or corrosives, and/or large quantities of particularly hazardous materials (nanomaterials, chemotherapy agents, highly toxic compounds). Gases in this category include full size cylinders of toxic/pyrophoric gases or over 3 cylinders of flammable gases. Risk Group 3 biological agents, Select Agents, or large quantities of Risk Group 2 agents are included in this rank. Non-traditional use of hazardous materials, lab equipment, or research fabricated equipment will also be

classified into LHR4. Labs that have had previous serious accidents, occupational disease, or poor previous audit results will also be placed in this category.

LHR 3 Moderate Hazard (12 month inspection program)

LHR 3 is our standard lab that works with non-production volumes of many toxic and flammable chemicals. Use of carcinogens, pyrophorics, acutely toxic materials, sensitizers, and reproductive toxins is typically in small quantities. Toxic gases are used only in lecture bottle sizes. Flammable gas usage is limited to two full size cylinders. Biological agents include Risk Group 2 infectious agents, recombinant DNA, and bloodborne pathogens are in this rank. LHR 3 also includes Class 3B or 4 lasers with controls. A lab in this category may use LHR 4 materials and quantities if the lab has been specifically designed to do so with superb engineering controls and procedures. LHR 2 or LHR 1 laboratories with previous major accidents, occupational disease, or poor previous audit results may be moved up into this category.

LHR 2 Low Hazard (18 month inspection program)

LHR 2 labs are relatively low hazard labs. Typical chemical work involves small volumes of solvents, acids and toxic chemicals. Hazardous materials are used with good engineering controls as necessary. Only low-hazard gases are used. Standard biomedical research involving tissue culture, PCR, and work with BL1 infectious agents are LHR 2. Well managed clinical labs working with larger volumes of solvent, formaldehyde, and tissue preparation procedures with good engineering controls are included in LHR 2. Other low hazard or well controlled labs involving class 3R and lower lasers, electronics labs, machine shops, fabrication labs, analytical labs, MRI, NMR facilities are LHR 2.

LHR 1 Very Low Hazard (24 month inspection program)

Laboratories in this category have minimal quantities of hazardous chemicals perhaps only used for critical surface cleaning. Hazards still exist but are well controlled with standardized equipment and procedures. LHR 1 includes: teaching labs, autoclave and dishwashing rooms, high performing BSL 1 or 2 labs, and those with an excellent safety and health record. Additional LHR 1 space includes lab related storage rooms, support spaces, freezer rooms, linear equipment corridors, and equipment rooms.

EHS Inspection Report

After an inspection EHS will prepare a report for the PI, laboratory Director/Supervisor and others, as appropriate (this may include the Chair or Manager of the department and the Dean of the respective college). The report will include all problems noted during the inspection, along with the criteria for correcting them. All critical deficiencies (one that creates an unsafe condition where there is reasonable probability that if allowed to continue will result in serious physical harm, fire, or significant environmental impact) must be abated within 2 business days. Non-critical deficiencies must be corrected within 60 days after which a copy of the inspection report will be sent to the Chair of the department. Once each year EHS will send a report to the Dean of each school that details any deficiencies that were not documented as corrected.

8.2 Lab Self-Inspection

Self-inspections must be conducted by laboratory personnel. When conducting the required annual self-inspection, interacting with the individuals in the laboratory is important. Laboratory personnel can provide a great deal of information and provide feedback for possible improvements to the laboratory safety program.

Take notes and make comments on the inspection form to be able to recall the details and describe any problems. Point out problems as they are found and show laboratory personnel how to fix them. If the problem is corrected during the inspection, make a note that it was resolved.

For certain types of equipment in constant use, such as gas chromatographs, daily inspections may be appropriate. Other types of equipment may need only weekly or monthly inspection or inspection prior to use if operated infrequently. Keep a record of the inspection attached to the equipment or in a visible area.

The [self-inspection form](#) located in the CHP Blue Binder tab 6 must be completed at least annually. The record must be maintained in your CHP Blue Binder and available for EHS to review. More frequent periodic inspections should be required at the PIs discretion based on the hazards in the lab.

8.3 Performance Verification of Engineering Controls and Safety Equipment

To help assure that primary engineering controls such as fume hoods, biosafety cabinets other types of local exhaust ventilation provide proper and adequate performance, UM-Dearborn EHS provides annual performance verification checks.

Safety equipment like fire extinguishers, eyewash stations and emergency showers must function properly at all times and must be tested as indicated below.

| Equipment | Frequency | Responsible Party |
|---|---------------|-----------------------|
| Eyewash | 6 months | Facilities Management |
| | Weekly flush | Laboratory |
| Safety shower | 6 Months | Facilities Management |
| | Weekly visual | Laboratory |
| Fume hoods, Biological Safety cabinets, Gas cabinets, paint booths, and other local exhaust ventilation (LEV) | Annually | EHS |
| Glove boxes | Weekly | Laboratory |
| Fire extinguishers | Monthly | Public Safety |

8.4 Laboratory Decommissioning

It is the policy of UM-Dearborn and EHS that formal decommissioning is conducted prior to the transfer of “ownership” of laboratory space. Upon notification of the departure or relocation within the University of a researcher, EHS will visit the laboratory space(s). The researcher/department is provided with a summary of decommissioning activities (chemical removal, cleaning, etc.) that must be performed prior to vacating the premises including a close out evaluation by EHS.

If the lab uses radioactive materials, UM-Ann Arbor EHS Radiation Safety Services must also be contacted for a [radiation decommission](#) survey. Building Services will not service or clean rooms that have not been decommissioned by EHS or EHS.

All chemicals for disposal must be properly labeled, manifested and packaged before the scheduled waste pickup. In the event there are unusually large amounts of chemical waste or several laboratories within close proximity will be vacated at one time, EHS may be able to provide additional assistance, as necessary, to expedite the process. EHS strongly recommends disposing of all unwanted chemicals at least 14-days prior to the actual move date.

8.5 Laboratory Equipment Decontamination

All laboratory equipment used in conjunction with hazardous materials must be decontaminated before being sent out for service, sale, or disposal. Hazardous materials include all potential chemical, radioactive, and biological contaminants.

Current UM-Dearborn policy requires that a [Laboratory Equipment Decontamination Form](#) be completed by the equipment owner and attached to the outgoing equipment. Facilities Operations and some outside contractors currently require that this form be completed before servicing the equipment. The form requires a signature certifying that the laboratory personnel have decontaminated the equipment.

EHS Radiation Safety Services (RSS) requires that the laboratory notify RSS before equipment used for radioactive work can be removed from the radiation use area. RSS will survey the equipment and determine when no detectable levels of radioactive contamination can be found. RSS can be contacted at (734) 764-6200.

9.0 EMERGENCY RESPONSE: EXPOSURE, FIRE, INJURY, AND CHEMICAL SPILL

All incidents require prompt action and proper notification. The goal is to limit injuries, chemical exposures, and impacts to property and the environment. The UM-Dearborn Emergency Management Department (EM) has detailed information on responses to various types of emergencies. These response procedures are mandatory.

UM-Dearborn offers an [Emergency Alert System](#) to UM-Dearborn students, faculty and staff that will notify them via text message, voicemail, or emails when they have determined there is an active emergency situation. These situations may include active shooters, hazardous weather, or hazardous chemical spills. For more information see the [UM Emergency Management website](#).

In case of any emergency call:

UM-Dearborn Public Safety Emergency: 9-1-1

Non-Emergencies can be reported to UM-Dearborn Public Safety at (313) 593-5333 and Facilities Operations at (313) 593-5270.

Building Evacuation

In the event that evacuation from a building is necessary, follow routes identified in the posted building evacuation floor plans. Building evacuation plans are posted in each

building per University policy. These plans should be reviewed upon starting work in any UM-Dearborn building.

9.1 Emergency Notification

In the event of an emergency or a disaster, the UM-Dearborn Department of Public Safety (DPS) has primary responsibility for immediate response, and shall cooperate and coordinate with official emergency response authorities and University administration in accordance with established policies and procedures.

All incidents involving hazardous materials are coordinated with the Director of EHS, or designee, who functions as the Site Safety and Health Officer.

9.2 Incident Reporting

All unplanned fires, regardless of magnitude, must be reported to Public Safety at (313)593-5333 or 911 from a campus phone as soon as discovered.

Laboratory personnel are required to report all occupational injuries, occupational illnesses, and near-miss incidents to the PI as soon as practical. A "Near-Miss" is considered a precursor to actual incidents and must be reported whether or not an injury occurred. The Principal Investigator must complete and submit the [Illness and Injury Report Form](#) to Work Connections for all injuries and illnesses. In addition, an [EHS Incident and Near-Miss Report](#) must be completed and submitted to umdehs@umd.umich.edu. The EHS form requires that the incident be investigated by the PI to determine the cause and identify preventive measures that can be put in place.

If you become ill or are injured at work, seek medical assistance at [Concentra Medical Center](#). All costs involved with such service will be paid for through the University of Michigan's Department of Risk Management. The employee will incur no costs for treatment involving an occupational exposure or injury.

9.3 Laboratory Posting Requirements

The following resources are designed to enhance emergency response and should be available within the laboratory:

- Post the [Emergency Response Flip Chart](#)
- A list of laboratory specific emergency contact names and numbers should be available to laboratory personnel in the lab.
- Post an informational door sign on the outside of each laboratory entrance. The UM-Dearborn laboratory door sign program is an important part of emergency response. The signs are used by response personnel to determine the primary hazards in the room and the emergency contacts. Every laboratory room must have an EHS provided door sign. The sign must include current emergency contact information including contact names, office location, and work and home phone numbers. To obtain a door sign, contact the Lab Director/Manager.

9.4 Chemical Spill Response

The cleanup of chemical spills should only be done by knowledgeable and experienced personnel. When available, consult chemical and process specific SOP for detailed information on spill and emergency response.

A minor chemical spill is one that the laboratory staff is capable of handling safely without the assistance of EHS and emergency personnel. All other chemical spills are considered to be major. Spill kits with instructions, absorbents, reactants, and protective equipment should be available in the lab to clean up minor spills of commonly used chemicals. Chemical spill cleanup kits, including instructions for use, are available from various laboratory safety supply vendors.

Procedures for minor chemical spills:

- Alert people in immediate area of spill.
- If spilled material is flammable, turn off ignition and heat sources. Don't light Bunsen burners or turn on other switches.
- Open outside windows, if possible.
- Wear protective equipment, including safety goggles, gloves and long-sleeve lab coat.
- Avoid breathing vapors from spill.
- Confine spill to as small an area as possible.
- **Do not wash spill down the drain.**
- Use appropriate spill kits/sorbents to neutralize corrosives and/or absorb spill. Collect contaminated materials and residues and place in container. For powdered chemicals sweep carefully to avoid generation of dust or, if appropriate, use moist sorbent pads or wet the powder with a suitable solvent and then wipe with a dry cloth. Label waste and contact the Laboratory Director/Supervisor for proper disposal.
- Clean spill area with water.
- Report the spill to the PI or the laboratory supervisor.

Procedures for a major chemical spill:

- Attend to injured or contaminated persons and remove them from exposure.
- Alert people in the laboratory to evacuate.
- If spilled material is flammable, turn off ignition and heat sources. Don't light Bunsen burners or turn on other switches.
- **Call Public Safety at (313) 593-5333 or 911 from a campus phone immediately for assistance.**
- Close doors to affected area.
- Post warnings to keep people from entering the area.
- Have person available that has knowledge of incident and laboratory to assist emergency personnel.

For chemical exposures in the lab:

- If the SDS or SOP is readily available, follow immediate first-aid measures specified.
- If the SDS is not readily available, remove clothing and rinse the affected part of the body using the safety shower and/or eyewash as necessary. Ensure the chemical has not accumulated in your shoes. Unless otherwise indicated, rinse for 15 minutes.
- If the eyes have been exposed to a chemical, forcibly hold the eyelids open to ensure effective rinsing. DO NOT use the eyewash if a foreign object enters the eye unless directed to do so by a medical professional.

- If the injury is minor, inform the laboratory Director/Supervisor and have someone drive the injured person to [Concentra Medical Center](#). Send a copy of the SDS with the person.
- If the injury is of a serious nature, call Public Safety at (313) 593-5333 or 911 from a campus phone to request an ambulance. If possible send someone outside to wait for the ambulance, and then direct them to the lab when they arrive.
- The PI will need to fill out and submit the [WorkConnections Illness/Injury Report Form](#). This form authorizes payment for the medical services. Failure to fill out and submit this form will result in the injured person being billed directly for services.
- Complete an [EHS Incident and Near-Miss Report](#) and submit it to umdehs@umd.umich.edu.
- Contact EHS for assistance with incident investigation and follow up actions as necessary.

9.5 Gas alarms, exhaust flow monitors, etc.

All types of monitors and alarms are used to warn occupants of an unsafe condition. In the event an alarm is activated, appropriate response is mandatory. Monitors and alarms will not be ignored and must be reported to the Principal Investigator/Laboratory Director or Supervisor. If the alarm or monitoring system is facility-specific, follow the established specific emergency response procedures. Contact the Facilities Management Call Center (313) 593-5270 for repair of systems in alarm.

9.6 First aid kits

First aid kits are recommended in each laboratory. If a first aid kit is made available in the lab, the following items are suggested:

| Basic Kit Contents | Quantity |
|--|----------|
| Absorbent compress, 32 sq. in. | 1 |
| Adhesive bandages 1 in. X 3 in. | 16 |
| Adhesive tape, 5 yd. | 1 |
| Antiseptic, 0.5 g | 10 |
| Burn treatment, 0.5 g | 6 |
| Medical exam gloves | 2 pair |
| Sterile pads 3 in. x 3 in. | 4 |
| Triangular bandage, 40 in. x 40 in. x 56 in. | 1 |

10.0 MEDICAL CONSULTATION, EXAMINATION, AND SURVEILLANCE

Medical consultation, examination, and surveillance are provided for employee laboratory personnel when:

- Symptoms or signs of exposure to a hazardous chemical develop.
- Exposure monitoring reveals an overexposure.
- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).
- Any work-related injury.
- A regulatory standard triggers medical surveillance.
- An EHS Representative refers an employee for medical surveillance.

Refer to the [Medical Surveillance](#) information on the EHS website.

10.1 Procedure for Medical Evaluation after Chemical Exposure

In the event an employee is believed to have been exposed to a toxic chemical through a spill, splash, inhalation, or other means, they should:

- Take whatever immediate first-aid measures are necessary or called for by a Safety Data Sheet (SDS).
- Seek immediate medical attention if needed at [Concentra Medical Center](#).
- All costs involved with such service will be paid for through the University of Michigan's Department of Risk Management. The employee will incur no costs for treatment involving an occupational exposure or injury.
- Report the incident to the PI as quickly as possible.
- Complete an [Illness or Injury Report Form](#) and submit to WorkConnections within 24 hours of the incident.
- Complete an [EHS Incident and Near-Miss Report](#) and submit it to umdehs@umd.umich.edu.

10.2 Health Care Providers

Medical consultations and examinations for employees are provided via:

Concentra Medical Center

17500 Federal Drive, Ste. 750

Allen Park, MI

Phone: 313-982-1376

MON – FRI: 8:00am – 5:00pm

Concentra Medical Center (After Hours and Non-Emergency)

11700 Metro Airport Center Drive, Ste. 104

Romulus, MI

Phone: 734-955-7000

24 hours – 7 days a week

Employees are responsible for informing the PI/Laboratory Supervisor of any work modifications ordered by the clinician as a result of exposure.

U-M WorkConnections

- 10.3 All work-related illnesses and injuries in all departments at UM-Dearborn must be reported to WorkConnections immediately (within 24 hours). The WorkConnections team cooperates with other programs and services within the University to help you and your supervisor receive needed or related services when you are ill or injured. Offices and services that coordinate with WorkConnections include your home department, Risk Management, Human Resources, and EHS.

The [WorkConnections](#) website is a great resource for all issues related to illness and injury.

Recordkeeping of Medical Records/Access to Medical Records

- 10.4 Medical records will be maintained by UM-Dearborn for the duration of the employee's employment plus 30 years. The confidentiality of medical records and test results is protected under the law. The University only receives a simple

physician's determination as to whether or not an employee is physically fit to work under the stressors presented by their work environment and personal protective equipment. The University receives no test results or diagnoses concerning the employee's general health or particular conditions. An employee medical determination of not physically fit for a particular type of work or task must be discussed in detail with the employee and noted as a restriction on the physician's determination.

10.5 Animal Handler Medical Surveillance Program

All faculty, staff, and students who have direct contact with animals; direct contact with non-sanitized animal caging or enclosures; direct contact with non-fixed or non-sterilized animal tissues, fluids, or wastes; and/or who provide service support to animal equipment, devices, or facilities must be enrolled in the Animal Handler Medical Surveillance Program. The types of animals and associated hazards that will be encountered in the workplace determine what type of health assessment and safety training each employee will receive. A description of the [Animal Handler Medical Surveillance Program](#) is provided on the EHS website.

Read the information provided for all animal handlers as well as the information specific to the species that your approval code pertains to. Complete the [medical surveillance questionnaire for personnel working with research animals](#) and fax it to UM Occupational Health Services for evaluation

Appendix 1: PPE Hazard Assessment

NOTES:

- 1) Minimum **required** PPE for **all** laboratories: Lab Coat, Safety Glasses¹, Appropriate Gloves, Closed Shoes & Long Pants.
- 2) Always consult the University of Michigan - Dearborn SOP in addition to lab-specific SOP for more information.
- 3) Always consult a material's SDS for additional PPE guidance.
- 4) **Use Engineering and/or Administrative controls whenever possible.**

1. Refer to [Tables 1 & 2](#) below for additional eye & face protection guidance.

| Tasks & Materials | Potential Hazard(s) | PPE Required |
|--|--|--|
| Working with small (< 1 Liter) volumes of corrosive liquids | <ul style="list-style-type: none"> • Splash hazards • Skin and eye damage | <ul style="list-style-type: none"> • Safety goggles (<i>if splash hazard</i>) • Chemical resistant gloves (refer to Corrosives SOP) |
| Working with large (> 1 Liter) volumes of corrosive liquids, acutely toxic corrosives or work which may create a splash hazard | <ul style="list-style-type: none"> • Large surface area skin and eye damage • Poisoning • Great potential for eye and skin damage | <ul style="list-style-type: none"> • Safety goggles • Face shield • Chemical resistant gloves (refer to Corrosives SOP) • Chemical resistant apron |
| Working with Hydrofluoric (HF) Acid | <ul style="list-style-type: none"> • Major skin damage • Major eye damage • Potential poisoning through skin absorption | <ul style="list-style-type: none"> • Safety goggles • Chemical resistant gloves (refer to HF SOP) • Chemical resistant apron <p>** Have unexpired Calcium Gluconate on-hand **</p> |
| Working with small (< 1 Liter) volumes of organic solvents | <ul style="list-style-type: none"> • Skin damage • Eye Damage • Slight poisoning potential through skin absorption | <ul style="list-style-type: none"> • Safety goggles (<i>if splash hazard</i>) • Chemical resistant gloves (refer to the EHS Glove Use Webpage & SDS) |
| Working with large (> 1 Liter) volumes of organic solvents, very dangerous organic solvents or work which may create a splash hazard | <ul style="list-style-type: none"> • Major skin damage • Major eye damage • Poisoning through skin absorption | <ul style="list-style-type: none"> • Safety goggles • Face shield • Chemical resistant apron • Chemical resistant gloves (refer to the EHS Glove Use Webpage & SDS) |
| Working with small (< 1 Liter) volumes of pyrophoric materials | <ul style="list-style-type: none"> • Body damage from burns • Fires | <ul style="list-style-type: none"> • Fire resistant (FR) lab coat • Safety goggles • Fire/chemical resistant gloves (refer to Pyrophoric Materials SOP) <p>** No synthetic clothing allowed **</p> |
| Working with large (> 1 Liter) volumes of pyrophoric materials | <ul style="list-style-type: none"> • Major body damage from burns • Fires | <ul style="list-style-type: none"> • Fire resistant (FR) lab coat • Safety goggles • Fire/chemical resistant gloves (refer to Pyrophoric Materials SOP) <p>** No synthetic clothing allowed **</p> |
| Working with small (< 1 Liter) volumes of human blood, body fluids or other Bloodborne Pathogens (BBP) | <ul style="list-style-type: none"> • Acquire an infectious disease (BBP) • Spread of infectious disease | <ul style="list-style-type: none"> • Light latex gloves |

Appendix 1: PPE Hazard Assessment

| Tasks & Materials | Potential Hazard(s) | PPE Required |
|--|---|--|
| Working with large (> 1 Liter) volumes of human blood, body fluids or other Bloodborne Pathogens (BBP) and/or splash hazards | <ul style="list-style-type: none"> • Greater risk of acquiring an infectious disease (BBP) • Greater risk of spreading an infectious disease | <ul style="list-style-type: none"> • Light latex gloves • Safety goggles • Face shield • Foot covers (<i>as applicable</i>) • N-95 respirator (<i>as applicable</i>) |
| Working with hazardous powders | <ul style="list-style-type: none"> • Skin damage • Eye damage • Poisoning through skin absorption | <ul style="list-style-type: none"> • Safety goggles for large quantities • Light chemical resistant gloves (refer to the EHS Glove Use Webpage) |
| Working with acutely toxic hazardous powders | <ul style="list-style-type: none"> • Greater risk for skin damage • Greater risk for eye damage • Greater risk for poisoning through skin absorption | <ul style="list-style-type: none"> • Safety goggles • Heavy resistant gloves • Chemical resistant apron • Booties (<i>as applicable</i>) • Also refer to Highly Toxic Chemicals SOP |
| Working with radioactive materials | <ul style="list-style-type: none"> • Cellular damage • Spread of radioactive materials | <ul style="list-style-type: none"> • Safety goggles (<i>if splash hazard</i>) • Light latex gloves |
| Working with radioactive chemicals, e.g., corrosives, solvents, powders, etc. | <ul style="list-style-type: none"> • Refer to appropriate chemical sections above • Cellular damage • Spread of radioactive materials | <ul style="list-style-type: none"> • Safety goggles (<i>if splash hazard</i>) • Light chemical resistant gloves • Use PPE for applicable tasks above |
| Working with radioactive human blood, body fluids or other BBPs | <ul style="list-style-type: none"> • Cellular damage • Spread of radioactive materials • Risk of acquiring an infectious disease (BBP) | <ul style="list-style-type: none"> • Safety goggles (<i>if splash hazard</i>) • Light latex gloves |
| Working with cryogenic liquids | <ul style="list-style-type: none"> • Major skin damage • Major tissue damage • Major eye damage | <ul style="list-style-type: none"> • Safety goggles for large volumes or splash hazards • Thicker insulated gloves • Also refer to Cryogenic Materials SOP |
| Working with very cold materials and equipment, e.g., freezers, dry ice | <ul style="list-style-type: none"> • Skin damage | <ul style="list-style-type: none"> • Insulated gloves • Also refer to Environmental Rooms SOP |
| Working in cold environments, e.g., walk-in cold rooms or freezers | <ul style="list-style-type: none"> • Frostbite • Hypothermia | <ul style="list-style-type: none"> • Insulated gloves and warm clothing • Also refer to Environmental Rooms SOP |
| Working with hot liquids, equipment and/or open flames, e.g., autoclave, Bunsen burner, waterbath, oil bath | <ul style="list-style-type: none"> • Skin damage • Eye damage | <ul style="list-style-type: none"> • Safety goggles for large volumes or splash hazards • Insulated gloves |
| Working with large volumes of hot, cold, or cryogenic liquids | <ul style="list-style-type: none"> • Major skin and eye damage • Frozen or burned body tissues | <ul style="list-style-type: none"> • Safety goggles • Face shield • Heavy insulated gloves • Chemical apron • Also refer to Cryogenic Materials SOP |

Appendix 1: PPE Hazard Assessment

| Tasks & Materials | Potential Hazard(s) | PPE Required |
|---|---|---|
| Working with Ultraviolet (UV) Radiation | <ul style="list-style-type: none"> • Conjunctivitis • Corneal eye damage • Erythema | <ul style="list-style-type: none"> • UV face shield • Safety goggles • Also refer to UV Radiation SOP |
| Working with LASER radiation | <ul style="list-style-type: none"> • Retinal eye damage • Skin damage | <ul style="list-style-type: none"> • Appropriate shaded goggles with optical density based on individual beam parameters. • Also refer to the EHS Laser Safety Guideline <p style="color: red; text-align: center;">** No jewelry or reflective items allowed **</p> |
| Working with Infrared (IR) emitting equipment, e.g., glass blowing | <ul style="list-style-type: none"> • Cataracts and flash burns to cornea | <ul style="list-style-type: none"> • Appropriate shaded goggles |
| Arc/TIG welding | <ul style="list-style-type: none"> • Conjunctivitis • Corneal eye damage • Erythema | <ul style="list-style-type: none"> • Appropriate shaded goggles and face shield • Work gloves |
| Instrument or equipment repair/service | <ul style="list-style-type: none"> • Eye damage from foreign objects | ** No loose clothing or jewelry ** |
| Metalworking/Woodworking shop | <ul style="list-style-type: none"> • Eye damage from foreign objects | ** No loose clothing or jewelry ** |
| Glassware washing | <ul style="list-style-type: none"> • Skin lacerations | <ul style="list-style-type: none"> • Heavy rubber gloves |
| Working in Industrial lab with potential injury from falling equipment or tools, e.g., Earthquake lab, Structural Engineering lab, etc. | <ul style="list-style-type: none"> • Head injury • Foot injury | <ul style="list-style-type: none"> • Hard-hat • Steel toe boots |
| Spill clean-up | <ul style="list-style-type: none"> • See potential hazards for applicable task section | <i>See applicable individual task section</i> |
| Changing Cryostat knife blade | <ul style="list-style-type: none"> • Skin lacerations • Risk of acquiring an infectious disease (BBP) | <ul style="list-style-type: none"> • Steel mesh glove |

Appendix 1: PPE Hazard Assessment

TABLE I. EYE AND FACE PROTECTION SELECTION CHART

*(To be used as a guide to select the proper **eye** and **face** protection.)*

| TYPE | HAZARD(S) | ASSESSMENT SEE NOTE (1) | PROTECTOR TYPE <i>(refer to graphic below)</i> | PROTECTORS | LIMITATIONS | NOT RECOMMENDED |
|--|---|---|--|--|---|--|
| I M P A C T | Chipping, grinding, machining, masonry, work, riveting, and sanding | Flying fragments, objects, large chips, particles, sand, dirt, etc. | B, C, D, E, F, G, H, I, J, K, L, N | Spectacles, goggles, face shields SEE NOTE (1) (3) (5) (6) (10) For severe exposures add N. | Protective devices do not provide unlimited protection. SEE NOTE (7) | Protectors that do not provide protection from side exposure SEE NOTE (10) Filter or tinted lenses that restrict light transmittance, unless it is determined that a glare hazard exists. Refer to OPTICAL RADIATION |
| H E A T | Furnace operations, pouring, casting, hot dipping, gas cutting, and welding | Hot sparks | B, C, D, E, F, G, H, I, J, K, L, N | Face shields, goggles, spectacles *For severe exposure add N. SEE NOTE (2) (3) | Spectacles, cup and cover type goggles not provide unlimited protection. SEE NOTE (2) | Protectors that do not provide protection from side exposure |
| | | Splash from molten metals | *N | *Face shields worn over goggles H, K | --- | |
| | | High temperature exposure | N | Screen face shields, reflective face shields SEE NOTE (2) (3) | SEE NOTE (3) | |
| C H E M I C A L | Acid & chemicals handling, degreasing, plating | Splash | G, H, K, *N | Goggles, eyecup, and cover types * For severe exposure, add N. | Ventilation should be adequate but well protected from splash entry. | < None > |
| | | Irritating mists | G | Special purpose goggles | SEE NOTE (3) | |

| | | | | | | |
|--|---|---|------------------------------------|---|---|---|
| D U S T | Woodworking, buffing, general dusty conditions | Nuisance dust | G, H, K | Goggles, eyecup, and cover types | Atmospheric conditions and the restricted ventilation of the protector can cause lenses to fog. Frequent cleaning may be required. | < None > |
| | | | | | | |
| O P T I C A L R A D I A T I O N | Welding: Electric Arc | O, P, Q | TYPICAL FILTER LENS SHADE | PROTECTORS | Protection from optical radiation is directly related to filter lens density. SEE NOTE (4) Select the darkest shade that allows adequate task performance. | Protectors that do not provide protection from optical radiation. SEE NOTE (4) |
| | | | 10 – 14 | Welding Helmets or Welding Shields | | |
| | | | SEE NOTE (9) | | | |
| | Welding: Gas Cutting Torch Brazing | J, K, L, M, N, O, P, Q | 4 – 8 | Welding Goggles or Welding Shields | SEE NOTE (3) | < None > |
| | Torch Soldering | | B, C, D, E, F, N | 1.5 – 3 | | |
| Glare | A, B | Spectacle SEE NOTE (9) (10) | | Shaded or special Purpose lenses as suitable SEE NOTE (8) | | |

NOTES TO TABLE I (ABOVE) EYE AND FACE PROTECTION SELECTION CHART:

- (1) Care should be taken to recognize the possibility of multiple and simultaneous exposure to a variety of hazards. Adequate protection against the highest level of each of the hazards should be provided. Protective devices do not provide unlimited protection.
- (2) Operations involving heat may also involve light radiation. As required by the standard, protection from both hazards must be provided.
- (3) Faceshields should only be worn over primary eye protection (spectacles or goggles).
- (4) As required by the standard, filter lenses must meet the requirements for shade designations in [Table 2](#). Tinted and shaded lenses are not filter lenses unless they are marked or identified as such.
- (5) As required by the standard, persons whose vision requires the use of prescription (Rx) lenses must wear either protective devices fitted with prescription (Rx) lenses or protective devices designed to be worn over regular prescription (Rx) eyewear.
- (6) Wearers of contact lenses must also wear appropriate eye and face protection devices in a hazardous environment. It should be recognized that dusty and/or chemical environments may represent an additional hazard to contact lens wearers.
- (7) Caution should be exercised in the use of metal frame protective devices in electrical hazard areas.
- (8) Atmospheric conditions and the restricted ventilation of the protector can cause lenses to fog. Frequent cleansing may be necessary.
- (9) Welding helmets or faceshields should be used only over primary eye protection (spectacles or goggles).
- (10) Non-sideshield spectacles are available for frontal protection only, but are not acceptable eye protection for the sources and operations listed for "impact."
- (11) Ventilation should be adequate, but well protected from splash entry. Eye and face protection should be designed and used so that it provides both adequate ventilation and protects the wearer from splash entry.
- (12) Protection from light radiation is directly related to filter lens density. See note (4). Select the darkest shade that allows task performance.

PROTECTOR TYPES (from Table 1 above):

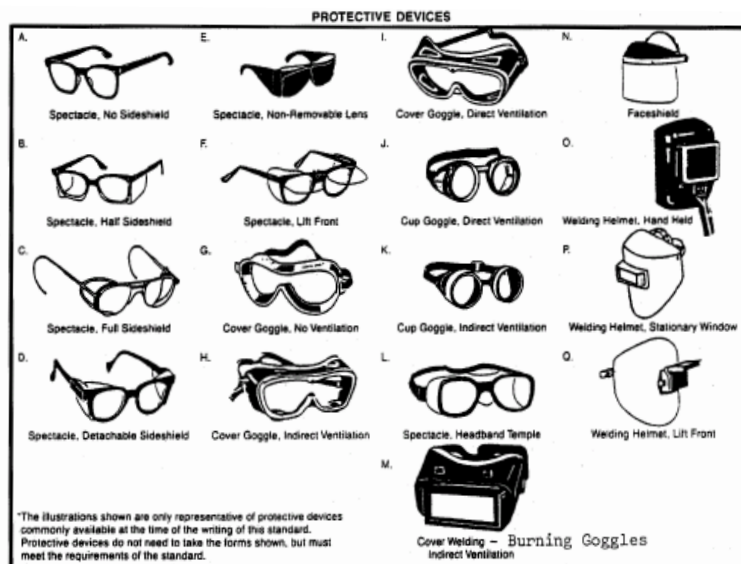


TABLE II. FILTER LENSES FOR PROTECTION AGAINST RADIANT ENERGY (A listing of appropriate shade numbers for various operations.)

| Operations | Electric Size $\frac{1}{32}$ in. | Arc Current (amps) | Minimum* Protective Shade |
|--|--|---------------------------|----------------------------------|
| Shielded metal arc welding | Less than 3 | Less than 60 | 7 |
| | 3 - 5 | 60 - 160 | 8 |
| | 5 - 8 | 160 - 250 | 10 |
| | More than 8 | 250 - 550 | 11 |
| Gas metal arc welding and flux cored arc welding | --- | Less than 60 | 7 |
| | | 60 - 160 | 10 |
| | | 160 - 250 | 10 |
| | | 250 - 500 | 10 |
| Gas Tungsten arc welding | --- | Less than 50 | 8 |
| | | 50 - 150 | 8 |
| | | 150 - 500 | 10 |
| Air carbon | Light | Less than 500 | 10 |
| Arc cutting | Heavy | 500 – 1,000 | 11 |
| Plasma arc welding | --- | Less than 20 | 6 |
| | | 20 - 100 | 8 |
| | | 100 - 400 | 10 |
| | | 400 - 800 | 11 |
| Plasma arc cutting | Light** | Less than 300 | 8 |
| | Medium** | 300 - 400 | 9 |
| | Heavy** | 400 - 800 | 10 |
| Torch soldering | --- | --- | 2 |
| Torch brazing | --- | --- | 3 |
| Carbon arc welding | --- | --- | 14 |

| Operations | Plate Thickness (inches) | Plate Thickness (mm) | Minimum* Protective Shade |
|------------------------|--------------------------------|----------------------|---------------------------|
| Gas Welding: | --- | --- | --- |
| Light | Under $\frac{1}{8}$ | Under 3.2 | 4 |
| Medium | $\frac{1}{8}$ to $\frac{1}{2}$ | 3.2 to 12.7 | 5 |
| Heavy | Over $\frac{1}{2}$ | Over 12.7 | 6 |
| Oxygen Cutting: | --- | --- | --- |
| Light | Under 1 | Under 25 | 3 |
| Medium | 1 to 6 | 25 to 150 | 4 |
| Heavy | Over 6 | Over 150 | 5 |

* As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives sufficient view of the weld zone without going below the minimum. In oxyfuel gas welding or cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.

** These values apply where the actual arc is clearly seen. Experience has shown that lighter filters may be used when the arc is hidden by the work piece.

APPENDIX 2: Regulatory Overview for Laboratory Safety (Derived from OSHA Laboratory Safety Guidance document OSHA 3404-11R 2011)

Section 5(a)(1) of the *Occupational Safety and Health Act of 1970* (OSH Act), the **General Duty Clause**, requires that employers “shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious physical harm to his employees.” Therefore, even if an OSHA standard has not been promulgated that deals with a specific hazard or hazardous operation, protection of workers from all hazards or hazardous operations may be enforceable under section 5(a)(1) of the OSH Act. For example, best practices that are issued by non-regulatory organizations such as the National Institute for Occupational Safety and Health (NIOSH), the Centers for Disease Control and Prevention (CDC), the National Research Council (NRC), and the National Institutes of Health (NIH) can be enforceable under section 5(a) (1). The principal OSHA standards that apply to all nonproduction laboratories are listed below. Although this is not a comprehensive list, it includes standards that cover the major hazards that workers are most likely to encounter in their daily tasks. Employers must be fully aware of these standards and must implement all aspects of the standards that apply to specific laboratory work conditions in their facilities.

The Occupational Exposure to Hazardous Chemicals in Laboratories standard (29 CFR 1910.1450), commonly referred to as the Laboratory standard, requires that the employer designate a Chemical Hygiene Officer and have a written Chemical Hygiene Plan (CHP), and actively verify that it remains effective. The CHP must include provisions for worker training, chemical exposure monitoring where appropriate, medical consultation when exposure occurs, criteria for the use of personal protective equipment (PPE) and engineering controls, special precautions for particularly hazardous substances, and a requirement for a Chemical Hygiene Officer responsible for implementation of the CHP. The CHP must be tailored to reflect the specific chemical hazards present in the laboratory where it is to be used. Laboratory personnel must receive training regarding the Laboratory standard, the CHP, and other laboratory safety practices, including exposure detection, physical and health hazards associated with chemicals, and protective measures.

The Hazard Communication standard (29 CFR 1910.1200), sometimes called the HazCom standard, is a set of requirements first issued in 1983 by OSHA. The standard requires evaluating the potential hazards of chemicals, and communicating information concerning those hazards and appropriate protective measures to employees. The standard includes provisions for: developing and maintaining a written hazard communication program for the workplace, including lists of hazardous chemicals present; labeling of containers of chemicals in the workplace, as well as of containers of chemicals being shipped to other workplaces; preparation and distribution of safety data sheets (SDSs) to workers and downstream employers; and development and implementation of worker training programs regarding hazards of chemicals and protective measures. This OSHA standard requires manufacturers and importers of hazardous chemicals to provide material safety data sheets to users of the chemicals describing potential hazards and other information. They must also attach hazard warning labels to containers of the chemicals. Employers must make SDSs available to workers. They must also train their workers in the hazards caused by the chemicals workers are exposed to and the appropriate protective measures that must be used when handling the chemicals.

The Bloodborne Pathogens standard (29 CFR 1910.1030), including changes mandated by the *Needlestick Safety and Prevention Act of 2001*, requires employers to protect workers from infection with human bloodborne pathogens in the workplace. The standard covers all workers with “reasonably anticipated” exposure to blood or other potentially infectious materials (OPIM). It requires that information and training be provided before the worker begins work that may involve occupational exposure to bloodborne pathogens, annually thereafter, and before a worker is offered hepatitis B vaccination. The Bloodborne Pathogens standard also requires advance information and training for all workers in research laboratories who handle human immunodeficiency virus (HIV) or hepatitis B virus (HBV). The standard was issued as a performance standard, which means that the employer must develop a written [Exposure Control Plan \(ECP\)](#) to provide a safe and healthy work environment, but is allowed some flexibility in accomplishing this goal. Among other things, the ECP requires employers to make an exposure determination, establish procedures for evaluating incidents, and determine a schedule for implementing the standard’s requirements, including engineering and work practice controls. The standard also requires employers to provide and pay for appropriate PPE for workers with occupational exposures. Although this standard only applies to bloodborne pathogens, the protective measures in this standard (e.g., ECP, engineering and work practice controls, administrative controls, PPE, housekeeping, training, post-exposure medical follow-up) are the same measures for effectively controlling exposure to other biological agents.

The Personal Protective Equipment (PPE) standard (29 CFR 1910.132) requires that employers provide and pay for PPE and ensure that it is used wherever “hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants are encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.” [29 CFR 1910.132(a) and 1910.132(h)]. In order to determine whether and what PPE is needed, the employer must “assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of [PPE],” 29 CFR 1910.132(d)(1). Based on that assessment, the employer must select appropriate PPE (e.g., protection for eyes, face, head, extremities; protective clothing; respiratory protection; shields and barriers) that will protect the affected worker from the hazard, 29 CFR 1910.132 (d)(1)(i), communicate selection decisions to each affected worker, 29 CFR 1910.132 (d)(1)(ii), and select PPE that properly fits each affected employee, 29 CFR 1910.132(d)(1)(iii). Employers must provide training for workers who are required to use PPE that addresses when and what PPE is necessary, how to wear and care for PPE properly, and the limitations of PPE, 29 CFR 1910.132(f).

The Eye and Face Protection standard (29 CFR 1910.133) requires employers to ensure that each affected worker uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation, 29 CFR 1910.133(a).

The Respiratory Protection standard (29 CFR 1910.134) requires that a respirator be provided to each worker when such equipment is necessary to protect the health of such individual. The employer must provide respirators that are appropriate and suitable for the purpose intended, as described in 29 CFR 1910.134(d)(1). The employer is responsible for establishing and maintaining a respiratory protection program, as required by 29 CFR 1910.134(c) that includes, but is not limited

to, the following: selection of respirators for use in the workplace; medical evaluations of workers required to use respirators; fit testing for tight-fitting respirators; proper use of respirators during routine and emergency situations; procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing and discarding of respirators; procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators; training of workers in respiratory hazards that they may be exposed to during routine and emergency situations; training of workers in the proper donning and doffing of respirators, and any limitations on their use and maintenance; and regular evaluation of the effectiveness of the program.

The Hand Protection standard (29 CFR 1910.138), requires employers to select and ensure that workers use appropriate hand protection when their hands are exposed to hazards such as those from skin absorption of harmful substances; severe cuts or lacerations; severe abrasions; punctures; chemical burns; thermal burns; and harmful temperature extremes, 29 CFR 1910.138(a). Further, employers must base the selection of the appropriate hand protection on an evaluation of the performance characteristics of the hand protection relative to the task(s) to be performed, conditions present, duration of use, and the hazards and potential hazards identified, 29 CFR 1910.138(b).

The Control of Hazardous Energy standard (29 CFR 1910.147), often called the “Lockout/Tagout” standard, establishes basic requirements for locking and/or tagging out equipment while installation, maintenance, testing, repair, or construction operations are in progress. The primary purpose of the standard is to protect workers from the unexpected energization or startup of machines or equipment, or release of stored energy. The procedures apply to the shutdown of all potential energy sources associated with machines or equipment, including pressures, flows of fluids and gases, electrical power, and radiation.

In addition to the standards listed above, other OSHA standards that pertain to electrical safety(29 CFR 1910 Subpart S-Electrical); fire safety (Portable Fire Extinguishers standard, 29 CFR 1910.157); and slips, trips and falls (29 CFR 1910 Subpart D – Walking-Working Surfaces, Subpart E - Means of Egress, and Subpart J – General Environmental Controls) are discussed at pages 25-28. These standards pertain to general industry, as well as laboratories. When laboratory workers are using large analyzers and other equipment, their potential exposure to electrical hazards associated with this equipment must be assessed by employers and appropriate precautions taken. Similarly, worker exposure to wet floors or spills and clutter can lead to slips/trips/falls and other possible injuries and employers must assure that these hazards are minimized. While large laboratory fires are rare, there is the potential for small bench-top fires, especially in laboratories using flammable solvents. It is the responsibility of employers to implement appropriate protective measures to assure the safety of workers.

APPENDIX 3: Definitions

Action level: The airborne chemical concentration that triggers air monitoring and the implementation of additional control measures. The action level is always lower than the corresponding OSHA permissible exposure limit (PEL) and is designed to protect personnel from overexposure. At UM, the more conservative of either the OSHA- defined action level (generally one-half the PEL) or one-half the ACGIH Threshold Limit Value is used as the action level.

Carcinogen: See "Select Carcinogen"

Chemical Hygiene Officer: An employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the chemical hygiene plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Compressed gas:

1. A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70° F (21.1°C); or
2. A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130° F (54.4°C) regardless of the pressure at 70° F (21.1° C); or
3. A liquid having a vapor pressure exceeding 40 psi at 100° F (37.8° C) as determined by ASTM D-323-72.

Controlled Substances: Drugs and certain other chemicals, both narcotic and non- narcotic, which come under the jurisdiction of federal DEA and state laws regulating their manufacture, sale, distribution, use and disposal.

Corrosive: Substance causing irreversible destruction of living tissue by chemical action at the site of contact (dermal or respiratory). Major classes of corrosive substances include strong acids, strong bases, and dehydrating agents.

Cryogenic liquids: Materials with extremely low boiling points (i.e. less than – 150 °F). Common examples of cryogenic liquids are liquid nitrogen, helium, and argon. Dry ice is the common term for frozen carbon dioxide. One special property of both cryogenic liquids and dry ice is that they undergo substantial volume expansion when converted to a gas phase, which can potentially lead to an oxygen deficient atmosphere where ventilation is limited.

Explosive: A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable: A chemical that falls into one of the following categories:

(1) "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(2) "Gas, flammable" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with

air greater than 12 percent by volume, regardless of the lower explosive limit.

(3) "Liquid, flammable" means any liquid having a flashpoint below 100° F (37.8° C), except any mixture having components with flashpoints of 100° F (37.8° C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(4) "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 29 CFR 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Hazardous Chemical: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed laboratory personnel (includes carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes).

Hematopoietic toxicants: Substances that decrease hemoglobin function and deprive the body tissues of oxygen (e.g. carbon monoxide, cyanides).

Hepatotoxin: Substances that produce liver damage (e.g. nitrosamines, carbon tetrachloride).

Highly Toxic: also referred as highly acute toxin) A chemical falling within any of the following categories:

1. A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm each.
2. A chemical with a median lethal dose (LD50) of 200 mg or less per Kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 Kg each.
3. A chemical that has a median lethal concentration (LC50) in air of 200 ppm by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm each.

Incompatible: Materials that could cause dangerous reactions by direct contact with one another.

Irritant: A substance, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact (dermal or respiratory).

NOTE: A wide variety of organic and inorganic compounds are irritants and consequently exposure to all laboratory chemicals should always be avoided.

Laboratory Personnel: Includes both employee and non-employee laboratory personnel who perform research activities, and covers individuals employed in the laboratory workplace that may be exposed to hazardous chemicals in the course of their assignments. Employees include faculty and staff and may include research associates, undergraduate and graduate students and post-

doctoral researchers, depending on their employment status. Non-employees include visiting scholars and may include research associates, undergraduate and graduate students, and postdoctoral researchers depending on their employment status.

Laboratory Supervisor: The individual in charge of the laboratory. It may be a Principal Investigator (PI), laboratory instructor, or laboratory manager.

Micro scaling (of process): Reducing the quantities of hazardous chemical used in a research operation to “microscale” quantities in order to reduce the risks to personnel and property and to minimize chemical waste streams. Microscale quantities range from 50-1000 milligrams.

Nanoparticle: A collection of tens to thousands of atoms approximately 1 to 100 nanometers in diameter that may be naturally occurring or engineered. Examples include: carbon buckeyballs or fullerenes; carbon nanotubes; metal oxide nanoparticles (e.g., titanium dioxide); quantum dots, among many others.

Nephrotoxin: Substances causing damage to the kidneys (e.g. certain halogenated hydrocarbons).

Neurotoxin: Substances that produce their primary toxic effects on the nervous system (e.g. mercury, acrylamide, carbon disulfide).

Non-Laboratory personnel: Laboratory personnel such as administrative staff, plumbers, and Heating, Ventilation & Air Conditioning (HVAC) technicians entering research laboratories to perform maintenance, administrative, or other non-research laboratory tasks.

Organic peroxide: An organic compound that contains the bivalent –o-o- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer: A chemical other than a blasting agent or explosive, that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Particularly Hazardous Substances: These consist of select carcinogens, reproductive toxins and substances that have a high degree of acute toxicity (also defined as highly toxic) or chronic toxicity.

Permissible exposure limit (PEL): the maximum permitted 8-hour time-weighted average concentration of an airborne contaminant.

Precursor Chemical: Precursor chemicals are chemicals used in the course of legitimate research that can potentially be used in the illicit production controlled substances such as methamphetamine, cocaine, heroin, and MDMA (ecstasy).

Pyrophoric: A chemical that ignite spontaneously in air at a temperature of 130 F or below.

Reproductive Toxin: A chemical that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). *IMPORTANT: Lab personnel should recognize that many chemicals have not been thoroughly assessed for their reproductive toxicity. Prior to selecting/using chemicals in the laboratory, researchers should determine their potential reproductive toxicity risks*

Sensitizer: A substance that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the substance. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock.

Select Agents: Bacteria, viruses, toxins, rickettsia, and fungi identified by the United States Department of Health and Human Services (HHS), Centers for Disease Control and Prevention (CDC), the United States Department of Agriculture (USDA), and the Animal and Plant Health Inspection Service (APHIS) that pose a potential threat to public health or welfare. NOTE: The safety practices and precautions provided by the Chemical Hygiene Plan are most applicable with the use of Select Agent toxins as opposed to infectious agents.

Select Carcinogen: means any substance which 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); or
- (iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or
- (iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
 - (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/m³;
 - (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.

IMPORTANT: Lab personnel should recognize that many chemicals have not been thoroughly assessed for their carcinogenicity. Prior to selecting chemicals for use in laboratory procedures, researchers should be familiar with the specific classes of compounds and functional group types that have been correlated to carcinogenic activity.

Substitution: When designing and planning a laboratory operation, using the least hazardous chemical possible to minimize risk to personnel and property.

Toxic Gas: A *highly toxic* gas has a median Lethal Concentration (LC 50) in air of 200 parts per million or less by volume of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for an hour, or less if death occurs within one hour, to albino rats weighing between 200 and 300 grams each. A *toxic gas* has a LC 50 in air more than of 200 parts per million but not more than 3,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 30 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for an hour, or less if death occurs within one hour, to albino rats weighing between 200 and 300 grams each.

Toxic Substance: Substances that cause adverse effects to specific target organs (i.e., lungs, liver, skin), or the nervous or blood systems. These substances can result in acute and/or chronic effects at moderate levels. A toxic substance must fall within one of the following categories:

- (a) A substance that has a median lethal dose (LD50) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- (b) A substance that has a median lethal dose (LD50) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of

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albino rabbits weighing between two and three kilograms each.

(c) A substance that has a median lethal concentration (LC50) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Unstable (reactive): A chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive: A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.