CHEMICAL HYGIENE PLAN

Per OSHA 29 CFR 1910.1450 and MIOSHA Part 431
Occupational Exposure to Hazardous Chemicals in Laboratories

September 2024

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TABLE OF CONTENTS

INTRODUCTION

PURPOSE

The purpose of the Chemical Hygiene Plan (CHP) is to establish a written safety and compliance guide that protects personnel working with hazardous chemicals here at Wayne State University (WSU). This plan describes roles and responsibilities, procedures, engineering controls, personal protective equipment, and work practices to protect personnel from potential hazards associated with chemicals.

Additionally, the WSU CHP is written to comply with the Michigan Occupational Safety and Health Administration (MIOSHA) laboratory standards and regulations, specifically Hazardous Work in Laboratories (MIOSHA Part 431).

SCOPE

The WSU CHP applies to all WSU facilities that handle hazardous chemicals. 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 the handling or use of such chemicals in which all the following conditions are met:

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

This CHP does not apply to laboratory procedures handling radioactive materials or biological agents.

HAZARDOUS CHEMICALS

A chemical is classified as hazardous if it contains either a physical hazard and/or a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or a hazard not otherwise classified. This applies to all hazardous chemicals regardless of the quantity and intended use. It is important to note that a single chemical may exhibit more than one hazard type and possess more than one hazard class.

Chemical-specific hazard information can be found on the chemical container labels and/or from the Safety Data Sheets (SDS) provided by the chemical manufacturer. The program outlines basic information on hazardous chemicals and references general standard operating procedures (SOPs)/fact sheets for the safe handling of the hazards associated with those chemicals at WSU.

RESPONSIBILITIES

OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY (OEHS)

- The Director of OEHS has the ultimate responsibility for the chemical hygiene program within the university.
- Establish, oversee, maintain, and review the institutional implementation of the CHP.
- Designate a Chemical Hygiene Officer (CHO) to assist with implementation.
- Provide technical guidance on matters of use of hazardous chemicals.
- Assist with the development and implementation of appropriate control measures and safe work practices.
- Conduct regular inspections of all applicable campus areas.

- Annually review and update the CHP to maintain its relevance and effectiveness based on relevant data.
- Identify and evaluate potential risks associated with the use of hazardous chemicals on campus.
- Ensure proper recordkeeping and accessibility of this procedure.
- Perform occupational exposure assessment following applicable regulations and department procedures.

PRINCIPAL INVESTIGATOR (PI)/MANAGER/SUPERVISOR

- Perform designated tasks and training as outlined in this plan.
- Develop written standard operating procedures (SOPs) for all highly hazardous chemicals being utilized/stored.
- Review applicable safe work procedures and SOPs before assigning new employee tasks.
- Ensure that all employees and students receive training in applicable SOPs before handling any hazardous chemicals or operating equipment.
- Ensure that all facilities and training are adequate for the use of all materials handled and ordered by the lab.
- Ensure that all personnel comply with the CHP.
- Determine and provide the appropriate personal protective equipment (PPE).
- Ensure that appropriate PPE is available to all employees.
- Ensure proper PPE is utilized by all employees, in good condition, and compatible with the degree of hazard of the chemical.
- Provide appropriate training to employees on the proper selection, use, and limitations of personal protective equipment.
- Ensure that visitors follow all applicable safe work SOPs and assume responsibility for visitor safety.
- Provide regular, formal chemical hygiene and housekeeping inspections, including routine inspections of emergency equipment.
- Ensure proper recordkeeping for all tasks outlined in this procedure.

WSU EMPLOYEES, STUDENTS, VOLUNTEERS, AND VISITORS

- Review and follow the WSU CHP and any departmental / laboratory safe work SOPs.
- Follow verbal and written safety work procedures, policies, regulations, and SOPs required for the tasks assigned.
- Gain approval from the PI/Manager/Supervisor for the use of Particularly Hazardous Substances (PHS), if applicable.
- Notify the PI/Manager/Supervisor of any potential changes or recommendations to a previously reviewed and approved safe work SOP, before implementing the changes.
- Review and understand the potential hazards associated with the chemicals, associated chemical reactions, experimental setups, and other work procedures before conducting work.
- Consistently and properly utilize appropriate safety measures including engineering, administrative controls, and appropriate PPE to mitigate potential hazards.
- Before using any PPE, notify your PI/Manager/Supervisor and follow the required approval and training process.

EXPOSURE CONTROL MEASURES

All WSU spaces are required to implement control measures based on an established hierarchy of controls to manage chemical exposures and other occupational hazards. These selected control measure(s) should ensure proper mitigation of the intended hazardous exposure and/or condition. It is important to prioritize all control measures from the most effective to the least effective, based on feasibility.

WSU research laboratories and other facilities using hazardous chemicals must evaluate their workplace procedures for possible exposure to hazardous chemicals and may use a combination of control measures to minimize such exposure. The following hierarchy should be consulted and implemented anytime a corrective measure is being implemented for a potential occupational exposure and/or hazardous condition.

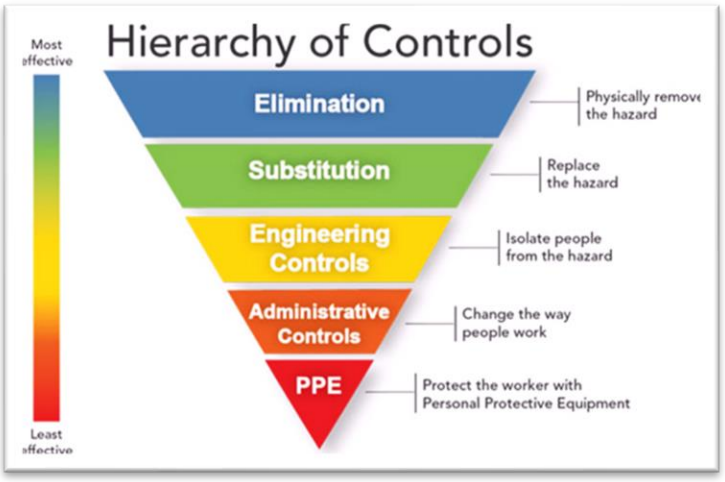

Figure 1: Hierarchy of controls. Source: National Institute for Occupational Safety and Health (NIOSH).

HIERARCHY OF CONTROLS

ELIMINATION AND SUBSTITUTION

Elimination is the most effective method for mitigating a hazard, which removes the hazard from the workplace entirely. If a hazard cannot be eliminated, the next-best method is substitution. This method involves replacing highly hazardous procedures/chemicals and other materials with one that is less hazardous.

ENGINEERING CONTROLS

Engineering controls are those that involve making changes to the work environment to reduce the exposure to occupational hazards including hazardous chemicals, such as isolating the hazard or placing a barrier between the worker and the hazard.

These types of controls are preferred over all others because they make permanent changes that reduce exposure to hazards and do not rely on worker behavior. WSU laboratories and designated chemical use areas are designed with different types of engineering controls and WSU Employees/Students/Volunteers/Visitors must include these controls in their work practices to reduce exposures to hazardous chemicals and other hazards.

WSU Employees/Students/Volunteers/Visitors must ensure the proper functionality of engineering controls prior to performing any associated task. If any engineering control is malfunctioning or in an alarm condition it shall not be used and must be reported to the applicable Principal Investigator (PI)/Manager/Supervisor.

VENTILATION CONTROLS

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

- **General Ventilation**
  - The general ventilation system provides a source of air for breathing and as an air input to local ventilation devices. This system directs the airflow into the laboratory from non-lab areas and then out from the laboratory to the exterior of the building.
  - General airflow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas.
  - A ventilation rate of 4-12 room air changes per hour is normally adequate to continually replace laboratory air, limiting airborne concentrations of both hazardous/non-hazardous vapors, fumes, and particulates.
  - General ventilation systems should also maintain laboratories under negative pressure compared to adjacent non-lab spaces.
  - However, general ventilation should not be used as the sole means of protection from hazardous airborne substances released into the laboratory and hence additional ventilation controls should be used with highly hazardous substances.
- **Local Ventilation**
  - Local ventilation controls include chemical fume hoods (CFHs), glove boxes, and other ventilation control devices including drop-down flexible ducts, paint booths, canopies, ducted biological safety cabinets, slot hoods, or ventilated gas cabinets. These devices provide ventilated, enclosed workspaces that can capture, contain, and exhaust airborne materials (chemical or biological) at the point of generation.
  - Proper use of these devices is critical, and users should adhere to the following general practices to reduce potential chemical exposures when working with local ventilation controls:
    - Select the appropriate local ventilation device (e.g., CFH, glove box, etc.) based on the hazards associated with the experimental procedure. Refer to the chemical safety data sheet(s) or contact OEHS for assistance with selecting the appropriate ventilation control device.
    - Re-evaluate the use of the engineering controls if the experimental procedure changes.
    - Confirm local ventilation control devices (e.g., Chemical Fume Hoods) are operating properly before use. For ventilation controls that require routine inspections and certifications, check certification is current and valid prior to use. Some devices require annual certification while others may require completion of routine maintenance within set time periods.
    - First-time users should obtain training on how to operate.
    - Do not change the design of the device, use it the way it was designed.
    - Contact OEHS for certification of Chemical Fume Hoods and Biological Safety Cabinets.
    - Do not use a local ventilation device that has been posted “out of service” or with an expired certification date.

- Laboratory personnel should not try to repair broken ventilation devices by themselves unless authorized. Contact WSU Facilities Planning & Management (313 577 4315) to repair local ventilation control devices that are installed as a part of the laboratory design (e.g., chemical fume hoods). For other local ventilation controls (e.g., glove boxes) that are purchased by the laboratory, contact the corresponding service provider for repair and maintenance.

VENTILATION INSPECTION AND CERTIFICATION

All Chemical Fume Hoods (CFHs) and Bio Safety Cabinets (BSCs) at WSU must be certified by OEHS annually and after any repairs/maintenance. If an inspection is needed, notify OEHS at (313) 577-1200.

If the CFH or BSC does not perform within the required performance limits it will be tagged out of service and reported for repair. Any system tagged out of service must not be used.

Employees must contact OEHS to determine if other local ventilation controls can be certified by OEHS or if outside service providers.

CHEMICAL FUME HOODS

A Chemical Fume Hood (CFH) is typically the primary engineering control for working with hazardous chemicals in the lab. During CFH operation, an exhaust fan on the roof draws air into the fume hood from the room, through an exhaust duct, and out of the building through the roof stack. It is important to note that 100% of the air drawn into the CFH is exhausted out of the roof stack.

- OEHS has established an acceptable operating range of 70 to 120 linear feet per minute (FPM) face velocity for CFH certification while new CFHs require a face velocity of 100 FPM at commissioning. Face velocities too high or too low can be detrimental to the performance and overall safety of the CFH.
    - Velocities greater than 120 FPM face velocity may create turbulence, causing contaminants to flow out of the hood and into the user's breathing zone. To reduce energy consumption, OEHS supports efforts to maintain face velocities closer to, but greater than the lower end of the acceptable range (70 FPM) during use.
    - The OEHS certification sticker on the CFH will note the passing face velocity measurement. Each hood CFH should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use, and a 20 cm (6 inch) line drawn from the edge, designating the safe work zone.
- Hazardous chemicals and substances must be handled in a CFH unless another effective control measure has been approved by OEHS. CFHs can contain chemical vapors, powders, and gases at the point of generation.
- Chemicals that have high acute toxicity, carcinogenic effects, or are identified as a reproductive toxin must be handled in a CFH except where there is only a very low risk of exposure (e.g., use of minimal quantities in a closed system).
- Leave the CFH "on" even when it is not in active use if toxic substances are in the unit or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is off. In addition, a CFH should be used when transferring chemicals or mixing solutions into new containers, especially highly corrosive, flammable, or reactive chemicals.

Refer to the OEHS Laboratory Health and Safety Fact Sheets: Using a Chemical Fume Hood for more information on the procedures for safe use of a chemical fume hood and the criteria for evaluating a CFH performance.

Chemical fume hoods are sometimes mistakenly used in place of a Biological Safety Cabinet (BSC) or glove box. The following chart and section provide guidance on which engineering control to use for examples of hazardous materials.

Chemical Fume Hood	Glove Box/Isolator	Biological Safety Cabinet
Volatile chemicals	Air reactive compounds	Biological aerosols including human blood
Flammable liquids	Highly toxic compounds	Risk Group 2 or higher 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)		

PERCHLORIC ACID FUME HOODS

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 the accumulation of explosive perchlorate crystalline material. You must receive lab-specific training before performing any work in a perchloric acid fume hood.

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. Typically, only found in laboratory environments here at WSU, 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 glove box. Contact the manufacturer's representative 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 Principal Investigator/Laboratory supervisor is responsible for maintenance, inspection, and proper use.
- The Principal Investigator/Laboratory supervisor can hire an external vendor or train and designate laboratory personnel to carry out these tasks.
- The lab is also responsible for writing a standard operating procedure (SOP) for the use of the glovebox and training of operators.
- Laboratories 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 workspace 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 the 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.

Refer to "A guidance document by the American Glovebox Society" for 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. It serves to protect users and the environment from biological aerosols, while protecting the product from the environment Unless the unit is ducted, a BSC is not an appropriate engineering control when using volatile chemicals. In a free-standing cabinet, exhaust air is passed through a certified HEPA filter, removing particulates/aerosols but not chemical vapors, and recirculated back into the laboratory. BSCs shall be evaluated annually in accordance with the National Safety Foundation (NSF) Standard 49. OEHS conducts the annual certification of BSCs at WSU and coordinates repairs with the Principal Investigator/laboratory supervisor. For more information on BSCs refer to the OEHS Biosafety Cabinet website.

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 CAN NOT effectively capture airborne contaminants beyond the effective work zone, which is typically one-half in diameter from the end of the hose. Please contact OEHS for a snorkel work zone demonstration.

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. For safe use, users should not place their heads between the contaminant source and the canopy hood.

SLOTTED HOODS

Slotted hoods are ventilation hoods that are specially designed to capture airborne contaminants for a specific process or operation. There are many types of slotted hoods, and they are typically used to exhaust open surface tanks like acid baths and work benches.

Slot hoods are suited when a larger working space is needed and when air contaminants are relatively low in toxicity. They are 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. Please contact OEHS for slotted hood work zone evaluation.

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.

The use of ductless hoods at WSU will be restricted to very specific procedures, nuisance chemicals, or small quantities that could be used safely on an open bench. Prior to the purchase and installation of a ductless hood, consult with OEHS to determine if a ductless hood is appropriate for the hazards that will be used in it.

VENTILATED COMPRESSED GAS CABINETS

Gas cabinets are enclosures designed to house and/or dispense toxic or 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 automatically shut off gas flow. Prior to working with toxic compressed gases, consult with OEHS to determine if a gas cabinet is required.

WET BENCHES

Wet benches, industrial hoods, or wet station hoods are ventilated workstations that may be free-standing or enclosed and 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 airflow 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. Consult with OEHS prior to purchasing or utilizing a wet bench.

GROSSING STATIONS, DOWNDRAFT HOODS, OR NECROPSY TABLES

These units are designed with ventilation slots or grates 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, the user must be standing laterally with the direction of airflow in order for the booth 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.

BENCHTOP VENTED ENCLOSURES

Benchtop 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.

ADMINISTRATIVE CONTROLS

These types of controls mainly consist of safety procedures, policies, work practices, and training programs to control potential exposures to occupational hazards. WSU laboratories and other facilities must develop and use safety procedures and obtain required training for any work involved with hazardous materials/procedures. In addition, administrative controls should be properly documented, specific to the procedures within each laboratory, and communicated to the lab members (e.g., via lab-specific training, hazard-specific or laboratory safety training, Standard Operating Procedures, etc.).

SAFE WORK PRACTICES

Administrative controls are basic and fundamental to all WSU facilities working with hazardous materials (chemical, radiological, biological, or physical), equipment, or operations to protect the safety and health of all persons working in the laboratory by reducing/preventing potential exposure to hazards.

The following prudent practices, mandated or not under federal or state regulations, have been vetted by many national agencies such as the National Research Council of the National Academies. These practices should be considered during the development of administrative controls.

CHEMICAL HANDLING

- Always read and understand the Safety Data Sheet (SDS) and the label before using a chemical in the laboratory and make others in the laboratory aware of any special hazards associated with your work.
- Wear appropriate Personal Protective Equipment (PPE) when handling hazardous materials. Inspect all gloves for holes and defects before use.
- Use only those chemicals for which the quality and the capability of the available ventilation system is appropriate.
- Require the use of certified fume hoods, glove boxes, or other ventilation devices for operations which might result in the release of toxic chemical vapors or dust. This includes the use of any apparatus that may discharge toxic chemicals (vacuum pumps, distillation columns, etc.). Preventing the escape of these types of materials into the working atmosphere is one of the best ways to prevent exposure.
- Properly label and store all chemicals.
- To reduce the chances of injuries from projectiles, when heating a test tube or other apparatus, never point the apparatus toward yourself or others.

- Dilute concentrated acids and bases by slowly pouring the acid or base into the water while stirring – never pour water into the acid or base as it can easily splash concentrated material during the chemical reaction.
- Contact the Principal Investigator/Manager/Supervisor or OEHS if you have questions about the chemical handling procedures and the adequacy of the safety equipment available to perform such procedures.
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan.
- Do not allow release of toxic substances or fumes into cold or warm rooms, as these types of areas typically involve re-circulated atmospheres.
- Do not smell or taste chemicals.
- 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.
- Do not dispose of any hazardous chemicals through the sewer system. These substances might interfere with the biological activity of wastewater treatment plants, create fire or explosion hazards, cause structural damage, or obstruct flow.
- Be prepared for an accident or spill and refer to the emergency response procedures for the specific material. Procedures should be readily available to all personnel. For general guidance, the following situations should be addressed:
    - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention.
    - Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. Seek medical attention.

TOOL AND EQUIPMENT

- Follow all manufacturer recommendations for use and maintenance. Only use for its designed purpose.
- Avoid storing materials and equipment in CFHs which would obstruct proper air flow.
- Procedures involving the modified use of equipment or tools require a situation-specific Standard Operating Procedure outlining any special health and safety considerations associated with the modifications.
- Routinely inspect equipment, system set-ups, 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, remove that equipment or tool from service and arrange appropriate maintenance by trained and qualified technicians.
- Employee should not conduct their own equipment or tool maintenance unless trained and authorized.
- Equipment and tools shall not be used after being found to require service.
- Equipment or tools that are damaged or require maintenance must be decontaminated and removed from service until corrected.

- Laboratories must use the OEHS Laboratory Equipment Decontamination Form. Review the Equipment Decontamination Procedures and the Laboratory Closures/Moves webpage for more information.
- Store laboratory glassware with care to avoid damage.
    - Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur.
- Do not use damaged glassware or other equipment.

LABORATORY OPERATIONS

- Do not work alone – use a buddy system so that assistance is available in an emergency.
- Laboratory personnel should not deviate from the assigned work schedule without prior authorization from the Principal Investigator/Laboratory supervisor so that someone knows you are in the lab.
- Never perform unauthorized experiments.
- Participate in both general training provided by OEHS and lab-specific training prior to beginning laboratory operations.
- New Principal Investigators/Lab supervisors should contact OEHS for a consultation when planning their laboratories.
- Plan appropriate protective procedures, PPE, and the positioning of all equipment before beginning any operation. Always follow the appropriate standard operating procedures in the laboratory.
- Know the location and proper use of all emergency response equipment (eyewash unit, safety shower, fire extinguisher, first-aid kit, fire blanket, emergency telephone, and fire alarm stations).
- Keep the work area clean and uncluttered. Adhere to good housekeeping practices that promote general care, cleanliness, orderliness, and maintenance of the laboratory.
- While in the laboratory and performing operations researchers must maintain situational awareness by being:
    - Fully aware of their surroundings and the events taking place around them.
    - 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.
    - Especially cautious and make sure they are not distracted while working with the hazard or unable to hear warnings from those around them. Inadequate situational awareness has been identified as one of the primary factors in accidents attributed to human error.
    - Not engaged in distracting behavior such as practical jokes in the laboratory. This type of conduct may confuse, startle, or distract another worker.

UNATTENDED REACTIONS

- Design unattended reactions (e.g., overnight reactions) with provisions to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas.
- Always obtain approval from the PI/ lab supervisor before beginning a reaction that must be left unattended.
- Choose a vented enclosure to set up the reaction. This includes but is not limited to, a CFH or glovebox.

- Ensure there are no combustibles, clutter, or items surrounding your setup.
- Have another lab member check the setup before leaving the lab.
- Double-check all glassware, hoses, and clamps for cracks, damage, and security.
- Use protection devices and sensors to turn off the experiment if there is an interruption in power, water flow, gas flow, device failure, or excessive pressure or temperature that would have a potentially serious impact.
- Close the CFH sash whenever possible.
- Laboratory lights should be left on, and appropriate signs should be posted on the entrance door(s) as well as near the experiment identifying the nature of the experiment and the hazardous substances in use.
- Leave information on the signs indicating how to contact you in the event of an emergency.

NEWLY SYNTHESIZED CHEMICALS

WSU research labs have the potential to synthesize/use novel chemical compounds with limited or unknown hazardous information. For safe handling of novel chemicals with known composition:

- Label the novel chemical with IUPAC name or a lab-designated name with the chemical structure.
- Label the chemical container with any known chemical hazard properties (e.g., flammable, explosive, toxic, etc.) determined by the researcher to the best of their ability.
- Communicate any known hazards (physical, health, environmental) of the chemical to the laboratory personnel.

If the composition of the novel chemical is unknown or yet to be characterized the compound must be treated as a particularly hazardous substance with unknown hazards.

For newly synthesized chemicals, it is prudent to follow standard chemical hygiene practices that limit potential exposures, which include but are not limited to PPE (e.g., lab coat, gloves, safety glasses), engineering controls (e.g., chemical fume hood, glove box), etc., until further information becomes available on the associated chemical hazards.

Contact OEHS for assistance if:

- Newly synthesized chemicals are to be transported to another user outside of the laboratory or university.
- Any laboratory personnel experience adverse health effects after exposure to the newly synthesized chemical.

NANOPARTICLES AND NANOMATERIALS

Nanoparticles and nanomaterials have different reactivities and interactions with biological systems than bulk materials, and understanding and exploiting these differences is an active area of research. However, these differences also mean that the risks and hazards associated with exposure to engineered nanomaterials are not well known. Because this is an area of ongoing research, consult trusted sources for the most up-to-date information available.

- Note that the higher reactivity of many nanoscale materials suggests that they should be treated as potential sources of ignition, accelerants, and fuel that could result in fire or explosion.
- Easily dispersed dry nanomaterials may pose the greatest health hazard because of the risk of inhalation.

- Operations involving these nanomaterials deserve more attention and more stringent controls than those where the nanomaterials are embedded in solid or suspended in liquid matrixes. Consideration should be given to all possible routes of exposure to nanomaterials including inhalation, ingestion, injection, and dermal contact (including eye and mucous membranes).
- Avoid handling nanomaterials in the open air in a free particle state. Whenever possible, handle and store dispersible nanomaterials, whether suspended in liquids or in a dry particle form, in closed (tightly sealed) containers.
- Unless cutting or grinding occurs, nanomaterials that are not in a free form (encapsulated in a solid or a nanocomposite) typically will not require engineering controls.
- If a synthesis is being performed to create nanomaterials, it is not enough to only consider the final material in the risk assessment but consider the hazardous properties of the precursor materials as well.
- To minimize laboratory personnel exposure, conduct any work that could generate engineered nanoparticles in an enclosure that operates at a negative pressure differential compared to the laboratory personnel breathing zone.
- Limited data exist regarding the efficacy of PPE and ventilation systems against exposure to nanoparticles. However, until further information is available, it is prudent to follow standard chemical hygiene practices.

EATING, DRINKING, SMOKING, COSMETICS, AND MEDICATIONS:

- Consumption, storage, and preparation of food and drink are prohibited in laboratory spaces.
- Laboratory equipment is prohibited from being used to prepare, store, or consume food or beverages, regardless of where the consumption occurs.
- Food and drink are only allowed in non-laboratory areas or desks that are physically separated from the laboratory operation by a door, partition, or engineered barrier which prevents cross-contamination of the consumable items by the hazardous materials.
- Smoking, vaping, applying cosmetics, chewing gum, adjusting contact lenses, taking/storing medicine, and other related activities are not permitted in areas where hazardous materials are used or stored.
- Laboratory water sources and deionized laboratory water must not be used as drinking water.

VISITORS, MINORS, AND PETS:

- For liability, safety, and security reasons, do not allow unauthorized persons in the laboratory.
- Visitors are required to wear appropriate lab attire and PPE, including eye protection.
- A responsible person must be appointed by the PI/ Laboratory supervisor to supervise all visitors or volunteers when they enter a laboratory to work, or for a visit.
- If minors are expected in a laboratory (e.g., as part of an educational or classroom activity or volunteering), they must be always under the direct supervision of a qualified adult. All laboratory personnel in the area should be made aware that minors are present. Follow the WSU Policy for Minors Working in Laboratories. Minors working in laboratories require prior approval from OEHS and may also require approval from appropriate WSU safety committees. Visit Minors working in labs & animal facilities for forms and approval process.
- No pets are permitted in any WSU laboratory or vivarium.

- **Note:** Service animals are not pets. They are highly trained and may be present in a laboratory after a risk assessment has been conducted by OEHS. A clean, safe area must be provided where the animal can wait.

MOBILE DEVICES

- Avoid handling personal mobile devices while wearing gloves.
- Avoid setting any mobile device, especially a cell phone, down on any surface in the lab that may be contaminated with chemicals.
- Mobile devices can act as an ignition source. Do not use them while handling flammable materials.
- Mobile devices can be a source of distraction and must not be utilized if they negatively impact personnel's situational awareness.

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 are not permitted to modify or work with facility electrical equipment or connections.
- Electrical panels must remain unblocked and only accessed by authorized personnel.
- Standard operating procedures outlining electrical safety and general safety must be produced for any field fabricated equipment. Contact OEHS and Enterprise Risk Management if planning to fabricate a new piece of equipment.
- Portable space heaters are prohibited in laboratories using and/or storing flammable, combustible, or explosive (highly energetic compounds) chemicals.

RISK ASSESSMENT

A risk assessment is a critical tool for ensuring the safe and responsible use of hazardous chemicals. By systematically identifying, evaluating, and controlling potential hazards, organizations can prioritize risks, implement effective safety measures, comply with regulations, and protect the health and well-being of their employees. Ultimately, a comprehensive risk assessment is essential for fostering a culture of safety and minimizing the environmental impact of chemical use.

Typically, a risk assessment begins by first identifying the task or group of tasks that need to be evaluated, such as the use of pyrophoric liquids or the use of compressed gas. Each procedural step that makes up a specific task is included in the review. This included task set-up, clean-up, waste generation, and disposal.

One effective method for conducting a risk assessment is to systematically address five key questions:

1. What are the hazards?
    a. Identify the specific hazards associated with the chemical, such as toxicity, flammability, or reactivity.
2. What is the worst thing that could happen?

   a. Determine the worst-case scenario that could result from exposure or misuse.

3. What can be done to prevent this from happening?
   a. Develop preventive measures to eliminate or minimize the likelihood of the worst-case scenario occurring.
4. What can be done to protect from these hazards?
   a. Subsequently, implement protective measures, such as engineering controls, administrative controls, or personal protective equipment, to mitigate the risks.
5. What should be done if something goes wrong?
   a. Establish emergency procedures and response plans to address potential incidents and ensure prompt and effective action in case of an emergency.

The information obtained from this brief assessment can be used to write standard operating procedures (generic and lab-specific) that integrate safe work practices and effective control measures. Chemical risks are regularly reviewed during routine audits and inspections. These assessments help to identify potential hazards, assess exposure risks, and ensure compliance with applicable safety regulations.

Any high-risk or atypical hazards identified must be promptly reported to OEHS for further evaluation. Labs can also reach out to OEHS at any time if they have questions or need assistance in determining potential risks associated with the use of hazardous chemicals on campus.

OCCUPATIONAL EXPOSURE ASSESSMENTS

Occupational exposure assessments are routinely performed by OEHS to evaluate the level of employee exposure to hazardous substances at WSU. These assessments involve a variety of methods, such as direct monitoring (e.g., personal sampling), indirect monitoring (e.g., area sampling), and historical data analysis.

By collecting and analyzing data on exposure levels, OEHS can identify potential hazards, assess the effectiveness of existing control measures, and implement appropriate actions to ensure occupational exposure levels are below applicable regulatory limits.

The frequency and location of these assessments are based on chemical inventory data, inspection results, risk assessment determinations, individual job classification, and other relevant information. WSU employees are encouraged to contact OEHS at (313) 577-1200 with concerns about possible chemical exposure levels.

STANDARD OPERATING PROCEDURES (SOPS)

SOPs are documents that detail the potential hazards of handling hazardous material(s) or a hazardous procedure(s) and how these hazards will be mitigated. SOPs are beyond the prudent (safe work) practices for general laboratory safety taken when working with laboratory chemicals. The development and implementation of SOPs is a core component of promoting a strong safety culture in the laboratory and helps ensure a safe work environment.

- All laboratory personnel who handle hazardous chemicals must comply with generic or lab-specific standard operating procedures.
- Laboratory personnel who are most knowledgeable and involved with the experimental process are qualified to develop and implement laboratory-specific standard operating procedures (SOPs) that address the specific hazards present in the lab's protocols.

- Lab-specific SOPs shall be reviewed by qualified personnel and shall be amended and subject to additional review and approval by the Principal Investigator where changes or variations in conditions, methodologies, equipment, or use of the chemical occur.
- For certain hazardous chemicals, Particularly Hazardous Substances (PHSs), or specialized practices, consideration must be given to whether additional consultation with safety professionals (i.e., OEHS) is warranted or required.
- All written SOPs (generic or lab-specific) must be maintained in the laboratory, used in laboratory training, and made available upon request to laboratory workers.
- Employees should read and sign these SOPs before beginning work and whenever the SOPs are updated or modified.

PERSONAL PROTECTION EQUIPMENT (PPE)

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.

- 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.
- If required for the work assigned (not voluntary use), the employer must provide PPE at no cost to employees, including temporary and part-time staff.
- Selection of PPE may vary based on the nature of the hazard present and laboratory personnel should be trained on the proper use, maintenance, and limitations of the selected PPE.
- Laboratory personnel must be aware that PPE does not eliminate the hazard.
- If the PPE fails, exposure will occur. To reduce the possibility of failure, PPE must be properly fitted and maintained in a clean and serviceable condition.
- The PPE selected must fit well and provide adequate protection from the hazard it was designed for. Make certain that personnel have the correct size of protective equipment. Whenever possible, select adjustable PPE.
- Personnel input in the PPE selection process is critical. PPE that fits properly fits the task 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 that is no longer functional or adequate for the hazards must be replaced.

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 laboratories with hazardous materials or processes:

- Shirts or tops must cover the upper torso. Layered clothing is a safety benefit 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. Pantyhose is 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, and protect the wearer from chemical splashes, hot liquids, and sharp objects.
    - Use of wheelies, roller skates, or roller blades is not permitted in areas where chemicals are stored or used.

The following rules are related to appropriate lab attire and are mandatory when actively working with hazardous materials, operations, or equipment:

- Hair must be trimmed or secured to avoid contact with hazardous materials, laboratory surfaces, open flames, or equipment. Hair must not impede vision. Serious injuries can result if hair becomes entangled in automated equipment or rotating parts. Microbial organisms and chemical contamination are easily passed from work surfaces to workers (and vice versa) via hair.
- 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 or face shields, hang loose, or come in contact with chemicals, biologicals, other work materials, equipment, or open flames.
- Loose or exposed jewelry should not be worn when working in the lab as indicated above. Dangling jewelry can become entangled in equipment, spread contamination, and conduct electricity. Chemicals can seep under jewelry and cause injuries to the skin. Chemicals can react hazardously with jewelry and potentially change its composition.
- Loose-woven, frilly, or flammable synthetic clothing materials are not allowed when working with open flames, pyrophorics, or flammable liquids. The weight, weave, and material composition 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 melting/burning fabric can cause severe burns.

EYE AND FACE PROTECTION

Appropriate eye or face protection shall be used where a hazard exists due to the presence or use of the following: liquid chemicals; acids or caustic liquids; chemical fumes, gases, or vapors; biohazardous liquids; flying objects or particles; pressurized systems, mechanical hazards, cryogenic liquids; molten metal; glare; injurious radiation; electrical flash; or a combination of these hazards. Safety glasses are required as the minimum level of protection where these hazards exist.

WSU research labs and facilities are encouraged to work with OEHS to assess risks and, when possible, eliminate or isolate the hazards (e.g., redesigning spaces to isolate hazardous from non-hazardous work). Removal or isolation of hazards may allow for OEHS-approved exceptions where eye and face protection are not required. Where hazards cannot be fully eliminated or isolated, labs and facilities are encouraged to work with OEHS to identify appropriate eye protection, such as safety glasses, goggles, face shields, or a combination of eye protection.

The following general guidance applies to eye protection:

- All eye and face protection must comply with ANSI Z87.1. Compliant eye and face protection devices will be clearly stamped with "Z87" or "Z87+". Note: The "+" symbol indicates that eye/face protection includes higher impact resistance due to flying objects.
- Standard prescription glasses are not considered a form of eye protection, due to gaps around the glasses and the lack of impact resistance.
- Safety glasses should be chosen to conform to the wearer's face and minimize gaps around the glasses.
- Safety glasses or goggles must be worn over prescription glasses and must be of a type intended to be worn over prescription glasses.
- 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 protect 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.
- 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 the use of engineering controls, chemical goggles shall be worn.
- ANSI Z87.1 chemical goggles must be worn during chemical transfer/ handling operations or any other operations having any likelihood of 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 of chemical splash/spray, or where flying fragments/particles are generated. Appropriate safety glasses or goggles are required for eye protection beneath the face shield.
- Laser safety eyewear must be specific to the lasers present. OEHS can be contacted to help determine appropriate laser eyewear.
- Other eye or face protection may be required, depending on the hazards present.

HEAD PROTECTION

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 where there is a risk of high voltage electric shock and burns. Contact OEHS if additional information is needed.

FOOT PROTECTION

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

HAND PROTECTION

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

It is important to select the appropriate glove for a particular application, determine how long the glove can be worn before degradation occurs, and whether it can be reused. Chemically protective gloves should be selected based on tested performance against specific chemicals.

The OEHS Glove Selection Guide provides an overview of glove types for certain classes of chemicals, and other hazards.

Glove manufacturers have also developed recommendations for the proper selection and use of chemically protective gloves, which can also be used as selection guidance.

- Incorrect selection can result in a false sense of security and increased exposure.
- Glove thickness is also important to consider, as this will affect how quickly a chemical may permeate the glove material. Glove material thickness is usually measured in mils (1 mil = 0.001" gauge).
- No single glove 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.
- It may be necessary to wear more than one glove type at a time due to the hazards present (e.g., wearing both chemical-resistant gloves and cut-resistant gloves when working with sharp metals being dipped into a corrosive chemical bath).
- Gloves should be selected that is a balance between protection against hazards, such as chemicals or sharp objects, versus the risk of loss of dexterity, being caught in rotating equipment, or ergonomic injury from gloves that are too heavy or stiff for manipulating small objects.

Proper use of gloves:

- Store gloves in a clean area away from chemicals, temperature extremes, and other hazards.
- 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.
- For disposable gloves, replace them when chemical contact occurs. Disposable gloves are not to be reused.
- For reusable gloves, wash after removal and air dry in the lab.
- Remove gloves before you leave the lab or handling objects such as doorknobs, telephones, or computer keyboards.
- Dispose of contaminated gloves in the proper hazardous waste container.
- Wash hands after removing gloves (even when double-gloving).

LAB COATS

Lab coats are required when handling chemical, biological, or radiological materials. The requirement also applies to working at a lab bench or with equipment where such materials are handled or working adjacent to areas with such work.

Important facts to consider when wearing a lab coat:

- The coats must be maintained in good condition and reasonably clean so as to not create a hazard.
- Lab coats are made of various fabrics and blends. The fabric material shall be selected primarily based on the hazards present. See the table below for selection information.

Lab Coat Fabric	Hazards	Note
20%-60% cotton - polyester blends	Appropriate for biological materials, powders, and small volume liquid chemical manipulation.	Burns more readily than 100% cotton or FR. Not appropriate for use with flammable liquids, pyrophoric materials, or near open flame.
100% Cotton	Appropriate for hazards above plus light flammable liquids use and can be used around open flames (such as alcohol burners).	Burns less readily than polyester blends. Not appropriate for use with pyrophoric materials.
Flame Resistant (FR) materials	Appropriate for hazards above. Flame resistant (FR) material is required for handling pyrophoric materials and for heavy use of flammable liquids.	FR fabrics can be made of Nomex, FR treated cotton or Tecasafe Plus. Some of these materials have special washing instructions.

- The proper fit of the lab coat is also important. The coats should cover the user's legs to the knees and arms to the wrist.
- 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, lunchrooms, 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.
- Home laundering of lab coats is not allowed. Lab coats must be laundered by a commercial company (e.g., Cintas) or at laundry units established within WSU departments. Some schools or departments have contracts with outside vendors. Check with your departmental administrator on specific procedures.
- Lab coats that are grossly contaminated by overuse or because of a spill (onto the lab coat) should not be turned in for laundering if the contaminants include heavy metals, nanomaterials, or chemicals that are acute or chronic health hazards (GHS category 01), biological hazardous materials, or flammable solvents. In such a case, the lab coat will be disposed of as chemical hazardous waste, biological waste, or autoclaved if biologically contaminated.

SKIN PROTECTION, OTHER THAN GLOVES AND LAB COAT

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 using various engineering controls designed for the lab.

When it is not feasible to conduct operations within a CFH, or where there otherwise may be a need for respiratory protection. OEHS must be contacted for initial exposure assessment and respirator approval prior to use. Regulations require that all employees complete a medical questionnaire, fit test & training before receiving any type of respiratory protection.

Refer to OEHS Respiratory Protection Program webpage for more information.

HEARING PROTECTION

Hearing protection is rarely required during laboratory operations. If a laboratory operation generates noise conditions in which researchers must raise their voices to be heard, please contact OEHS for an assessment.

Hearing protectors, such as earmuffs or earplugs, may be necessary when sound levels exceed comfortable noise levels over an extensive period of time, or when there is very loud impact noise.

OEHS can conduct noise monitoring to determine if noise exceeds regulatory thresholds. Personnel who perform tasks where noise exceeds thresholds must be in a Hearing Protection Program, which includes regular audiograms to monitor their hearing, mandatory annual training, and the use of appropriate hearing protection during those tasks. Contact OEHS for more information.

PPE REASSESSMENT AND TRAINING

Once appropriate PPE has been identified and approved by OEHS, employees must receive training that includes 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.

Additionally, personnel should be aware of the following:

- Laboratory personnel must be instructed to remove gloves and lab coats prior to entering common areas (hallways, elevators, eating areas, restrooms, 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.

- PIs/Laboratory 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 PPE used in the workplace should be reassessed 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 PI/Laboratory 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 workplace changes or type(s) of PPE that render previous training obsolete.

STANDARD OPERATING PROCEDURES

WSU research/teaching labs and other facilities conducting hazardous chemical procedures using Particularly Hazardous Substances (PHS) and other non-PHS hazardous chemicals, MUST develop and maintain written SOPs. Principal Investigators, Laboratory supervisors, and/or managers of those labs/facilities are responsible for providing written SOPs of hazardous chemical procedures for their laboratory personnel/staff. Researchers performing independent research or working autonomously are responsible for developing new SOPs or customizing existing SOPs appropriate to their work.

Particularly Hazardous Substances (PHS) defined by OSHA include chemicals that are "select carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity." In addition, the Wayne State University Chemical Safety Committee (WSU CSC) also considers some reactive materials, nanoparticles, and investigational chemicals with unknown hazards as PHS. The WSU CSC further classified PHS that possess extremely hazardous characteristics as "High Risk Chemicals". The following resources have been provided by WSU OEHS to assist with the SOP development:

- The "WSU Step by Step Guide on Standard Operating Procedures (SOPs) and Animal Hazard Agent Form II Chemical (AHAF II) requirements for Chemical Use in Research"
    - This guide can be used to identify:
        - Hazardous chemicals (high risk PHS, PHS and non-PHS hazardous) which require labs to develop and maintain written SOPs. These chemicals possess chemical hazards listed in Chapter 02 and other non-GHS chemical hazards.
        - The type of SOP (lab-specific or generic) and fact sheets to be used.
    - In addition, this guide provides guidelines to develop AHAF II forms as a means to communicate hazardous chemical information to the DLAR staff, who handle animals administered with hazardous chemicals.
- A template to draft lab-specific chemical SOPs
- Generic SOPs and fact sheets for hazardous chemical classes, specific chemicals, and laboratory equipment.

Prior to using the new lab-specific SOPs, PIs/Laboratory supervisors must:

- Ensure the SOP developed is adequate and provides sufficient guidance to laboratory personnel to maintain a safe workplace.
- Train laboratory personnel on applicable SOPs.
- Once training is complete, laboratory personnel must certify the training was received by signing the SOP(s).

SPECIAL PRECAUTIONS

Specific consideration shall be given to the following provisions which shall be included where appropriate:

- Establishment of designated storage and work areas;
- Use of containment devices such as CFHs or glove boxes;
- Procedures for the safe removal of contaminated waste; and
- Decontamination procedures.

In addition, laboratory personnel must consult with the PI/laboratory supervisor on special precautions for hazardous chemical procedures involving:

- PHS and other non-PHS which are highly reactive chemicals (e.g., explosives)
- Procedural changes, significantly increase the hazards associated with the existing procedure detailed in the SOP. This includes scaling up of the procedure, change in experimental conditions, or introduction of highly hazardous chemicals.
- Unattended operations. Potential malfunctions of the unattended procedure (e.g. power outage, high pressure/temperature generations, chemical spills) may result in significant chemical hazards that affect the laboratory facility and personnel.
- Working alone in the laboratory during afterhours/ weekends or holidays.

CHEMICAL HANDLING

To establish a safe environment, chemicals purchased/produced by labs must be labeled, segregated, stored, inventoried, used, and disposed of properly. Such practices will avoid confusion or mistaken identity of a chemical, provide separation of incompatible materials to prevent spontaneous chemical reactions (which may result in a fire, explosions, toxic fumes, etc.), and provide information for emergency response personnel.

CHEMICAL PROCUREMENT

WSU facilities (i.e., research, teaching, and other non-research facilities) purchasing a chemical assume responsibility for that chemical. When a chemical is purchased and before it is used, information on proper handling, storage, and disposal should be made known to those who will be working with the chemical. If a safety data sheet (SDS) accompanies the purchase, it must be kept on file in the laboratory.

Prior to purchasing a chemical, the purchaser must consider the following:

- Has the purchase been reviewed to ensure that any special requirements (e.g., licenses) can be met?
- Is the material already available on campus?
- What is the minimum quantity that will suffice for the current use?
    - The potential savings when buying in bulk are often outweighed by storage space limitations, chemical expiration date (where applicable), and the disposal cost for excess chemicals.
- What is the maximum size container or overall quantity allowed in the location where the chemical will be used and/or stored?
    - Contact OEHS for assistance in determining maximum quantities.
- Can the chemical be safely stored when it arrives? Is any required special storage available, such as explosion proof refrigerator or inert/dry storage cabinet? Will arrangements need to be made to notify someone as soon as the chemical arrives?
- Is the proper PPE available to handle the chemical?
- What are the engineering controls (e.g., chemical fume hood, glove box, etc.) required for safe handling of the chemical, and are such devices available?
- Has an SOP been developed that addresses proper handling, storage, and disposal of the chemical?
- Are there special containment or emergency response considerations in the event of a spill, fire, or flood?

Whenever possible, all chemical shipments must be received and logged-in at designated departmental locations (such as Science Stores, Purchasing, etc.) where someone is available to accept the delivery.

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

- Be aware of the chemical labeling system (e.g. hazards and storage conditions) and must be able to identify the chemical.
- 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.

Procurement of Controlled Substances: Due to their potential for misuse and abuse, scheduled drugs (controlled substances) listed by the US Department of Justice, Drug Enforcement Administration (DEA) and/or the Michigan Department of Licensing and Regulatory Affairs (LARA), are subject to strict regulation. These rules prevent the

diversion of controlled substances through various administrative and physical controls, including special procurement, storage, use, and disposal requirements.

It is the responsibility of individual researchers and staff ordering and using these materials to obtain appropriate registrations and licenses. Researchers must obtain federal and state licensing (prior to procurement), maintain detailed storage and use records, and follow proper disposal procedures. For more information refer to the WSU Controlled Substances Program.

LABELING

Chemical labeling is a key method to communicate hazardous chemical information to other users (i.e., possible chemical exposure groups and other personnel who may be at risk of exposure). Every chemical must be properly labeled and contain the following information:

- Product Identifier - How the hazardous chemical is identified. This can be (but is not limited to) the chemical name, code number, or batch number. The same product identifier must be both on the label and in section 1 of the SDS.
- Signal Word - Indicate the relative level of severity of the hazard and alert the reader to a potential hazard on the label. There are only two words used as signal words, "Danger" and "Warning." Within a specific hazard class, "Danger" is used for the more severe hazards and "Warning" is used for the less severe hazards. There will only be one signal word on the label no matter how many hazards a chemical may have. If one of the hazards warrants a "Danger" signal word and another warrants the signal word "Warning," then only "Danger" should appear on the label.
- Hazard Statement(s) - Describe the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard. For example: "Causes damage to kidneys through prolonged or repeated exposure when absorbed through the skin." All of the applicable hazard statements must appear on the label. Hazard statements may be combined where appropriate to reduce redundancies and improve readability. The hazard statements are specific to the hazard classification categories, and chemical users should always see the same statement for the same hazards no matter what the chemical is or who produces it.
- Precautionary Statement(s) – Describe the 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 a well-ventilated space.
- GHS Pictogram(s) - Convey specific information about the hazards of a chemical. Each pictogram consists of a different symbol on a white background within a red square frame set on a point. All pictograms are diamond-shaped with a red border and black image.
- Name, address, and telephone number of the chemical manufacturer, importer, or other responsible party.
- Labels must remain on all containers and must not be defaced in any way.

- Each container should be labeled with the date it was produced in the lab, received from the manufacturer, and/or first opened. Peroxide-forming chemicals must be labeled with the date received, and date opened.
- Expiration dates must be clearly marked for materials known to deteriorate or to become unstable or reactive, including:
    - Picrics originating at less than 10% hydration.
    - Perchlorates
    - Peroxides
    - Peroxidizable materials
    - Polymerizes that react violently or become hazardous after polymerization.
- Labels must be legible, in English, and prominently displayed.
- 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, primary health and/or physical hazard(s) and the expiration date if applicable. Labels can be handwritten or printed.
- Working containers (such as spray bottles) must be labeled with the identity of the substance and appropriate hazard warnings.

SEGREGATION AND STORAGE

Proper chemical segregation and storage are essential for a safe work environment. Inappropriate storage of incompatible or unknown chemicals can lead to spontaneous and hazardous chemical reactions (e.g., fire, explosions, release of toxic gases, etc.).

Prior to working with chemicals, training on proper chemical segregation and storage must be provided. The chemical segregation and storage procedures listed below are not intended to be all-inclusive but should serve, instead, to supplement more specific procedures and recommendations obtained from container labels, Safety Data Sheets (SDSs), and other chemical reference material. For more information about chemical segregation and storage contact the Office of Environmental Health and Safety (313) 577-1200.

STORAGE GUIDELINES

- Chemical storage rooms should be posted with appropriate signage, have controlled access, and fire suppression systems.
- All chemicals should be stored in approved, labeled storage cabinets/containers by compatibility and not alphabetically. Refer to the chemical segregation flow chart for general guidelines on chemical storage by compatibility. Refer to EPA'S Chemical Compatibility Chart EPA's Chemical Compatibility Chart for more information on incompatible chemicals.
- Storage areas should be cool, dry, ventilated, well-lit, and away from direct heat and sunlight.
- Avoid storing chemicals on bench tops, in CFHs, on the floor, in the aisles, in hallways, or near exits.
- Do not store more chemicals than necessary. Store only those amounts that will be used in a reasonable amount of time.
- Controlled Substances must be stored in a securely locked, substantially constructed cabinet, located where access is limited to those individuals with controlled substances authorization.

- Stored chemicals must be examined periodically (at least annually) for deterioration and container integrity. Dated chemicals must be disposed of on or before expiration based on SDS information.
- 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, floor, or benchtop.
- Do not store liquid chemicals above eye level.
- Do not store chemicals within 18 inches of sprinkler heads.
- Use secondary containment devices (e.g., chemical-resistant trays) where appropriate.
- Chemical, biological, or radiological materials must be placed in compatible secondary containers to be safely transported between areas of use (e.g. labs) or from the chemical stock room.

FLAMMABLE LIQUIDS

Flammable liquids are required to be stored in either:

- Flammable liquid storage cabinets that are either UL 1275 rated or FM Class #6050 approved and meet the National Fire Protection Association (NFPA) and MIOSHA Flammable Liquids specifications.

Or

- Flammable liquid storage rooms meeting MIOSHA Flammable Liquids requirements. MIOSHA's requirements include fire-resistant rated walls, ventilation, dikes, explosion-proof lighting, intrinsically safe wiring, and 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. Do not store flammable chemicals next to exit doors. Consult OEHS or WSU Fire Marshall (313 577-3110) for assistance, if needed.

Only laboratory-grade flammable liquid storage or explosion-proof refrigerators and freezers may be used to store properly sealed and labeled flammable or explosive 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 as these possess ignition sources which can cause dangerous and costly laboratory fires and explosions.

Refer to the Fire Safety Fact Sheets for more information on proper storage and handling of flammable liquids.

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 (e.g., perchloric acid, nitric acid, chromic acid, and hydrogen peroxide) are even explosive in contact with organic materials.

TOXIC AND POISONOUS MATERIALS

Store in isolated areas. Do not store with acids or flammable materials. The laboratory must provide one additional layer of physical security for highly dangerous acute toxins (e.g., secured within a locked freezer, or secured within a permanently fixed lock box).

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. Cryogenic liquids are not permitted to be stored in environmental rooms (e.g., cold or warm rooms). The liquid form of cryogenic gases will instantly cause cold-contact burns to live tissue upon contact.

Refer to the Physical Hazard Fact Sheets for more information on proper storage and handling of Cryogenic Liquefied Gases.

WATER REACTIVE COMPOUNDS

Store in an isolated dry location (e.g., in a desiccator, dry box, or glove box) away from any water sources (including moisture and humidity)

PYROPHORIC COMPOUNDS

Store in an isolated location under nitrogen or other appropriate storage method specified by 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 the storage and handling of peroxides, see the Chemical hazard Fact Sheets for more information on Peroxides and Peroxide Forming Chemicals.

SPECIAL CHEMICALS KNOWN TO DETERIORATE, EXPLODE, OR BECOME UNSTABLE OR REACTIVE.

- 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 temperature-sensitive 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 as they may become explosive when mixed.
    - Examples include silver perchlorate, ammonium perchlorate, sodium perchlorate, and potassium perchlorate. Organic perchlorates like methyl perchlorate are self-contained explosives.

CONTROLLED SUBSTANCES

Must be inventoried and stored in a securely locked, substantially constructed cabinet, located where access is limited to those individuals with controlled substances authorization.

Due to the responsibilities associated with the acquisition, administration, and storage of controlled substances, WSU requires that all individuals conducting research with controlled substances be appropriately licensed with the State of Michigan and registered with the Drug Enforcement Administration (DEA).

For more information, refer to the WSU Controlled Substances Program

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 to prevent it 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, lockers, and environmental rooms 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 flammable 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. For more information on Compressed gas safety, refer to Physical Hazard Fact Sheets.

CHEMICAL INVENTORY

Managers and supervisors are responsible for maintaining an up-to-date inventory of chemicals (including gases) stored, used, or produced within each laboratory/facility that is under their responsibility.

OEHS provides a Laboratory Chemical Inventory Form for laboratories to develop and maintain their chemical inventory. All WSU labs and other facilities using chemicals, except those taking part in the CHIMERA chemical tracking system, will be required to use the Laboratory Chemical Inventory Form to complete the chemical inventory. The chemical inventory must be updated on an annual basis, or more often if warranted, and an updated copy must be submitted annually to OEHS. WSU labs/facilities must also produce updated inventory records at the request of regulatory agencies or the Chemical Hygiene Officer.

The laboratory's chemical list/inventory will include the following elements:

- Common product or chemical name.
- CAS number.
- Approximate amount in each container.
- Room number and building name.
- Storage area or cabinet (storage location within the room).
- Date of inventory should be included in the file name.

There are many benefits of performing annual chemical inventory reviews and updates, including:

- Use of the inventory to find needed chemicals.
- Avoid unnecessary redundant purchases.
- 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 and other materials known to deteriorate or to become unstable or reactive.
- Ensures integrity of shelving and storage cabinets.
- Encourages Principal Investigators/laboratory supervisors and building managers 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.

Important safety issues to consider when performing an inventory review and update are:

- Wear appropriate PPE.
- Use a chemical cart with side rails and secondary containment.
- Know where the safety shower and emergency eyewash are located.
- If necessary, cease all other work in the laboratory while performing the review.

CHEMICAL TRANSPORT

It is prudent practice to use a compatible secondary containment device (e.g., 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 appropriate secondary containers to contain a spill that may occur. Bottles of liquids should be separated or secured to avoid breakage and spills. Gas cylinders should be capped during transport and when not in use. Cylinders should be transported using a secure gas cylinder dolly.

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.

For more information on chemical transportation refer to Transportation of Research Chemicals on the WSU Campus.

TRANSFERRING CHEMICALS BETWEEN CONTAINERS

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

- The material is not used within the work shift of the individual who makes the transfer.
    - Labels on receiving containers are not required if the worker who made the transfer uses all of the contents during the work shift and the container is not left unattended by the worker.
- The worker who made the transfer leaves the work area.

- Check chemical compatibility with original container content or container material to verify that chemical storage is appropriate.

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

- Wear appropriate PPE based on the type of material being transferred.
- Make sure that the large container is stable and, in your control, if you are lifting it to pour the 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. Follow grounding and bonding procedures to safely transfer flammable liquids.
- Use a properly operating chemical fume hood, local exhaust, or adequate ventilation when transferring chemicals.
- Whenever possible use a hand pump or siphon to transfer liquids, rather than pouring.

SHIPPING HAZARDOUS MATERIALS AND DRY ICE

Shipment of hazardous research materials is regulated by the Department of Transportation (DOT) 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 the marking/labeling on the parcel is not complete.

OEHS provides guidance, training, and services on shipping containers with dry ice, and domestic and international shipments of hazardous materials. If chemically hazardous materials need to be shipped by a research organization on campus, OEHS should be contacted.

Refer to the OEHS website on "Shipping Dangerous Goods" for more information.

HAZARDOUS CHEMICAL WASTE MANAGEMENT

According to U.S. Environmental Protection Agency (EPA) hazardous waste is simply defined as "a waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste is generated from many sources, ranging from industrial manufacturing process wastes to batteries, and may come in many forms, including liquids, solids gases, and sludge".

In regulatory terms, as defined by the Resource Conservation and Recovery Act (RCRA), waste is hazardous if it is specifically listed as a known hazardous waste or meets the characteristics of hazardous waste. Hazardous waste may meet one or more of the following criteria:

- P- or U-list – pure and commercial grade formulations of certain unused chemicals that are being disposed.
- K-list – hazardous waste from specific sectors of industry and manufacturing and are considered source-specific wastes.
- F-list – waste from common hazardous manufacturing and industrial processes.
- Materials exhibiting hazardous characteristics.
    - Ignitability
    - Corrosivity
    - Reactivity
    - Toxicity

Chemicals not in frequent use must be carefully managed to prevent them from being considered hazardous waste. This is especially true for certain compounds that degrade and destabilize over time and require careful management so that they do not become a safety hazard.

HAZARDOUS WASTE MANAGEMENT (HWM) PROGRAM

WSU OEHS conducts the hazardous waste management program to:

- Ensure that minimal harm to people, other organisms, and the environment will result from the disposal of hazardous waste by WSU laboratories and other facilities,
- Ensure compliance with all applicable local, state, and federal waste disposal regulations.

The university requires all hazardous waste (chemical, biological, radioactive, pharmaceutical, and universal) to be disposed of through OEHS hazardous waste management program.

In addition to hazardous waste pickup, the OEHS HWM program 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 hazardous waste.
- Electronic Waste (E-Waste) Disposal Program
- Emergency response to hazardous material spills
- Technical advice and training on emergency response to spills
- Laboratory cleanouts.
- Waste disposal supplies.

- WSU Recycling program.
- Asbestos Management Program

CHEMICAL WASTE MANAGEMENT

All personnel who are responsible for handling, managing or disposing of hazardous waste are required to complete Laboratory Safety Training which includes training for proper management of hazardous chemical waste.

WASTE CHARACTERIZATION

Laboratory personnel must identify the constituents of the chemical waste generated and the associated chemical waste incompatibilities chemical waste incompatibility. For each waste container generated, this step is essential to avoid mixing incompatible waste, which may result in violent chemical reactions. Such vigorous reactions may rupture containers and explode, resulting in serious injury and property damage, a common cause of laboratory accidents.

The following guidelines may help to properly characterize laboratory chemical waste:

1. Review of chemical SDS to identify chemical properties and incompatibles of the chemicals used in an experimental protocol.
2. Carefully document and review all chemical reactants used, and waste byproducts formed in the experimental protocol.
3. Waste streams that have ingredients listed as proprietary information should be discussed with the Hazardous Waste Manager.
4. For uncertainty about the composition of waste generated from an experimental process, laboratory personnel must consult the PI/Laboratory Supervisor, the Chemical Hygiene Officer, or the Hazardous Waste Manager.

WASTE COLLECTION AND SEGREGATION

When collecting waste, do not mix incompatible waste materials in the same waste container (e.g., do not mix acids and solvent waste). Please note, that OEHS does not permit drain disposal of chemical wastes unless a specific dilution and/or neutralization method for a consistent waste stream has been reviewed and approved by the OEHS waste management group. Drain disposal of biohazardous liquids disinfected with 10% bleach for a minimum of 30 minutes is acceptable if the liquids contain no other hazardous constituents. Disinfection with any other disinfectant requires disposal as hazardous chemical waste. Waste must not be evaporated through a CFH or on the open bench.

Segregation of chemical waste streams should be conducted in a similar manner to segregation of chemical products. Whenever possible, keep different hazardous chemical waste streams separate so that disposal options are clearer and more cost-effective. If this is not possible, collect waste in compatible containers segregated into these categories:

- Halogenated solvents (e.g., methylene chloride, chloroform, carbon tetrachloride)
- Non-halogenated solvents (e.g., xylene, toluene, acetone, alcohols)
- Acids
- Bases
- Heavy Metals

- Special Wastes: collect separately (e.g., cyanide, sulfide, oxidizers, organic acids, explosives, peroxides)
- Waste Oil: whenever possible do not mix with solvents, PCB's, etc.

WASTE STORAGE CONTAINERS

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

When choosing chemical waste storage containers:

- Select containers in good condition (free of defects, cracks, rust, etc.) and have leak-proof lids.
- Check compatibility of the waste container with the waste in them
- Use containers that originally held liquids to store liquid waste and containers that held solids to store solid waste.
- Collect organic wastes in empty organic solvent containers.
- Collect inorganic (acid/base) wastes in empty inorganic containers.
- Secure lids tightly and store flammable waste in a flammable cabinet or on shelves.
- Do not store bottles on the floor or in the hallway! Place containers in secondary containers.
- Use SHARPS containers for disposal of chemically contaminated sharps. Dispose of SHARPS containers when about 2/3rd full or within 90 days, whichever is sooner. Do not recap the needles after use. Recapping could lead to serious needle stick injuries. Discard them directly into the designated rigid sharps container. Post a caution note near the sharps disposal container stating, "Do not recap the needles after use. Discard them directly into the sharps containers".

Chemical waste containers are available to labs free of charge through OEHS upon completing the Chemical Waste Pick-up and New Container Request Form.

LABELING

Label waste containers correctly and completely with chemical content waste tags. Waste tags can be obtained from OEHS upon completion of the Chemical Waste Pick-up and New Container Request Form. Waste tags must be completed and attached to the waste container from the initial time of accumulation.

When completing waste tags:

- Fill out & attach waste tags to bottles/containers as soon as you begin to collect waste in it. The tag must include:
  - Date when personnel began adding waste to the container.
  - Complete the chemical name of each chemical in English. NO FORMULAS OR ABBREVIATIONS!
  - Estimated percentage of each chemical present in the container.
  - Identify and Circle Hazardous Characteristic(s).
- Update the tag immediately when a new constituent is added to a waste container so that others in the laboratory will be aware and manage it accordingly.

- Make sure each tag is completely filled out before waste is picked up.
- OEHS staff may refuse to collect waste that has been improperly collected, labeled, or stored.

STORAGE

Satellite accumulation areas (SAAs) are required to restrict accumulating hazardous waste on-site to 90 days from the day the hazardous waste was first placed into the waste container. To ensure your waste will be removed before the 90-day time limit, please submit an online request for chemical waste pick-up when your container is full or if you are approaching 60 days at https://research.wayne.edu/oehs/forms/chem-waste.

To help ensure chemical waste is removed from laboratories within 90 days, smaller-sized waste containers will be available. We also encourage using recycled containers that are compatible with the waste stream being collected.

Other SAA requirements include:

- Collect all chemical waste in appropriate receptacles with attached waste tags.
- Constituents within each waste stream must be compatible and must be stored in compatible waste containers.
- When chemical waste is first added to a container, a waste tag with a start date must be placed on the container. Chemical waste containers and waste tags are available from OEHS.
- Waste must be collected and stored at or near the point of generation.
- The maximum amount of waste that can be stored in an SAA is 55 gallons of non-acute hazardous waste or either 1 quart (0.96 liters) of liquid acute hazardous waste or severely toxic hazardous waste or 1 kilogram of solid acute hazardous waste or severely toxic waste in containers at or near any point of generation where wastes initially accumulate and that is under the control of the operator of the process that generates the waste. If a lab reaches these volumes for a specific waste stream, the lab must dispose of the waste within 3 days.
- All hazardous waste containers in the laboratory must be kept closed when not in use.
- Hazardous liquid waste containers must be stored in secondary containment at all times, irrespective of where they are being stored.

MANAGING EMPTY CHEMICAL CONTAINERS

- Empty containers that hold Extremely Hazardous waste (e.g., original containers) must be managed as hazardous waste and placed in a solid hazardous waste container. Do not rinse or reuse these containers.
- All other empty chemical containers, if less than or equal to 5 gallons in size, should either be properly cleaned and reused for hazardous waste collection, or be cleaned and discarded in the trash or in plastic-lined cardboard boxes designated for non-contaminated glass, or recycled. Proper cleaning involves triple-rinsing the container, with the rinse liquid collected as hazardous waste.
    - When reusing containers, the original/previous labels should be completely defaced or covered up.

TRANSPORTATION

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

the point of generation until collected for disposal by the OEHS waste management group. OEHS provides routine waste removal services for all generated research wastes throughout the campus.

BENCH TOP TREATMENT

Due to the stringent nature of these requirements, any treatment of hazardous chemical waste in labs must be reviewed and approved by OEHS.

HANDLING OF SPECIAL WASTE

UNKNOWNS

Unlabeled chemical containers and unknown/unlabeled wastes are considered unknowns and incur an additional cost to have these materials analyzed and identified. These containers must be labeled with the word “unknown” on both the container and waste tag. Never mix unknowns for any reason.

PEROXIDE FORMING CHEMICALS

- Peroxide forming chemicals (PFCs) include several substances that can react to shock, spark, heat, or friction; react with air, moisture, or product impurities; and undergo a change in their chemical composition during prolonged storage. Peroxides are not particularly volatile and thus tend to precipitate out of liquid solutions. It is particularly dangerous to allow a container of these materials to evaporate to dryness, leaving crystals of peroxide on the surfaces of the container. There are four classes of peroxide-forming chemicals, with each class having different management guidelines. See the Peroxides and Peroxide Forming Chemicals fact sheet for more information.
- Each container of peroxide-forming chemicals should be marked with the date received and the date first opened in order to track when the chemical expires. Ensure containers of PFCs are kept tightly sealed to avoid unnecessary evaporation, as this inhibits the stabilizers that are sometimes added and may lead to dangerous crystallization in the container. Visually inspect containers periodically to ensure that they are free of exterior contamination or crystallization. PFC containers must be disposed of prior to the expiration date.
- If expired containers of peroxide-forming chemicals are discovered in the laboratory, or if the date of the container is unknown, do not handle the container. If crystallization is present in or on the exterior of a container, do not handle the container. Restrict access to the container and contact the OEHS (313) 577-1200 for pick-up and disposal.
- Restrict access to the container and contact the OEHS (313) 577-1200 for pick-up and disposal.

DRY PICRIC ACID

- Picric acid (also known as trinitrophenol) must be kept hydrated at all times, as it becomes increasingly unstable as it loses water content. When dehydrated, it is not only explosive but also sensitive to shock, heat, and friction.
- Picric acid is highly reactive with a wide variety of compounds (including many metals) and is extremely susceptible to the formation of picrate salts.
- Be sure to label all containers that contain picric acid with the date received and monitor water content at least quarterly.
- Add distilled water as needed to maintain a consistent liquid volume. More information on Picric Acid including a document monitoring usage, can be found in the Chemical Hazard Fact Sheets.

- If an old or previously unaccounted for bottle of picric acid is discovered, **do not touch the container**. Depending on how long the bottle has been abandoned and the state of the product inside, even a minor disturbance could be dangerous.
    - Visually inspect the contents of the bottle without moving it to evaluate its water content and look for signs of crystallization inside the bottle and around the lid.
    - If there is even the slightest indication of crystallization, signs of evaporation, or the formation of solids in the bottle, **do not handle the container** and contact the OEHS immediately at 313 577-1200.
    - **Secure the area and restrict access to the container** until it can be evaluated by OEHS personnel.

EXPLOSIVES AND COMPOUNDS WITH SHIPPING RESTRICTIONS

A variety of other compounds that are classified as explosives or are water or air-reactive are used in research laboratories. These compounds often have shipping restrictions and special packaging requirements. When disposing of explosive and highly reactive material waste, those must be packaged individually and stored separately from each other. Contact OEHS for a special pickup of these items.

MERCURY

Keep Mercury compounds and other materials contaminated with mercury separate from all other wastes and label properly.

POLYCHLORINATED BIPHENYLS (PCB)

Keep PCB and other PCB-contaminated materials separate from all other wastes.

PHARMACEUTICAL WASTE

- Pharmaceuticals are drugs that are used to treat human and animal ailments. Some pharmaceuticals are toxic (e.g., chemotherapy agents) while others cause more limited physiological changes.
- Unused pharmaceuticals may not readily break down after release into the environment and can be absorbed by plants, animals, and/or humans.
- All unusable prescription or non-prescription pharmaceuticals and pharmaceutical compounds must be disposed of through the OEHS waste management group as chemical waste.
- Refer to the OEHS web page on Pharmaceutical Waste for more information.

UNIVERSAL WASTE

Fluorescent bulbs, batteries, computers, aerosols, and more fall into a hazardous waste category called "Universal Waste". The Universal Waste collection program is designed to divert mercury-bearing wastes into recycling programs. All of these materials, if disposed of in the trash, are considered hazardous waste by state and federal regulatory agencies. It is also more environmentally sound and cost-effective to recycle than to dispose of these items as regular solid waste. For more information refer to the WSU Universal Waste Disposal Program.

HAZARDOUS WASTE MINIMIZATION

Administrative controls (purchasing and inventory controls) and operational controls can be implemented to reduce hazardous waste generation and is essential to reduce the costs, health hazards, and environmental impacts associated with hazardous waste disposal.

- Administrative Controls:

- Purchasing
  - Check the laboratory chemical inventory before new products are ordered. When ordering chemicals, be aware of any properties that may preclude long term storage, and order only exact volumes to be used. Using suppliers who can provide quick delivery of small quantities can assist with reducing surplus chemical inventory. Consider establishing a centralized purchasing program to monitor chemical purchases and avoid duplicate orders.
- Inventory
  - Rotate chemical stock to keep chemicals from becoming outdated. Locate surplus/unused chemicals and attempt to redistribute these to other users or investigate returning unused chemicals to the vendor.
  - Keep chemical inventories up to date by adding and removing chemicals as they are purchased and used up.
  - An updated chemical inventory is required to be submitted annually to OEHS.

- Operational Controls
  - Review your experimental protocol to ensure that chemical usage is minimized. Reduce total volumes used in experiments; employ small-scale procedures when possible.
  - Instead of wet chemical techniques, use instrumental methods, as these generally require smaller quantities of chemicals.
  - Evaluate the costs and benefits of off-site analytical services. Avoid mixing hazardous and non-hazardous waste streams. Distill and reuse solvents if possible.
  - Spent solvents can also be used for initial cleaning, using fresh solvent only for final rinse. Use less hazardous or non-hazardous substitutes when feasible. Some examples include:
    - Specialty detergents can be substituted for sulfuric acid/chromic acid cleaning solutions.
    - Gel Green and Gel Red are recommended in place of ethidium bromide.

SAFETY DATA SHEETS (SDSS)

SDSs must be readily available to laboratory personnel. Laboratory personnel need to be knowledgeable on how to access SDS either as a hard copy in the laboratory or from an Internet source. Copies of SDSs for highly hazardous materials being used in the lab should be kept in the lab with the Chemical Hygiene Plan and the written Laboratory Specific Standard Operating Procedure (SOP) involving the chemical.

GHS requires the standardization of the SDS format, and the minimum information required for an SDS includes:

1. Identification of the substance or mixture and the supplier.
2. Hazards identification
3. Composition/information on ingredients
4. First aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information including information on the preparation and revision of the SDS

In the event that SDS information is incomplete, or in cases where the chemical is generated by the laboratory itself, additional information may be necessary and must be provided before the operation begins.

In addition to SDSs and chemical labels, references on chemical hazards, signs and symptoms of exposure, safe handling, storage, and disposal of hazardous chemicals are available from various other resources, including but not limited to the following:

- PubChem
- Haz-Map
- Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards
- National Library of Medicine, National Institutes of Health
- Pocket Guide to Chemical Hazards distributed by the National Institute of Occupational Safety and Health (NIOSH).

PROGRAM TRAINING

The Principal Investigator/Manager/Supervisor must inform personnel of the location and availability of the WSU Chemical Hygiene Plan (CHP). The CHP fulfills the regulatory requirement and is a resource on how to identify the hazards of chemicals and associated laboratory operations.

Any chemical hazard information beyond those covered in the CHP must be addressed by the Principal Investigator/Supervisor in the form of lab specific SOPs, generic SOPs, fact sheets or guidelines and lab specific training which must be documented in their laboratory safety binder. WSU OEHS developed many fact sheets and generic SOPs, some of which can be found at the following links:

- Laboratory Safety
- Chemical Safety Fact Sheets
- Standard Operating Procedures (SOPs) for Hazardous Chemicals

SAFETY MEETINGS/DISCUSSIONS

It is recommended that brief, but effective, discussions are conducted on basic safety topics as part of these or other regular meetings. When requested, an OEHS representative can attend those meetings to discuss specific safety topics.

The following is a list of safety topics with suggested talking points for discussion:

- Introduction
    - Read through the entire online CHP and review lab-specific SOPs. Determine lab location for safety documents so that they 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 SOPs. Discuss any related questions, such as: Do you have the type(s) 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 and safety duties properly assigned within your lab(s)? Are people properly performing their assigned duties in your lab(s)?
        - Note: Ultimate responsibility resides with the Principal Investigator/Manager/Supervisor.
- 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
    - Annually review and update the Chemical Inventory for your laboratory. Properly dispose of unused or expired chemicals.
- Waste Disposal Program
    - Review the WSU OEHS Waste Handling Procedures in chapter 6.0 of the CHP. Discuss and answer

any related questions. Is waste being properly managed in your lab(s)? Do you have unusual waste disposal problems? Are wastes being adequately labeled? For compliance with WSU OEHS hazardous waste management requirements, 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 lab waste.

- Chemical Procurement, Distribution, and Storage
  - Discuss current chemical storage practices. Develop lab-specific procedures for chemical procurement, distribution, and storage.
- Highly Hazardous Procedures or Substances
  - Discuss the use of highly hazardous materials (e.g., hydrofluoric acid, peroxide forming chemicals) in the lab or how to get rid of old peroxide formers. Set aside a specific area for the use of highly toxic materials. Develop lab-specific procedures for highly hazardous substances and/or 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?
- Working with Special Equipment
  - Discuss electrical safety. Are electrical cords damaged? Are gas cylinders properly secured, valve protection caps on, empty or unused cylinders set for pickup? Schedule a refrigerator/freezer cleanout. Develop procedures for the safe management of any lab-specific equipment. Review previous incidents using the equipment and develop ways to prevent another incident.
- Personal Protective Equipment (PPE) and Engineering Controls
  - Discuss when safety glasses, goggles, or face shields are required. Discuss any need for respirators. Discuss CFH and glove box use.
- Housekeeping, Maintenance, and Inspections
  - Discuss proper management of materials/equipment stored or frequently present on the floor. Identify emergency exits. Discuss maintenance items. Develop any related, lab-specific procedures.
- Environmental Monitoring
  - Discuss applicable exposure limits 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. If required, in conjunction with OEHS, develop any lab-specific procedures for environmental monitoring as needed.
- Occupational Health Program
  - Discuss the need for any exposure monitoring. Discuss lab-specific injuries, how when, and to whom to report during an injury/emergency. Is the health of each employee working with hazardous materials being adequately monitored?

- Training Program
    - Have employees attended appropriate Departmental and/or OEHS training sessions? Develop and document internal training. Are workers reading, understanding, and following SDS precautions? Are signs and labels properly posted? Are training 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.

SAFETY TRAINING

A comprehensive training program is the single most important aspect of employee protection. The aim of the institutional training program is to ensure that all individuals at risk are adequately informed about the operations and substances in their laboratory, their risks, and the proper precautions to take to protect their safety and health in the laboratory.

All employees must be trained at the time of initial assignment, prior to the use of a hazardous material or procedure, and when changes occur to procedures or equipment. The need and frequency of refresher training of lab-specific procedures shall be determined by the Principal Investigator/Laboratory supervisor.

WSU OEHS Health & Safety Training program provides both in-person (classroom) or online safety training (initial and/or annual refresher training) in various safety areas including but not limited to chemical safety (more information below), biological safety, radiation safety, laser safety, and laboratory animal safety.

Laboratory safety training is provided online through the Collaborative Institutional Training Initiative (CITI). It is required for all faculty, staff, and students working in WSU laboratories before beginning work in the lab and as an annual refresher. The course includes general information on:

- Recognition of laboratory hazards.
- Lab chemical safety.
- Types of engineering controls and personal protective equipment.
- Hazardous waste disposal.
- Fire safety and emergency response procedures.

LAB SPECIFIC TRAINING

- In addition to the OEHS required training, each laboratory must set up and implement a Laboratory Specific. Training program to provide personnel with information on lab-specific policies and procedures associated with hazardous materials and processes.
- This training must cover necessary work practices, procedures, and policies to ensure that employees are protected from all potentially hazardous materials and procedures used in the lab.
- The training must be conducted by someone thoroughly knowledgeable of the lab-specific hazards and proper safety techniques.

- The lab trainer must provide laboratory personnel with lab-specific information and training at the time of their initial assignment to the laboratory, and before assignments involving new exposure situations, work with hazardous substances, and hazardous operations.
- Training must be documented, with laboratory personnel signing the Laboratory Specific Safety Training Checklist and relevant Laboratory Specific SOPs.
- Keep signed training documents in a designated area of the laboratory.

SAFETY TRAINING RECORDS

It is the responsibility of the Principal Investigator/Laboratory supervisor to make sure that all employees have completed the mandatory lab safety training provided by OEHS and required laboratory-specific training. The Principal Investigator/Laboratory supervisor must also maintain written verification of employee training. Up-to-date records of all OEHS required and lab-specific training, inspections, or related safety activities should be maintained in a designated area of the lab and should be maintained for 5 years past the end of employment.

WORK CONDUCTED AUTONOMOUSLY OR INDEPENDENTLY

The Laboratory Director/ Supervisors shall provide access to the online CHP and lab specific safety binder to persons working autonomously or performing independent research before they undertake work in WSU laboratories. Anyone working in WSU 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 WSU laboratories.

LABORATORY INSPECTIONS AND OTHER SERVICES

Laboratory inspections are implemented to safeguard the quality of the WSU laboratory safety program. These inspections ensure laboratory facilities and equipment are in a safe operating condition by identifying and addressing potential health and safety deficiencies. In addition, periodic inspections help to ensure all regulatory compliance requirements are being met.

CHEMICAL HYGIENE INSPECTIONS (CHIS) AND GENERAL LAB SAFETY INSPECTIONS (GLSIS)

WSU OEHS Chemical Safety Group conducts Chemical Hygiene Inspections (CHI) and/or General Lab Safety Inspections (GLSI) of WSU laboratories and other facilities. CHIs are geared towards WSU facilities conducting procedures with chemicals (wet labs) while GLSIs are conducted in both wet and dry labs which conduct procedures associated with nonchemical, mechanical, electrical, or theoretical in nature.

The primary goal of these inspections is to ensure that WSU facilities handling chemicals:

- Are in safe operating condition by identifying both existing and potential chemical and general lab safety deficiencies and implementing corrective actions.
- Maintain laboratory facilities and equipment in a safe, code-compliant operating condition in compliance with all federal, state, and university safety requirements.
- 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.

OEHS chemical and general safety inspections are comprehensive in nature, assessing key aspects of working with hazardous chemicals and associated general lab safety issues including but not limited to:

- General Laboratory Safety
- Personal Protective Equipment
- Emergency Response and Equipment
- Laboratory Fire Safety
- General Chemical Safety
- Chemical Segregation and Storage
- Chemical Fume Hood Safety
- Compressed and Cryogenic Gas Safety
- Hazardous Waste Management
- Laboratory Safety Training and Documentation

The typical CHI/GLSI cycle is composed of a four-step procedure:

- Step 1: Completion of a self-inspection by the laboratory personnel to identify chemical and general lab safety issues.
    - OEHS will provide the lab with a self-inspection checklist and required supporting documentation. Labs must return the completed checklist and other requested information to OEHS within the time frame provided by an OEHS chemical hygiene inspector.

- Step 2: A Chemical Hygiene Inspection to be conducted by an OEHS chemical hygiene inspector in conjunction with laboratory personnel and/or the Principal Investigator/Laboratory Supervisor.
    - OEHS chemical hygiene inspectors will review the self-inspection checklist and other requested information received from the lab (e.g., chemical inventory, photos of key areas, laboratory personnel comments/concerns, etc.).
    - Based on the information provided by the lab, the OEHS chemical hygiene inspector will conduct a more extensive inspection (in person or virtual), with focus on areas of concern and common problem areas found in labs across campus.
    - OEHS chemical hygiene inspectors will also provide education in safety topics where appropriate. Upon completion of the inspection, if any chemical/ general lab safety deficiencies were identified, chemical hygiene inspectors will provide the lab with a Corrective Action Plan (CAP), which lists the deficiencies identified, background information about the safety issues, and an overview of required corrective actions.
    - Laboratories are then required to outline the specific corrective actions that will be implemented, including actual or estimated corrective action completion dates, and return the signed corrective action plan to OEHS.
- Step 3: Chemical Hygiene spot check inspections to verify that laboratories have implemented the required corrective actions addressed during the chemical hygiene inspection (Step 2).
    - OEHS chemical hygiene inspectors will review the completed CAP and will conduct a follow-up spot check inspection (in person) to ensure the corrective actions have been implemented, are appropriate, and are effective.
- Step 4: Once the inspection cycle is completed for an individual lab, department, or building, OEHS will present the inspection findings and corrective actions taken via a Laboratory Inspection Report and/or a CHI presentation to the individual PIs/Laboratory supervisor, Department chair, or building coordinator.
    - The report/presentation identifies the number of different safety issues (chemical/general) and the corrective actions taken.
    - A copy of the most recently completed CAP (individual labs) or final Inspection Report should be maintained by labs/departments either electronically or as a physical copy that is easily accessible.

In addition to routine chemical and general lab safety inspections mentioned above, OEHS encourages laboratories and departmental safety coordinators to conduct their own program of periodic laboratory inspections using the Self-Inspection Checklist provided by the OEHS.

These forms contain commonly identified chemical and general lab safety issues. Regular self-inspections using either form will reduce the occurrence of issues and improve overall safety.

NOTIFICATION AND ACCOUNTABILITY

- PIs/Managers/Supervisors are responsible for providing timely responses throughout the chemical hygiene inspection process and taking appropriate and effective corrective actions upon written notification of inspection findings. The standard timeline to outline and implement corrective actions is 30 days.
- However, for serious chemical or general lab safety issues immediate corrective actions are required as notified by the chemical hygiene inspector. Serious issues are those that have the potential to lead to severe injuries, have a high likelihood of occurring, and/or be of critical importance in the event of an

emergency. These are typically required to be corrected within 24 -48 hours or according to the timeline specified by the chemical hygiene inspector.

- Failure to respond to the CHI notifications or implement the corrective actions listed in the CAP within the specified timeframe will result in a notification to the Department Authority and the WSU Chemical Safety Committee for adjudication under the WSU Laboratory Safety Compliance Procedure.

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 their credentials and contact OEHS at (313) 577-1200 immediately.

OEHS will take the lead on all applicable regulatory inspections/visits on behalf of WSU and will reach out to other WSU groups as required. If an inspector arrives on campus, please request that the individual(s) wait while you contact OEHS so that a member of the OEHS team can accompany them. The individual(s) should be directed to wait at a neutral location such as a lobby or main office.

OTHER CHEMICAL SAFETY SERVICES

In addition to conducting routine CHIs and GLSIs, OEHS provides other chemical safety relevant services for WSU research laboratories including, but not limited to, providing:

- Information, consultation, training, and educational services
- Annual performance verification checks on primary engineering controls such as Chemical Fume Hoods
- Laboratory commissioning and modification guidelines/ consulting
- Laboratory decommissioning and relocation guidelines and services
- Waste management services

Additional information on chemical safety services provided by WSU OEHS can be found at https://research.wayne.edu/oehs/chemical.

EMERGENCY RESPONSE PROCEDURES

Call WSU Police at 313-577-2222.
Do not call 911.

Laboratory emergencies can include events such as personnel injuries, fires, explosions, spills, hazard exposures, and natural disasters all of which require prompt action to prevent or reduce undesirable effects. All laboratory employees MUST be:

- Familiar with and aware of the location of their laboratory's emergency response plans and safety manuals.
- Able to Identify the location of safety equipment including first aid kits, eye wash stations, safety showers, fire extinguishers, fire alarm pull stations, and spill kits.
- Aware of the location of the closest fire alarms, emergency gas shut-off valves, exits, and telephones in your laboratory.
- Able to immediately take control of the situation and quickly assess the existing and potential hazards and carry out the appropriate response actions.

INJURIES/EXPOSURES REQUIRING MEDICAL ATTENTION

- Emergencies: Call WSU Police, report to Henry Ford Hospital-ER at 2799 W. Grand Blvd. or Detroit Receiving Hospital-ER at 4201 St. Antoine
- Non-emergencies during business hours M-F 8 AM to 4 PM: Henry Ford Harbortown Occupational Health, SUITE 100, 3300 E. Jefferson, 313-656-1618 (walk-in clinic)
- Non-emergencies after hours: Henry Ford Hospital-ER or Detroit Receiving-ER
- After seeking medical attention, complete and submit a Report of Injury form to Enterprise Risk Management & Insurance Programs, 313-577-3112, risk.wayne.edu

FIRES

- Pull the closest fire alarm pull station and exit the building.
- Call the Wayne State Police at 313-577-2222

HAZARDOUS MATERIAL SPILLS

WSU employees are not to engage in any emergency response operation unless they have received adequate training and have been approved by OEHS to participate in response operations.

- Emergency spills and after-hours incidents: Call WSU Police 313-577-2222.
- Non-emergency spills M-F 8:30 AM to 5:00 PM: Call WSU Office of Environmental Health & Safety at 313-577-1200.

EQUIPMENT FAILURE

- In the event of any failure/malfunction of a critical safety system (e.g., chemical fume hood, snorkel, biosafety cabinet, etc.), immediately perform the following actions, if it is safe to do so:

- Cease all hazardous operations (i.e., operations that generate toxic or hazardous fumes, gases, or vapors).
- Stop all chemical reactions, secure hazardous materials, terminate gas supply, and/or de-energize any electrical equipment in use.
- Close the sash where appropriate.
- Notify lab personnel and supervisor.
    - Post a notification if doing so will not compromise your safety.
- Report the failure to the appropriate parties:
    - Emergency
        - Wayne State Police at 313-577-2222.
    - Non-Emergency
        - FP&M
            - Building Integrated Ventilation Systems (e.g., chemical fume hood, Snorkel, etc.)
            - Eye Wash
            - Safety Showers
        - OEHS
            - Biosafety Cabinets

UTILITY OUTAGES

- In the event there is a utility (electrical, gas, ventilation, or water) outage to your laboratory space, it is important to properly evaluate/assess the situation in order to ensure the safety of the laboratory's occupants as well as others who may respond to the utility outage.
- If safe to do so, secure all applicable experiments that are, or maybe, be affected by the outage by unplugging or turning off non-essential electrical equipment (including ovens and hot plates), shutting off research gases and water, and fully closing all CFHs and biological safety cabinets.
- Also ensure that all chemical, biological, radioactive materials and hazardous waste containers are properly covered and sealed.
- Keep refrigerators and freezers closed throughout the outage to help keep contents cold.
- After the laboratory has been secured, vacate the laboratory and report the utility outage to the building coordinator or Facilities Planning & Management (FP&M) at 313 577-4315.

EMERGENCY EVACUATION

Immediate evacuation of your laboratory space may be required during a fire, severe weather event, utility outage, or other type of emergency. When informed you must evacuate by following 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 WSU building.

If safe to do so, take the following actions as you leave:

- Stop all reactions, chemical processes, etc.
- Unplug or turn off non-essential electrical equipment (including ovens & hot plates)
- Shut off research gases and water.
- Fully close all CFHs and biological safety cabinets
- Ensure all chemical, biological, radioactive materials and hazardous waste containers are properly covered and sealed.
- Securely close all refrigerators and freezers

Inform emergency responders of any processes, experiments, or equipment still in operation that may pose a threat to health, property, or the environment.

LABORATORY SAFETY EQUIPMENT

All WSU laboratories and other facilities handling hazardous materials must be familiar with the location and proper use of all laboratory safety equipment. This equipment, including, but not limited to eyewash, safety shower, fire extinguisher, first-aid kit, fire blanket, emergency telephone, and fire alarm stations, must be visible, unobstructed, and readily accessible.

SAFETY SHOWERS AND EYEWASH STATIONS

All laboratories using injurious or corrosive substances must have immediate access to safety showers and eyewash stations, which are on the same level as the hazard (i.e., the same floor). This applies to all substances based on the following GHS classifications:

Skin Corrosion (GHS hazard category 1A, 1B, 1C)

Serious Eye Damage/Eye Irritation (GHS hazard Category 1 and 2A)

Travel paths to the equipment must remain unobstructed and access routes must be kept clear. Access must be available within 10 seconds (roughly 55 feet) or less of an operation where personnel are at risk of exposure. Regular testing is required to ensure the eyewash and/or safety shower remains free of microbial growth and is functioning correctly.

- Eyewash Stations
    - If the water supply is interrupted, research and teaching labs must immediately stop working with hazardous materials. Without water, safety showers and eyewashes wouldn't work in an emergency.
    - Contact OEHS (7-1200) for assistance with evaluating eyewash installation options.
    - Clear the area surrounding the eyewash of any obstructions (e.g., cleaning agents, glass wear).
    - If the eyes have been exposed to a chemical or other hazardous material,
        - Remove gloves.
        - Activate the eyewash.
        - Hold eyelids open with thumb and index finger and direct water flow into eyes. If an exposed individual is unable to perform this step, assistance needs to be provided by a coworker.
        - Remove contact lenses while flushing eyes.

        - Do not be concerned about water on yourself or on the floor.
        - Do not rub your eye(s).
        - Flush eyes for 15 minutes.
        - Call Wayne State Police at 313-577-2222 for medical assistance.
    - Flush eyewash stations weekly for 60 seconds or until the water is clear. During flushing ensure:
        - Eyewash access is unobstructed.
        - Eyewash covers in place and comes off when activated.
        - Sink & eyepieces clean.
        - Water flow from both eyepieces is adequate and continuous.
        - Water drains from the bowl/sink.
    - Designate a laboratory member to be responsible for weekly testing of eyewash units.
    - Weekly testing must be documented on an Emergency Maintenance Eyewash Log.
- Safety Showers
    - Must always have a minimum clearance of 24 inches from the centerline of the spray pattern in all directions.
    - This means that no objects should be stored within this distance of the safety shower.
    - Non-electrical items must not be within 24 inches of a safety shower and electrical equipment must not be within 60 inches of a safety shower.
    - In the event of an emergency,
        - Individuals using the safety shower should be assisted by an uninjured person to aid in decontamination and to call Wayne State Police at 313-577-2222 for medical assistance.
            - Note: The assisting personnel MUST take measures to protect themselves first, to prevent themselves from being exposed. This includes donning appropriate PPE.
        - Remove contaminated clothing and activate the shower.
            - Note: If the exposure occurred on the upper body, personnel may need to remove all clothing to prevent the hazardous material from spreading and collecting in other clothing.
        - Immediately flush the hazardous material from the skin for a minimum of 15 minutes.
    - Safety showers should be tested annually by OEHS personnel.
        - If no safety shower is available, consult with Facility Planning and Management and OEHS to have a safety shower installed.

For more information refer to the MIOSHA fact sheet: Eyewashes and Safety Showers.

FIRE EXTINGUISHER

All laboratories working with combustible or flammable chemicals must be equipped with appropriate fire extinguishers and should be familiar with their location, use, and classification.

All fire extinguishers should be:

- Mounted on a wall in an area free of clutter or stored in a fire extinguisher cabinet.
- Tagged with the most recent date of inspection and routinely inspected as required by the WSU Fire Marshall.
- Fully charged, as indicated by the pressure indicator gauge.

Only attempt to extinguish small fires, which can be extinguished with one portable fire extinguisher by an individual who has been trained in its use and if it is safe to do so.

For more information on emergency responses to fire refer to the WSU Fire Safety webpage.

FIRE DOORS

Many areas of research buildings at WSU are designed with fire doors, a critical element of a building's fire containment system. Usually, the corridor door used to enter a laboratory is a "fire door."

These doors are equipped with a closing mechanism and hardware that latches. Fire doors are designed to remain in the closed position at all times. Should a fire occur in a laboratory, a closed corridor fire door will help contain the fire and smoke in the laboratory and still allow laboratory personnel to exit the area safely.

OCCUPATIONAL HEALTH PROGRAM

All employees or laboratory personnel who work with hazardous chemicals shall have an opportunity to receive an employer-provided medical evaluation, including supplemental examinations which the evaluating physician determines necessary, under the following circumstances:

- An employee develops signs and symptoms of exposure to a hazardous chemical. Such symptoms may include headache; rash; nausea; coughing; tearing, irritation or redness to the eye; irritation of the nose or throat; dizziness; or loss of motor ability or judgment.
- An employee has direct skin or eye contact with a hazardous chemical.
- A chemical release (spill, leak, fire, explosion) results in the likelihood of a hazardous exposure.
- Air monitoring reveals an airborne concentration of a hazardous substance routinely above the regulatory exposure limits for which there are exposure monitoring and medical surveillance requirements.

MEDICAL SURVEILLANCE

Routine medical surveillance should be established if required by any regulations (e.g., respiratory protection program, lead standard, or any other substance-specific OSHA/MIOSHA standard). The WSU-approved medical provider and OEHS will determine the need for, and the frequency of, medical surveillance for specifically regulated materials.

GENERAL REFERENCES

- Occupational Exposure to Hazardous Chemicals in Laboratories (29 CFR 1910.1450)
- MIOSHA Hazard Communication Standard
- Toxic and Hazardous Substances Subpart Z (29 CFR 1910.1200)
- NFPA 30 Flammable and Combustible Liquids Code
- NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals
- NFPA 55 Compressed Gases and Cryogenic Fluids Code
- NIOSH/OSHA Pocket Guide to Chemical Hazards
- OSHA Hazard Communication Standard: Safety Data Sheets
- OSHA Hazard Communication Standard: Labels and Pictograms
- OSHA Steps to an Effective Hazard Communication Program for Employers That Use Hazardous Chemicals
- MIOSHA Hazardous Work in Laboratories Standard
- MIOSHA Part 33. Personal Protective Equipment
- EPA's Chemical Compatibility Chart
- WSU Office of Environmental Health and Safety
- WSU Chemical Safety Committee (CSC) Charter
- Globally Harmonized System of Classification and Labelling of Chemicals (GHS), Eighth revised edition

ACKNOWLEDGMENTS/REFERENCES

The contents of this written plan are based on applicable regulatory requirements, best practice guidelines, current site-specific operations, and peer collaboration. This comprehensive approach ensures that the elements of this plan are aligned with key industry standards, address our unique site-specific needs, and positively benefit from the collective expertise of our peers.

The following organizations and entities provided valuable insights, recommendations, and/or information that was used in the development of this plan, either through direct interaction or by referencing their publicly available resources:

- University of Michigan – Environmental Health and Safety
- National Institute for Occupational Safety and Health
- Michigan Occupational Safety and Health Administration
- Occupational Safety and Health Administration
- Environmental Protection Agency
- National Fire Protection Association

VERSION CONTROL

Version	Date	Notes
1.0	Various	Uncontrolled Versions
2.0	September 2024	Full update and revision. Implement document control process.