# *Messiah University*

## School of Science, Engineering and Health

# Chemical Hygiene Plan

**2024-2025**
**(reviewed 7/31/2024)**

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# 1 *Purpose of the Chemical Hygiene Plan*

The *Chemical Hygiene Plan* (CHP) exists to provide the guidelines for the safe and effective use of all laboratory equipment and chemicals by the employees and students at Messiah University in accordance with all federal and state regulations put forth by the U.S. Occupational Safety and Health Administration (29CFR 1910.1450), the Environmental Protection Agency, and the Pennsylvania Department of Environmental Protection. It is the goal of this document to minimize and/or eliminate employees' and students' exposure to hazardous (or potentially hazardous) chemicals, procedures, or equipment associated with all laboratory activities through the use of personal protective equipment, engineered controls, laboratory practices, as well as policies and procedures. All applicable users of chemicals under this plan, as defined below, must be familiar with the requirements set forth in this plan and applicable state and federal regulations, and must conduct their operations in accordance with them. It is essential that Messiah University employees follow the "cradle to grave" responsibility under the Resource Conservation Recovery Act (RCRA) and Superfund Amendments, and Reauthorization Act (SARA Title III) regulations when purchasing and disposing of chemicals. Further information is provided in Section 13 regarding proper waste disposal. This plan is available for inspection at any time from the School of Science, Engineering and Health's Chemical Hygiene Officer and through FalconLink.

# 2 *Scope*

## *2.1 Applications*

This plan implements the provisions of the OSHA Laboratory Standard (29CFR 1910.1450) for laboratory spaces which use or store hazardous chemicals as defined by that standard. These include all laboratories in Kline and Jordan Halls within the Department of Biology and Department of Chemistry and Biochemistry. In addition, the following laboratories are covered: the Nutrition Laboratory (J057), the Psychology Research Lab (K111), and three Engineering Department laboratories located in Frey Hall: the Biomedical Research Lab (F51), the Materials Lab (F49) and the Environmental Lab (F45).

The policies and procedures set forth in this document apply to all laboratory courses, experimental settings, classroom environments, and any other area or situation associated with courses or research conducted in the above-mentioned laboratories as determined by the Dean of the School of Science, Engineering and Health, the Chemical Hygiene Officer, or the Office of Human Resources and Compliance.

This document does not replace the OSHA standards for workplace safety including, but not limited to, lock-out/tag-out, electrical safety, machine safety, walking/working surfaces, and evacuation planning, but it defines regulations specific to working in a laboratory with hazardous chemicals. These regulations, in addition to those guidelines outlined by the University's *Safety Manual*, address all hazardous chemical, laboratory, and workplace safety concerns.

## *2.2 Exclusions*

This *Chemical Hygiene Plan* does not include provisions for the following:

- Areas within the Department of Engineering located in Frey Hall not specifically listed above. Chemicals found in those areas fall under the purview of the OSHA HAZCOM Standard (29CFR 1910.1200) and guidance of the Office of Human Resources and Compliance.
- Hazardous chemicals used in departments other than the School of Science, Engineering and Health such as Art, Sustainability, University Operations, and departments at Winding Hill. While chemicals in support of these departments may be located in Kline, Jordan, and Frey, they also fall under the purview of the OSHA HAZCOM Standard (29CFR 1910.1200) and guidance of the Office of Human Resources and Compliance.

# 3 Responsibilities

## 3.1 Office of Human Resources & Compliance

1. Advises departments of current issues and requirements for worker health and safety.
2. Assists with the development of departmental policies and procedures pertaining to worker health and safety.
3. Maintains a contract with the 3E Company for Messiah University's Safety Data Sheets (SDS) online access program and chemical inventory as outlined in the *Hazard Communication Program: Chemical Safety Manual.*
4. Updates 3E Protect (the online SDS and chemical inventory system) for the Engineering Department.
5. Provides guidance, training, and conducts audits for University-wide compliance with federal, state, and local environmental, health and safety (EHS) regulations.
6. Maintains EHS resources including, but not limited to, *Safety Manual*, *Hazard Communication Program*, *Waste Manual*, *Exposure Control Plan,* and *SPCC Plan.*
7. Develops campus-wide procedures for compliance with EHS regulations and provides guidance for the waste programs, including proper storage, inspection, disposal, and record retention.
8. Serves as contact for EHS agencies, including US EPA, PA DEP, and OSHA.
9. Completes and submits EHS reports (ex., Tier II) required for the University.
10. Manages all Workers' Compensation claims.
11. Maintains all employee medical records in accordance with federal regulations.
12. Schedules all medical evaluations as required by OSHA or at the recommendation of Public Safety, medical personnel, or laboratory managers/coordinator.

## 3.2 Dean of the School of Science, Engineering and Health

1. Responsible for the overall development, writing, implementation, and adjustment or updating of the School of Science, Engineering and Health's *Chemical Hygiene Plan*.
2. Develops an attitude of and commitment toward the safety and health for the School of Science, Engineering and Health by emphasizing the importance of the program and by setting a good example.
3. Notifies the Safety and Risk Management Committee of the implementation of the *Chemical Hygiene Plan* and updates them as changes are made.
4. Communicates *Chemical Hygiene Plan* policies to faculty and School employees and ensures compliance with the *Chemical Hygiene Plan*.
5. Delegates authority to the Chemical Hygiene Officer as needed to ensure compliance with the *Chemical Hygiene Plan*.

## 3.3 Chemical Hygiene Officer

1. The Chemical Hygiene Officer (CHO) is appointed by the Dean of the School of Science, Engineering and Health.
2. Serves as the technical advisor to the School of Science, Engineering and Health on issues of chemical hygiene and the management of hazardous chemicals.
3. Serves as a resource for assistance with the *Chemical Hygiene Plan*.
4. Serves as a resource for campus-wide chemical safety.
5. Maintains a current copy of the *Chemical Hygiene Plan*.
6. Provides assistance to faculty and staff in the proper handling of hazardous material spills and other emergencies.
7. Informs the appropriate personnel within the School of Science, Engineering and Health of any changes in legal requirements pertaining to regulated substances as needed.
8. Sits on the Safety Committee.
9. Functions as the Radiation Safety Officer for the campus.

### *3.4 Office of Facilities Services*

1. Performs all necessary maintenance for laboratory ventilation systems including fume hoods, local exhaust systems, and general ventilation in accordance with federal and state regulations.
2. Conducts annual testing of fume hoods and maintains records of annual fume hood inspections and performance of individual fume hoods.
3. Maintains laboratory and building systems including, but not limited to, all HVAC, plumbing and electrical systems.
4. Conducts annual inspections and testing of all eye wash stations and safety showers. Maintains records of eye wash station and safety shower inspections.
5. Repairs any hazard or safety concerns pertaining to the building or mechanical systems.
6. Alerts the appropriate personnel of any possible hazards.
7. Oversees the disposal of chemical and hazardous waste for all campus departments. Maintains all necessary Environmental Protection Agency and Pennsylvania Department of Environmental Protection documents pertaining to waste disposal.

### *3.5 Biological Sciences Lab Coordinator, Engineering Technician, Engineering Project Manager, and Natural Sciences Laboratory Program Manager*

1. Oversee the daily operations of University laboratories within their respective departments within the School of Science, Engineering and Health. They work with the Office of Human Resources and Compliance to address health and safety issues in their designated laboratories. The Natural Science Laboratory Program Manager serves as the CHO for the School assisted by the Biological Sciences Lab Coordinator, Engineering Technician, and Engineering Project Manager.
2. Inform all laboratory workers (employees and work study students) of the guidelines put forth in the *Chemical Hygiene Plan*.
3. Maintain responsibility for laboratory safety, regulatory compliance, and implementation of (and compliance with) the *Chemical Hygiene Plan* for laboratories within their applicable departments.
4. Oversee the proper disposal of all hazardous and chemical waste generated within their respective laboratories in conjunction with the Office of Human Resources and Compliance.
5. Conduct periodic testing of the function of emergency equipment including, but not limited to, eye wash stations and safety showers. Eye wash stations must be flushed weekly and documented. Safety Showers must be flushed quarterly and documented. Maintain access to emergency equipment through general housekeeping.
6. Work with faculty in the development of Standard Operating Procedures for specific hazardous procedures.
7. Identify hazardous or potentially hazardous chemicals or processes in the laboratory.
8. Report possible overexposures to hazardous chemicals to the Office of Human Resources and Compliance.
9. Inspect and control inventory of hazardous chemicals used in their operations to minimize inventory and assure proper storage. A physical annual audit will be conducted every year in the May/June timeframe and an electronic copy forwarded to the School's Chemical Hygiene Officer and Office of Human Resources and Compliance.
10. Update 3E Protect (the online SDS and chemical inventory system) as outlined in the *Hazard Communication Program: Chemical Safety Manual* and Section 6.5 Safety Data Sheets of this document.

### *3.6 Faculty*

1. When designing new experiments, considers the hazards involved and chooses to use chemicals (starting materials, intermediates and products) which will provide the desired learning experience with minimum hazard. They will investigate the hazards of each chemical being introduced to the laboratory for the first time by referring a Safety Data Sheet (SDS) for that chemical and substitute less hazardous

chemicals when practical. Faculty are also required to complete a Project Checklist as contained in the Messiah University *Safety Manual* for any new projects/assignments.
2. Provides laboratory assistants, students conducting research, and laboratory manager or lab coordinator under their direction with safety and health information needed to avoid hazards prior to their involvement in experiments.
3. Inspects and controls inventory of hazardous chemicals used in their operations to minimize inventory and assure proper storage and keeps the appropriate laboratory manager or lab coordinator appraised of changes to requirements or generation of new wastes.

### *3.7 Laboratory Instructors*

1. Review physical and chemical hazards of all experiments to be performed under their direction in the laboratory. Where special precautions may be necessary, discuss the situation with the Chemical Hygiene Officer.
2. Assure that pre-lab discussions include consideration of specific safety and health hazards of the experiment, safety equipment to be used, and steps to be taken in case of emergency. Make learning how to be safe an integral part of the chemical education process.
3. Set a good example by observing all rules, wearing recommended protective equipment, and being enthusiastic about safety.
4. During the laboratory period observe whether students are following instructions and provide prompt corrections where needed. Instructors must insist on safe procedures and use of personal protective equipment, including cleaning and storage.
5. Assume responsibility for visitors and require that they follow the same rules as students and other laboratory workers whenever in the lab.
6. Report accidents, near misses, or significant safety/health incidents to the appropriate laboratory manager or lab coordinator promptly.
7. Ensure that hazardous waste is disposed of properly and in accordance with the Messiah University Hazardous Waste Disposal Protocol.
8. Ensure that all operations under their direction are performed in accordance with the *Chemical Hygiene Plan*.

### *3.8 Laboratory Workers*

1. Attend all required trainings.
2. Wear personal protective equipment as required.
3. Perform all required tasks in accordance with the *Chemical Hygiene Plan*.
4. Maintain ultimate responsibility for their personal on-the-job safety.
5. Report potential or suspected hazards to the appropriate laboratory manager or lab coordinator.

### *3.9 Building Maintenance and Custodial Staff*

1. Maintain general cleanliness for aesthetic and safety purposes.
2. Report potential or suspected hazards to the appropriate laboratory manager or lab coordinator.
3. Use appropriate precautions and/or personal protective equipment when cleaning laboratory areas.

### *3.10 Students*

1. Follow all instructions as provided by the instructor.
2. Become familiar with posted safety rules, location of safety equipment, and availability/location of chemical hygiene information.
3. Report to the instructor any safety or chemical hygiene problems, injuries, accidents, or incidents.

### *3.11 Radiation Safety Officer*

1. Determines Standard Operating Procedures (SOP's) for all radioactive materials used in the laboratory in conjunction with faculty.
2. Provides approval for the purchase of radioactive materials within the School of Science, Engineering and Health.

3. Maintains all necessary permits for the Commonwealth of Pennsylvania.

### *3.12 Department of Safety*

1. Conducts fire extinguisher inspections in accordance with applicable regulations.
2. Maintains all emergency systems such as fire alarms, sprinkler systems, and emergency lighting systems.

# 4 *General Laboratory Safety Guidelines*

## *4.1 Introduction*

Laboratory work involves potential hazards which cannot be completely removed even by the use of proper procedures and safety equipment. Messiah University is committed to providing a safe environment for all students and employees, but in the end, individuals are responsible for exercising safe behavior. Safety Rules for Laboratories for each department have been developed to achieve the goal of making the laboratory as safe as possible. They must be followed by all workers (including students) in all laboratories and laboratory storerooms. The set of general rules common to all departments follows.

## *4.2 General Laboratory Safety Rules*

1. Proper eye protection must be worn at all times in laboratories and lab related activities.
   In laboratories where there is a risk of splashes from toxic, corrosive, infectious, or otherwise dangerous chemicals (referred to below as wet chemistry) chemical splash goggles and/or other protective measures such as face shields or sashed hoods as appropriate must be used. Appropriate safety glasses must be worn in laboratories where chemicals are not in use, but laboratory procedures (such as dissection or engineering work) would create a physical hazard to the eyes. Safety glasses do not provide splash protection; therefore, they do not meet lab safety requirements in wet chemistry laboratories. In laboratories where both wet chemistry work is being conducted and equipment is being used which would preclude the wearing of goggles (i.e. microscope), then the wet chemistry must be restricted to a specified area of the room and chemical splash goggles must be worn in that area. Visitors to laboratory rooms must wear the appropriate eye protection even if they are not working in the laboratory. Workers who do not have proper eye protection will not be able to participate in the lab and will be asked to leave the laboratory.

2. Horseplay, pranks, or other acts of mischief are especially dangerous and are prohibited.

3. The hazards of chemicals used must be known prior to the experiment.
   In order to understand the hazards involved in an experiment, all workers must read through and become familiar with the lab protocol prior to the lab period. These hazards include, but are not limited to, corrosiveness, flammability, reactivity, stability, and toxicity. This information will be supplied by the instructor or obtained by workers as advance preparation prior to laboratory work. Additional information, in the form of Safety Data Sheets (SDS), is available from the school's Chemical Hygiene Officer, through FalconLink (search "SDS"), from the manufacturer's website, or the 3E Company whose phone number is posted on laboratory phones. An SDS contains information about the chemical properties of a substance such as hazards, reactivity, melting point, flash point, etc. An SDS also contains information on spill cleanup and accident procedures.

4. Eating and drinking are not allowed in the laboratory.
   In addition to not consuming food or drink in the lab, chewing gum and candy are also prohibited. Unopened food and beverages may not be brought into the lab.

5. Unauthorized experiments are prohibited.
   No chemicals or equipment may be used by students unless they have received permission and instruction from the lab instructor. There are no exceptions to this rule.

6. Appropriate clothing and shoes must be worn.
   When specified by the instructor, gloves and a protective apron or lab coat will be required. The following dress is required in the laboratory: closed-toe shoes which completely cover the feet, long pants, and shirts which cover the upper body. Clothing articles such as shorts, short skirts, bare midriffs, tank tops, items with draping sleeves, and footwear which does not completely cover the feet are prohibited. In addition, long hair must be pulled back. Workers who do not meet the dress code will not be able to participate in lab and will be asked to leave the laboratory.

7. Experiments may not be performed when a worker is alone in a laboratory unless suitable arrangements have been made with the course instructor.

8. All persons must wash their hands prior to leaving the laboratory.
   Even if a worker did not use a hazardous chemical, it is very possible that someone who used the space beforehand failed to properly cleanup.

9. No chemicals or equipment may be removed from the laboratory without the specific permission and supervision of the instructor.

10. All accidents and significant near-accidents must be reported to the instructor.

11. All workers must know the location and proper use of all safety equipment including, but not limited to, safety shower, eye wash, fire blanket, and fire extinguisher.

12. All chemicals must be disposed of in the proper manner.
    All chemicals and waste must be disposed of as outlined by the Messiah University Hazardous Waste Disposal Protocol. Used chemicals must be put in an approved, labeled container. Never assume it is safe to put a chemical down the drain or in the trash.

13. If an injury occurs which is not incapacitating but causes bleeding, a sterile bandage must be placed over the wound and workers must seek treatment, if needed. No other person, unless properly trained in First Aid and Bloodborne Pathogens, must be involved in any way which might cause contact with blood. The Laboratory Accident Procedure must be followed. Campus Events must be contacted to properly clean up and disinfect the area if blood is present.

14. Broken glass must be disposed in an approved, labeled, cardboard container. No trash or chemicals may be discarded in this container. Sharps items (microscope slides, razor blades, etc) must be disposed in red sharps containers.

15. In Case of Fire:
    If the fire alarm sounds, but there is no fire in the immediate vicinity, workers must turn off sources of heat or flame and leave the building according to the Fire Alarm Response Instructions. A primary exit route and area of accountability outside of the building is posted in each lab. If a small fire starts, such as a lab manual or beaker, the worker must smother it with a fire blanket, sand, or otherwise depriving it of oxygen. If clothing has caught on fire, the worker must use the safety shower if available or stop, drop to the floor, and roll back and forth until the fire is out. For more information, refer to the Messiah University *Safety Manual* or the Fire Safety Office webpage (http://www.messiah.edu/info/20572/fire_safety_office).

16. In Case of a Chemical Spill:

If chemicals have splashed on a worker's skin, wash the area in running water. If the splash is to the face, be sure to avoid washing the chemical into the eyes. If chemicals have spilled on clothing, the contaminated clothing must be removed, and the safety shower used as needed. Refer to the Spill Response Plan (available in the Messiah University *Hazard Communication Program: Chemical Safety Manual*) if chemicals have spilled on the bench top or floor. Remember that a spilled chemical is still hazardous; materials used to clean spills must not be disposed of in the trash.

17. Lab Cleanup Responsibilities:
    Workers are responsible for keeping their work areas and common-use areas clean and orderly. This includes keeping equipment and surrounding areas free of any spilled chemicals.

18. Some laboratory experiments involve chemicals which are reproductive hazards. Workers who are pregnant or suspect they may be pregnant must report their condition to the laboratory instructor or supervisor so that proper precautions can be taken.

19. Egregious or repeated safety violations could, at the discretion of the instructor or supervisor, result in the worker being expelled from the lab.

### *4.3 Safety Equipment*

1. All laboratories are equipped with safety equipment which may include fire blankets, fire extinguishers, and eyewash stations.
2. Students will be instructed on the use and location of safety equipment at the start of each laboratory course. Workers using chemicals shall be trained in the location and proper use of eyewash stations and safety showers. It is recommended that the affected body part be flushed immediately and thoroughly for at least 15 minutes.
3. Fire extinguishers are located in many laboratories. Emergency evacuation primary exit routes and areas of accountability outside of the building are posted near laboratory exits.
4. All laboratories are maintained in such a way that access to emergency and safety equipment is not obstructed by laboratory equipment or storage. All eye washes and safety showers must always be accessible.

### *4.4 Safety Inspections*

1. Safety audits will be carried out regularly by the Office of Human Resources and Compliance.
2. Weekly walkthroughs of applicable laboratories will be conducted by the laboratory managers or lab coordinator in each department to ensure access to and functioning of safety equipment. If safety equipment is non-functional, steps will be taken to arrange for the repair or replacement of the equipment as soon as possible. These inspections will be documented on a form similar to Appendix D and retained.

### *4.5 First Aid*

First aid kits are located in accessible areas of each building. First aid kits are checked yearly and resupplied, if necessary, by the Department of Safety. The *Exposure Control Plan* and *Safety Manual,* Section 9 Injuries and Illnesses, contains additional information about treatment and reporting of injuries. Supplies for treating minor cuts, burns, and bruises may be maintained in some lab rooms. These supplies are maintained and replenished by the appropriate laboratory manager or lab coordinator.

If an injury occurs which is not incapacitating but causes bleeding, a sterile bandage must be placed over the wound. No other person, unless properly trained in First Aid and Bloodborne Pathogens, must be involved in any way which might cause contact with blood. Students must go to the Engle Health Center for treatment, if needed. Employees (including student employees) injured on the job and seeking treatment must go to one of the medical providers approved by the University's Workers Compensation insurance carrier. Additional information for employees can be found in the *Safety Manual*, Section 9 Injuries and Illnesses.

If the injury is major, Dispatch (6005) must be phoned immediately.

If a chemical contacts the eyes, promptly flush the eyes with copious amounts of water for at least 15 minutes and contact Dispatch (6005) and the Chemical Hygiene Officer immediately.

### *4.6 First Aid for Acutely Hazardous or Toxic Chemicals*

See Section 7 "Standard Operating Procedures for Chemicals of Special Concern" for specific treatments for exposure to certain hazardous chemicals used in the laboratory. If a specific treatment is not listed, consult the chemical's Safety Data Sheet.

### *4.7 Fume Hoods and Glove Boxes*

Laboratory hoods are provided to protect personnel from breathing vapors or dust from chemicals that are being handled or stored. Hoods provide a high degree of protection when properly used but they are secondary devices. The primary controls are proper design of experiments and careful operating techniques.

#### *4.7.1 Fume Hood Performance*

Properly operating hoods must have an average face velocity of at least 60 linear feet per minute for hoods (doors open wide) and air supply systems that are optimally designed and installed. Hoods for more demanding operations need a face velocity of 75 to 125 fpm. Higher face velocities can cause eddy currents and decreased protection. Tests have shown that hood performance is strongly affected by factors such as amount, size, and placement of equipment within the hood; room drafts from open doors or windows; traffic past the hood; position of the hood door; and the user's position and actions in front of the hood. Doors may be opened wide to install tall equipment, but they must be closed to the sash stop (on hoods that have it) or approximately half open whenever possible.

The average face velocity can be increased by closing the sash. For example, closing the sash to one-half of the maximum face opening approximately doubles the average face velocity. Partially closing hood doors to achieve an average face velocity of 60 fpm is not an acceptable solution for increasing face velocity of malfunctioning hoods.

#### *4.7.2 Fume Hood Testing*

Faculty and laboratory instructors are responsible for monitoring fume hood operation in their area and must be alert to signs of malfunction such as unusual sounds, reduced draft, and odors in the room. Any suspected inadequacy must be checked immediately. It can be checked by use of a portable vaneometer available from the Chemical Hygiene Officer or by requesting air flow measurements by Facility Services. Facility Services will check hood face velocity at yearly intervals. The tests will be performed in accordance with the ASHRAE 110-1995 testing procedure.

#### *4.7.3 Guidelines for Fume Hood Use*

1. Fume hoods must be used when using chemicals which are hazardous, flammable, corrosive, or give off strong odors. Safety Data Sheet (SDS) instructions and warnings on containers must be followed at all times.
2. Fume hoods must be kept clear of unnecessary equipment. Only equipment that requires ventilation may be used in the fume hood.
3. Fume hoods are not to be used for long term storage of chemicals.
4. Hazardous Waste is only to be stored in fume hoods marked "Hazardous Waste Satellite Accumulation Area."
5. Use minimum required opening when working in the hood and close hood doors when not handling the equipment inside the hood.
6. Use traps or scrubbers as primary devices to prevent toxic and/or noxious materials from being vented.

7. Do not permit materials such as paper to enter exhaust ports; they can lodge in the ducts or fan and reduce efficiency. Do not store items or set up apparatus in such a way that the exhaust ducting is blocked.
8. Keep all sources of emissions at least 6 inches inside the front of the hood. This greatly reduces the possibility of exposure.
9. Keep operator's face outside plane of sash, i.e., do not lean forward into the hood when working with chemicals in the hood.
10. Prepare a plan of action in case of ventilation failure, e.g., by power failure. Fume hoods must be closed completely in the event of loss of airflow to the hood.

#### *4.7.4 Glove Boxes*

Glove boxes are used in areas where procedures must be carried out in protected or inert atmospheric conditions. Often these processes involve toxic or highly reactive chemicals. Glove boxes must be inspected for signs of wear and degradation prior to use. The seal must not allow the escape of any gases. Do not use a glove box if it is damaged in any way.

### *4.8 Housekeeping*

1. Laboratories must be maintained in a general state of cleanliness with work areas kept clear of unnecessary equipment or glassware. Work areas must be clear of spills or chemical contamination.
2. Bench tops used in student laboratories are not to be used for storage.
3. All aisles and walkways must remain clear including pathways to eyewash stations and safety showers.
4. Fume hoods may only contain the equipment required by the current procedure. Hoods are not to be used as equipment storage areas.

### *4.9 Working Alone*

Working alone in the laboratory must be avoided if possible. No one may perform experiments in the laboratory when alone unless arrangements have been made with the laboratory instructor. Faculty and staff may not work alone in the laboratory without first notifying a colleague.

If it is necessary to perform laboratory work alone, the following guidelines must be used to help minimize the potential risks:

1. An instructor or research mentor must be notified in advance of when you intend to work.
2. Acutely hazardous chemicals, carcinogens, or embryo toxins may not be used when working alone.
3. Extremely reactive chemicals, toxic gases, or compounds that could potentially release a toxic gas may not be used when working alone.
4. Secondary containment for toxic substances must be used.
5. The use of headphones or loud music is prohibited while performing laboratory experiments alone.

### *4.10 Exposure*

Every effort must be made to minimize and mitigate exposure to hazardous and/or toxic chemicals, intermediates, and products in the laboratory. This can be accomplished through careful planning of experiments by faculty and laboratory instructors and the use of engineered controls, standard operating procedures, administrative procedures, and personal protective equipment. When possible, less hazardous substances must be substituted for more hazardous ones within a procedure.

### *4.11 Laboratory Maintenance*

Each week, the laboratory managers or lab coordinator will conduct a walkthrough of all laboratories to ensure that access to safety equipment is not hindered. Emergency eyewash stations are flushed weekly, and a log maintained by the appropriate laboratory manager or lab coordinator. The dust caps must pop off easily with the application of water pressure. Inspection logs for annual testing of eyewash stations and safety showers are maintained by Facilities Services.

### 4.12 Fire Extinguishers

Fire extinguishers are provided in an area that is easily identifiable and accessible. Laboratory instructors must inform students and researchers of the location of fire extinguishing equipment at the beginning of each laboratory section. Only employees/students who have been trained in the proper use of fire extinguishers within the past 12 months may use a fire extinguisher. In addition to general purpose extinguishers throughout campus, a Class D (flammable solids), and Class B (flammable liquids) are kept in Kline 301.

### 4.13 Fire Blankets

Laboratories may be equipped with fire blankets. The location and use of fire blankets must be noted by students and researchers at the beginning of each laboratory section. Fire blankets must be used with caution – do not wrap yourself in one to try to extinguish a clothing fire. The first thing anyone must do if their clothing is on fire is stop, drop, and roll. The fire blanket can trap heat and create a chimney effect that directs the hot, toxic gases and flames into the face, breathing zone, and lungs of the victim. If others are present, they can use the blanket to smother the flames once the victim has dropped and rolled. The blankets can also be used for: 1) modesty curtain for using the safety shower, 2) wraps for after the shower, 3) temporary stretcher, 4) to keep someone warm to avoid shock, 5) a pillow if the victim needs to be on the floor, and 6) to smother other fires.

## 5 Additional Messiah University Policies

In addition to the School of Science, Engineering and Health *Chemical Hygiene Plan*, several other Messiah University policies apply to safe laboratory work. These policies are found in the *Hazard Communication Program*: *Chemical Safety Manual*, the *Safety Manual*, the *Waste Manual*, and the *Exposure Control Plan*. All environmental health and safety manuals are available through FalconLink. These policies, in combination with the *Chemical Hygiene Plan*, serve to meet all applicable OSHA and EPA safety regulations.

### 5.1 Service Animals

A service animal is defined by the Americans with Disabilities Act (ADA) as a dog that has been individually trained to do work or perform tasks for an individual with a disability and includes dogs trained to take a specific action, such as dogs trained to alert for low blood sugar in diabetics, those that detect the onset of seizures, and even those that alert the time for medication in depressed individuals. Dogs used for emotional support therapy, comfort, companions, and dogs-in training are not considered qualified service dogs.

The accommodation of service animals in laboratories provides some unique challenges. Every attempt will be made to accommodate a student and their service animal. There may be hazards in clinical practicums of nursing and health sciences programs, in food services programs, or in laboratories. The associated risks would need to be considered individually to determine whether the risks can be mitigated, and if reasonable accommodation can be provided. Additionally, consideration must be given to circumstances where the presence of a service animal would fundamentally alter the nature of the laboratory activity. Individuals seeking to bring a service animal into a laboratory assume responsibility for all risks involved in the use of their service animal including the risk of exposure of their service animal to hazardous materials and objects.

Service animals will only be permitted in laboratories covered under the *Chemical Hygiene Plan* if a detailed plan for the animal's presence is developed among the Office of Academic Accessibility, the student, the instructor, and the appropriate laboratory manager or laboratory coordinator. The detailed plan will include a hazard assessment for each course activity and will outline all mitigations and accommodations. **Students should notify instructors and the Office of Academic Accessibility promptly when they register for a laboratory course as the process to develop the detailed plan may take a few weeks.** All service animals and their owners are required to follow the rules and regulations set forth in Messiah University's Animal Assist Policy, found at https://www.messiah.edu/download/downloads/id/6670/Animal_Assist_Policy_1_2019.pdf

While the specific accommodations for each case may vary, they should adhere to the guidance contained in relevant publications such as the American Chemical Society's *Teaching Chemistry to Students with*

*Disabilities*, 5th ed. and the Journal of Chemical Health & Safety's paper: *Service Dogs in the Chemistry Laboratory*. Both documents are available in the Natural Science laboratory Manager's office (Kline 301) or online:
https://www.acs.org/content/dam/acsorg/about/governance/committees/cwd/tcswd-5th-edition.pdf

https://doi.org/10.1016/j.jchas.2015.05.002

In general, a service animal will be allowed only in designated safe areas which minimizes its exposure to chemicals, spills, broken glass, and other hazards. The animal may not be allowed to freely follow the student's movements throughout the laboratory because this could not only pose a danger to the animal but also create a trip hazard for others in the laboratory. In all cases, our top priority is ensuring the safety and health of the individual student and their service animal, as well as the other participants in the laboratory. When acceptable accommodation cannot be provided, reasonable efforts will be made to provide alternative assignments, in accordance with the instructor's policy, but it must be emphasized that the laboratory is an integral part of all laboratory science courses, and no student will be excused from substantial participation in the laboratory. Please note that emotional support animals are not permitted in laboratories.

### *5.2 Demonstrations*

All demonstrations involving chemicals, whether they occur on campus or off campus, must be carried out in a safe environment with particular attention paid not only to the safety of the presenter but also the audience. The SEH policy for such demonstrations will follow the guidance contained in "Safety Guidelines for Chemical Demonstrations" published by the American Chemical Society Division of Chemical Education is contained in Appendix E.

### *5.3 Exposure Limits*

The use of OSHA regulated substances will be assessed and monitored as necessary to determine if individuals using regulated substances in laboratory settings within the School of Science, Engineering and Health are exceeding, or potentially exceeding, the Action Level or Permissible Exposure Limit (PEL) as defined in 29 CFR 1910 Subpart Z. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) or Biological Exposure Indices (BEI) may also be used where appropriate to determine if corrective action is necessary to minimize and mitigate employee or student exposure to hazardous materials.

### *5.4 Monitoring*

Messiah University will determine the individual exposure for any substance regulated by OSHA or for which there is a TLV, BEI, or action level for each process where there is reason to believe that exposure levels regularly exceed recommended levels. Records of exposure and possible exposure will be maintained by the Chemical Hygiene Officer and the Office of Human Resources and Compliance. Monitoring will be conducted if there is reason to believe that exposure levels regularly exceed recommended levels. If exposure to a particular substance is found in excess for a particular process or area, subsequent monitoring and/or sampling for that substance will be conducted.

### *5.5 Overexposure*

An exposure assessment must be conducted to determine the nature and extent of the harmful exposure if one of the following conditions is met:

- An employee or student develops signs or symptoms associated with hazardous chemical exposure which they may have encountered in the laboratory.
- Exposure monitoring reveals an exposure level routinely above the action level (or PEL, TLV or BEI).
- An event takes place in the laboratory such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure.
- Several employees and/or students who work in the same laboratory area have similar complaints.
- An employee or student has direct contact with a hazardous chemical, an intermediate, or product that is suspected of possessing hazardous qualities.

The assessment is only a tool to determine the events surrounding a specific incident. It is not intended to replace the evaluation and recommendation of the Chemical Hygiene Officer in relation to necessary corrective actions.

## *5.6 Employee Notification*

The Department of Human Resources and Compliance is responsible for the notification of occupationally exposed individuals of the results of any monitoring tests pertaining to the laboratories or events in which those persons may have been exposed to hazardous chemicals. Employees who may have been exposed to hazardous materials must be notified in writing within 15 days of the receipt of the monitoring results. Employee medical records shall also be maintained by the Department of Human Resources and Compliance, and employees are guaranteed access to their records as described in Messiah University's *Hazard Communication Policy*. Students who may have been exposed to hazardous materials as part of laboratory coursework shall be notified in writing by the Engle Health Center within 15 days of the receipt of exposure monitoring results. Student medical records are to be maintained in the Engle Health Center.

## *5.7 Medical Examinations*

Messiah University will provide an opportunity for any employee or student to receive a medical examination (including any follow-up examinations determined to be necessary by the examining physician) in the event that any or all circumstances outlined in Section *5.5* Overexposure, are met. All examinations of students will take place through the Engle Health Center. Examination of employees, including student workers, must be in compliance with the University's worker compensation requirements and use medical care from the approved Panel of Physicians.

In the event of an emergency, Emergency Services must be notified via 911. The Department of Safety (6005) must also be contacted and will coordinate EMS on campus.

If the situation is not an emergency but requires the immediate attention of University health care personnel, the Engle Center (6035 or 717-691-6035 after hours) must be notified of the incident by phone, and the exposed student(s) must be taken to the Engle Center without delay. Exposed employees, including student employees, must be taken to a health care provider on the Panel of Physicians (the Engle Center is not on that list).

During the summer when classes are not in session, the Engle Center is closed and thus not available to students in need of medical attention during that period. If there is a need for medical attention during the summer, Dispatch (6005) must be contacted for assistance.

Messiah University will provide the following information to the physician:

- The identity of the hazardous chemical(s) to which the employee or student may have been exposed.
- A description of the conditions under which the exposure occurred including quantitative exposure data if available.
- A description of the signs and symptoms of exposure the affected person is experiencing, if any.
- A Safety Data Sheet (SDS), if available, or the toxic effect information which is available for the chemical.

When a medical consultation or examination occurs under the above circumstances Messiah University will obtain from the attending health care provider a written opinion which will include the following:

1. Results of the medical examination and any associated tests
2. Any recommendation for further medical follow-up
3. Any medical condition which may have been revealed by the examination which may place the affected person under increased risk because of exposure to a hazardous chemical found in the laboratory
4. A statement that the affected person has been informed by the physician of the results of the consultation or examination and any medical condition that may require further examination or treatment

The Department of Human Resources and Compliance will maintain all employee medical records. The Engle Health Center will schedule all medical examinations and maintain all medical records for students. Medical records, the results of any examination, or any medical test results are considered confidential. The physician's written opinion obtained by the University must not contain any information or findings not immediately related to occupational exposure.

# 6 *Chemical Procurement, Distribution and Storage*

## *6.1 Procurement of Chemicals*

The objective of this procedure is to assure that proper attention is given to planning for safe handling procedures, storage, and disposal of chemicals prior to purchase of the chemical. This is the responsibility of the faculty member requesting the chemical. Assistance will be provided upon request by the Chemical Hygiene Officer.

In planning laboratory experiments, professors must choose chemicals with minimal hazard where practical. However, it is impractical to try to educate undergraduates properly in chemistry without having them perform some laboratory work involving handling some hazardous chemicals. In fact, since any students who choose chemistry as a career will eventually encounter work with hazardous chemicals, it is prudent to include an introduction to safe procedures for handling such chemicals in their education. However, it is important to assure that careful thought is given to:

1. Hazards of the chemical
2. Potential routes of exposure
3. Whether or not a less hazardous chemical could be substituted
4. The safe handling procedures that are necessary to ensure the safe use of the chemical
5. The amount of the chemical that will be needed, to minimize the amount which will eventually be discarded
6. How long the chemical will remain stable in storage
7. How the chemical and its waste products will eventually be discarded safely

The following procedure is designed to ensure that this planning will take place prior to purchase of any chemical.

Prior to purchasing any chemical, the faculty member involved must:

1. Investigate the hazards of the chemical considered for purchase. Messiah University maintains a contract with 3E Company to provide Safety Data Sheets (SDS) for the University's chemical inventory. Additional information about the chemical may also be available from the manufacturer.
2. Check the current chemical inventory and avoid ordering more of the chemical than is needed for the near future. This is important to avoid accumulating more stock and possibly more waste than necessary. Access to the chemical inventory can be obtained from the department's laboratory manager or lab coordinator.

The purchase of acutely hazardous, carcinogenic, embryo toxic, highly reactive, or unstable chemicals must be approved by the Chemical Hygiene Officer prior to submitting a purchase requisition.

## *6.2 Receiving Chemicals*

Shipments of chemicals to Messiah University are received by the Campus Store in Eisenhower Campus Center or Central Receiving in the Lenhert Building. It is the responsibility of personnel receiving packages to only accept intact and correctly labeled packages. If a damaged package containing chemicals is received, the Chemical Hygiene Officer must be contacted immediately, and the Messiah University Spill Procedure must be followed, as needed.

The Campus Store and Central Receiving must also conform to all Department of Transportation (DOT) and Environmental Protection Agency (EPA) guidelines and regulations regarding the shipping and receiving of hazardous materials. Only DOT certified and University approved personnel may sign for chemical shipments.

#### *6.2.1 Adding New Chemicals to the Chemical Inventory Databases.*

- All newly received chemical containers must be recorded in the appropriate departmental chemical inventory database by the applicable laboratory manager or lab coordinator.
- These entries will include the full name, hazard information, inventory control number, date received, and either the manufacturers stock number or the CAS number. In addition, the stock bottle must be labelled with an inventory control number, the date received, and the appropriate GHS hazard label (if not already present). Some chemicals also require a disposal date.
- In addition, a copy of all Safety Data Sheets (SDS) must be forwarded to the following individuals to ensure that they are included in 3E Protect, the online SDS and chemical inventory system:
    1. Natural Sciences Laboratory Program Manager – for all SDSs received for the Department of Chemistry and Biochemistry and the Nutrition Lab.
    2. Biological Sciences Lab Coordinator – for all SDSs received for the Department of Biology and the Psychology Research Lab.
    3. Office of Human Resources and Compliance – for all SDSs received for the Department of Engineering.

### *6.3 Chemical Storage*

#### *6.3.1 Location*

For the Department of Chemistry and Biochemistry, the primary chemical storage area is located in Kline Room 301C. Smaller quantities of chemicals are also stored in Kline 304, Kline 316, and Jordan 361. These rooms are equipped with ventilation systems that do not recirculate air through the building. Small quantities of chemicals may be stored in designated areas in fume hoods, laboratory shelves, or designated bench tops. All chemical storage shelves must have a one-inch lip.

Chemical storerooms are secure areas. Only approved employees and students may be granted access to chemical storage areas. Particular caution must be taken to limit and monitor access to areas where toxic, radioactive, explosive, or carcinogenic chemicals are stored.

### *6.4 Special Storage Considerations*

#### *6.4.1 Storage for Flammable Materials*

The use of flammable materials is very common in the laboratory setting and special consideration must be given to the proper storage of large quantities of flammable materials. Flammable materials in quantities less than five liters may be stored on bench tops or designated chemical storage hoods. The storage of flammable materials in quantities greater than five liters requires an approved flammable storage cabinet. In addition, metal storage cabinets must be properly grounded.

#### *6.4.2 Storage of Explosives and Peroxide Formers*

Currently, all explosive materials and materials with the potential to degrade into explosive materials are stored in flammable storage cabinets. Certain potentially explosive materials and highly flammable materials are stored in explosion proof refrigerators or flammable storage refrigerators. These refrigerators are designed to suppress sparks that may ignite flammable vapors. The storage of peroxides and peroxide forming materials in these refrigerators is done with extreme caution as the lower temperature can cause peroxides to precipitate and crystalize into a more dangerous form. See also “7.8 Explosive Materials & Peroxide Formers” and “7.15 Perchloric Acid”.

#### *6.4.3 Compressed Gas Cylinders*

Compressed gases are used throughout the School of Science, Engineering and Health. Some of these gases are inert and others are highly flammable. The pressure at which these gases are stored can make

improper handling of gas cylinders very dangerous. Compressed gas cylinders must only be moved with their safety caps in place and using the gas cylinder hand truck which has a strap to secure the cylinders. When storing these cylinders (even empty ones) in the receiving room or at the point of use, they must be chained individually in the gas cylinder rack with their safety caps on. The changing of regulators must only be performed by personnel who are familiar with the safe handling of compressed gases.

### *6.4.4 Cryogenic Liquids*

The School of Science, Engineering and Health currently uses cryogenic liquids in limited quantities. Liquid nitrogen is used in the Kline 313, 214, 227, Frey 049, and Jordan J364 NMR room. The NMR spectrometer is also filled with liquid helium. Special care must be given to the handling and transport of liquid nitrogen and other cryogenic liquids as they can cause severe burns if they contact skin. The liquid nitrogen Dewars are stored in the Kline 103 receiving room and the NMR room. Persons transporting or dispensing liquid nitrogen must wear long pants and sleeves, a lab coat, chemical splash goggles, and insulated gloves. Liquid nitrogen must only be transported in an adequately insulated container such as a Dewar. Cryogenic liquids may only be stored in either the liquid nitrogen Dewar supplied by the vendor or an approved vacuum container. Passengers must not ride on the elevator when transporting cryogens to different floors within the building. The Dewar canister must be placed on the elevator, along with proper signage, and the elevator sent unmanned to the destination where it will be met by the operator to retrieve the canister. Transportation of liquid nitrogen off campus in a vehicle is only permitted in an approved Dewar with a capacity less than 10 liters. Per DOT regulations, this exception is only for transporting liquid nitrogen for use in science related demonstration. Procurement and transportation of liquid nitrogen to the University is expressly forbidden. Liquid nitrogen is contracted for and delivered from a commercial vendor under the purview of the Natural Science Laboratory Manager. All University personnel with a legitimate need must obtain liquid nitrogen through the Lab Manager.

### *6.4.5 Ethanol*

In accordance with the Commonwealth of Pennsylvania regulations, large quantities of ethanol are stored in a doubly locked flammable storage cabinet in Kline 301. Access to this cabinet is extremely restricted. Only the Natural Science Laboratory Manager and the Biology Lab Coordinator have keys to the ethanol cabinet. A spare key is kept in the Department of Chemistry lock box for emergency use only. Small quantities of dilute ethanol (up to five liters) may be stored in laboratories where ethanol is in use for laboratory procedures.

### *6.4.6 Water Reactive Substances*

Water reactive chemicals such as alkali metals are stored in a waterproof storage container in the flammable storage cabinets in Kline 301. This is the only approved storage area for water reactive chemicals. These materials are distributed in limited quantities and must be kept in sealed, waterproof containers at all times. Storage containers may only be opened to remove the amount needed to carry out the current procedure.

## *6.5 Safety Data Sheets*

Messiah University has contracted with 3E Company to provide Safety Data Sheet (SDS) information for all chemicals in the University's possession as described in the *Written Hazard Communication Program: Chemical Safety Manual*. SDSs may be accessed online through FalconLink, "Safety Data Sheet (M)SDS Online System", or from the chemical manufacturer's website. In an emergency or when the online system is not available and/or accessible, 3E Company may be contacted at any time, 24 hours a day, (800) 451-8346, to provide current SDS information. 3E Company can also provide exposure control information and poison control advice in the event of an accident. As new chemicals are received on campus, they must be added to 3E Protect, the SDS and chemical inventory system. If a chemical is no longer present and there is no immediate need to reorder that chemical, the chemical must be removed from the active inventory in 3E Protect, and if the

chemical is not used anywhere else on campus the SDS must be archived in 3E Protect. The following individuals should be contacted to make these adjustments in 3E Protect:

- Natural Sciences Laboratory Program Manager – for the Department of Chemistry and Biochemistry, and the Nutrition Lab.
- Biological Sciences Lab Coordinator – for the Department of Biology, and the Psychology Research Lab.
- Office of Human Resources and Compliance – for the Department of Engineering.

### *6.6 Annual Audit/ Chemical Inventory Reconciliation*

Once a year, each departmental chemical inventory will be audited to ensure that all chemical containers in the possession of the School of Science, Engineering and Health are accounted for. A copy of that audit will be maintained by the laboratory supervisors in a suitable database. During the annual audit, the chemical inventory will be evaluated based on anticipated use, storage container integrity, label legibility, and shelf life. If during the audit, it is discovered that:

1. The original bottle/container is damaged, corroded, does not seal properly, or is leaking, the bottle must be discarded according to the Chemical Waste Disposal Policy (See Section 13) or the container shall be replaced and a new label affixed to it.
2. The original label is illegible, damaged, erroneous, or coming off of the container, it shall be replaced with a label that contains all necessary information including, but not limited to, chemical name, chemical formula, common name (if known), CAS number, date received, GHS hazard information, and quantity.
3. Large quantities of old chemicals (date received > 10 years) shall be disposed of according to the Chemical Waste Disposal Policy (Section 13) to limit the chemical inventory only to what is needed for current procedures.
4. Chemicals being stored beyond their usable shelf shall be disposed of in accordance with the Chemical Waste Disposal Policy (See Section 13).

Unused or unwanted department chemicals may be redistributed to other areas of campus provided that:

a) The chemical(s) has not passed its expiration date (if any).
b) The chemical is used in accordance with the *Chemical Hygiene Plan* for that department and any relevant standard operating procedures.
c) The Messiah University *Hazard Communication* is updated to inform the appropriate employees and students outside of the School of Science, Engineering and Health who may use or come in contact with the reused chemical.
d) The chemical is ultimately disposed of properly according to the guidelines in the Chemical Waste Disposal Protocol.

The annual audit is intended to identify chemicals that are no longer useful to store and to correct any discrepancies in the database that may have developed throughout the year. The chemical inventory database is maintained in such a way that it is an up-to-date and accurate inventory at any time of the year. Every effort must be made by students, faculty, staff, and administrators to keep the inventory current by removing depleted chemical supplies from the database and updating chemical locations.

### *6.7 Labels*

All chemicals stored in the original bottles must maintain the manufacturer's label which contains all the necessary information including, but not limited to, chemical name, chemical formula, common name (if known), CAS number, date received, GHS hazard information, and quantity. Damaged or partial labels that render important information illegible must be replaced immediately. Labelling with only a chemical formula is not permissible.

#### *6.7.1 Secondary Labels*

OSHA has two standards that cover the required labeling of secondary containers. The *Hazard Communication Standard* (HCS 2012), 29 CFR1910.1200 which covers most of the campus and the OSHA *Laboratory Standard*, 29 CFR 1910.1450 which covers those laboratories within School of

Science, Engineering and Health which are covered by this CHP as delineated in Paragraph 2.1 above. All secondary labels for items in storerooms or teaching laboratories must include the chemical name, date, appropriate hazard warning, and the identification of the individual who prepared the secondary container. If numerous containers are needed for teaching labs for the period of a particular experiment, an acceptable alternative is to post the name and appropriate GHS symbol on a poster prominently displayed in the laboratory. Likewise, long-term storage of biological samples in a preservative must have that preservative either individually labeled or appropriate signage containing the name and hazard.

All materials stored in research labs for continuing use must contain the chemical name, date, appropriate hazard warning, and personal identification. However, the OSHA *Laboratory Standard* does allow some flexibility here: "For experimental materials where the items are stored and retained within a laboratory where the properties of materials are likely to be well understood, only sample identification and names are needed." With this statement in mind, research materials and reactions vessels must be marked to be clear to workers in the lab and a reaction in process sign indicating components must be posted if the reaction vessels are being held for longer than one working session. As above, labeling with only the chemical formula is not considered adequate.

### *6.8 Distribution*

In the Department of Chemistry and Biochemistry, the distribution of chemicals is monitored by the Natural Sciences Laboratory Program Manager. Chemicals are assigned to a specific location and must be signed out using the reagent sign out sheets posted by the door of the main chemical storage room. Reagent bottles that are removed from their assigned storage areas must be returned promptly.

Chemicals must not be transported throughout the building without secondary containment. It is recommended that chemicals be transported using a cart with secure secondary containment to hold any spills. Small quantities of chemicals being transported may be placed in a plastic bucket for transport.

### *6.9 Off Campus Transportation of Chemicals*

Messiah University is not a registered hazardous material transporter. Therefore, chemicals cannot be transported off campus by employees driving either private or Messiah University vehicles. The U.S. Department of Transportation does permit exceptions for small quantities of chemicals for educational demonstrations (see Section 5.2) and research. In those cases, small quantities of chemicals can be transported by individuals if they are properly labeled and packaged. Transportation by public convenience is not permitted. Also prohibited are acutely toxic substances, biological hazards, radioactive materials, and compressed gas cylinders. In addition, 49 CFR 172-101 contains quantity limits on specific substances. Any member of the School of Science, Engineering and Health wishing to transport any chemical off campus must report it to the Chemical Hygiene Officer for review, guidance, and approval. Hazardous Waste must not be transported off campus by any individual under any circumstance.

## *7 Standard Operating Procedures for Chemicals of Special Concern*

### *7.1 Introduction*

In the laboratory setting there are a multitude of chemicals that may be in use at any one time. It is possible that many of these chemicals have specific health hazards that are unknown or undocumented. Intermediate and unknown research products may also have hazards not documented within chemical literature. For this reason, it is impossible to develop Standard Operating Procedures for all hazardous chemicals that may be encountered in the laboratory. It is recommended that all chemicals in the laboratory be handled as though they are hazardous to protect laboratory workers from unnecessary skin contact and inhalation of potentially hazardous chemicals. The Standard Operating Procedures included here are written for general classes of chemicals and are not intended to be complete guidelines for the use of specific substances. Individuals may need to develop additional procedures and precautions when using hazardous materials in a particular laboratory. If additional procedures are necessary, the supervising faculty member and the Chemical Hygiene Officer must be consulted

prior to using the hazardous substance. Ultimately, it is the responsibility of the individual(s) using the chemical(s) to ensure that all necessary safety precautions are followed.

Generally, the principle that must govern the handling of all hazardous substances is limiting exposure. This can be accomplished through the use of personal protective equipment, laboratory fume hoods, glove boxes, respirators, or other administrative or engineered controls.

## 7.2 Acutely Hazardous Chemicals and Particularly Hazardous Substances (PHS)

### 7.2.1 Designated Areas

Acutely hazardous chemicals and particularly hazardous substances must only be used in designated areas and under the supervision of a faculty member. (See Section 8 Signs)

### 7.2.2 Record Keeping

Faculty and staff must maintain records of the names of students or employees using acutely hazardous materials under their direction, as well as the name of the chemical, the amount used, and the time spent exposed to the chemical. For assistance in monitoring exposure, the Office of Human Resources and Compliance must be contacted.

## 7.3 Carcinogens

Several organizations including the Occupational Safety and Health Administration (OSHA), the American Council for Governmental Industrial Hygienists (ACGIH), the National Toxicology Program (NTP), and the International Agency for Research on Cancer (IARC) maintain lists of known or suspected carcinogens. These lists are not exhaustive; therefore, it is possible that chemical carcinogens used in the laboratory do not appear on the list. However, the list has been compiled from the most up-to-date research available. The list will be updated periodically as new information becomes available.

### 7.3.1 Select Carcinogens

A substance is a select carcinogen if:

- It is regulated by OSHA as a carcinogen in a specific standard
- Listed as "known to be a carcinogen" or "reasonable anticipated to be a carcinogen" by the National Toxicology Program (NTP)
- Or, it is listed as "carcinogenic to humans" or "probably or possibly carcinogenic to humans" by the International Agency for Research on Cancer.

These materials are strong carcinogens and must be handled as particularly hazardous substances. All guidelines, including record keeping and designated areas for use, outlined for acutely hazardous or particularly hazardous substances, must be observed when using select carcinogens. Access to areas where carcinogens are in use must be restricted.

## 7.4 Embryo and Reproductive Toxins

Embryo and reproductive toxins are substances that alter normal reproductive functions. They include materials that are potentially harmful to men, women, and fetuses. This category of chemicals includes toxins that cause mutations, chromosomal damage, birth defects, fetal deformities, and fetal death. These substances are regulated by the Toxic Substance Control Act with information about specific hazards available in the SDS for that substance. The most extensive list of suspected Embryo and Reproductive toxins is maintained by the State of California under Proposition 65 and is referenced by both the State of Pennsylvania and the Federal government. This list can be found at: https://oehha.ca.gov/proposition-65/proposition-65-list. It should be noted that this list is under constant review. The current SDS for a given chemical must be consulted for the latest information.

Due to the potential harm these toxins can cause, every precaution must be taken to preclude exposure. In general, these substances must not be used in freshman and sophomore level laboratories. In upper class laboratories, or research where use of these substances may be required, the instructor will advise students of

the risk, ensure that appropriate safety equipment is used, and that proper laboratory techniques are observed. If a student is pregnant, lactating, or expresses concern about being exposed to these substances, an alternative assignment may be developed if alternative assignments are requested for fewer than 10% of the experiments in a semester. In courses (for example, BIOL 465 Gross Anatomy and CHEM 342 Advanced Synthesis and Spectroscopy) with routine and repeated exposure to such hazards, an alternative assignment may not result in the same educational outcome. In these courses, students who are pregnant, lactating, or who express concern will be allowed to take the course only with the specific written approval of their medical doctor.

### *7.5 Radioactive Materials*

All procedures, demonstrations, research studies, and other activities involving radioactive materials are subject to the approval the Radiation Safety Officer. The Department of Computer, Mathematics & Physics maintains low level radiation sources that are exempt from licensing. Those sources must be managed under the guidance provided by Section 24 of the University *Safety Manual*. The Radiation Safety Officer will monitor that compliance. In addition, all purchases of radioactive materials must be approved by the Radiation Safety Officer.

### *7.6 Flammable Substances*

Flammable liquids are any liquids that form a combustible or explosive mixture in air. The liquid itself does not burn, but rather the vapors released by the liquid. For this reason, it is important to note the flashpoints of several common laboratory materials as they have very low flashpoints and will combust readily in the presence of an ignition source. Care must be taken to use flammable materials only in areas that are free of ignition sources such as electric motors, open flames, and hot surfaces. Avoid static electricity sparks by grounding metal containers. When using significant quantities of flammable materials, a fume hood must be used to prevent the buildup of flammable vapors.

### *7.7 Hydrofluoric Acid*

Hydrofluoric acid is an extremely toxic substance that poses particular health risks due to the fact that it deeply penetrates the skin and body tissue causing severe chemical burns. These burns can be excruciating painful, long lasting, and disfiguring. Once in the body, the fluoride ion can spread quickly, causing multiple organ toxicity. The Chemical Hygiene Officer must be consulted prior to working with hydrofluoric acid.

When working with hydrofluoric acid it is necessary to use neoprene gloves, chemical splash goggles or a face mask, and a rubber or plastic apron. All procedures with hydrofluoric acid must be carried out in the hood. A supply of calcium gluconate gel must be readily available in the event of exposure. Any suspected exposure must be rinsed immediately with copious amounts of water and treated with calcium gluconate gel. Medical attention must be sought as soon as possible.

### *7.8 Explosive Materials and Peroxide Formers*

Explosives are materials that are sensitive to heat, friction, impact, sparks, and other forms of ignition. They react violently when exposed to such conditions. Explosive compounds are part of a broader hazard class, reactive chemicals, some of which also have explosion risks. The use of explosive materials and other material with explosion risks must be discussed with the Chemical Hygiene Officer prior to purchase or use. In addition, appropriate hazard controls and personal protective equipment must be used.

Many of the explosive materials used in the laboratory come in the form of organic peroxides and peroxide forming compounds. As a class, organic peroxides are low power explosives, but their unpredictable and sensitive nature makes them one of the most dangerous classes of chemicals handled in the academic laboratory. These compounds are also light sensitive and highly reactive when exposed to strong oxidizing or reducing agents. The remainder of this section focuses on peroxide-forming chemicals.

A significant number of laboratory solvents are peroxide formers (PFs) which may undergo auto-oxidation under normal storage conditions resulting in the *unwanted* formation of unstable and dangerous peroxides. For

some compounds, the peroxide is stable enough to accumulate in the container or vessel. Shock, heat, or friction may cause an unexpected explosion of peroxidized chemicals. Due to their unpredictable and sensitive nature, special care must be taken when handling PFs, including specific inventory, handling, storage and disposal procedures.

There are three general categories of organic peroxide-forming chemicals based on the hazard of peroxide formation.
**Important note**: The ability to form peroxides is a hazard category that is not identified by GHS pictogram. Check the chemical's Safety Data Sheet (SDS) for specific hazard information in Section 2, 7, and/or 10.

**Class A** – High Hazard without Concentration. These chemicals may spontaneously form peroxides that will make the materials shock- or heat-sensitive "on the shelf", that is without any further concentration through evaporation or distillation. These chemicals must be disposed within 3 months of the date opened and 18 months from date received. Currently, there are no Class A chemicals in inventory in SEH.

**Chemicals that form explosive levels of peroxides without concentration** (list not all inclusive)

| | | |
|---|---|---|
| Butadiene (liquid monomer) | Chlorobutadiene (liquid monomer) aka chloroprene | Divinyl acetylene |
| Isopropyl ether | Potassium amide | Sodium amide aka sodamide |
| Tetrafluoroethylene (liquid monomer) | Vinylidene chloride | |

**Class B** – Hazard upon Concentration. These chemicals can produce peroxides when stored, and there is increased risk when the chemicals are distilled, evaporated, or otherwise concentrated. Distillation can lead to heat induced detonation of the concentrated, less volatile peroxides. Do not heat, distill, or evaporate without first testing for the presence of peroxides. Peroxides may concentrate to higher viscosity or form a separate liquid phase. Some of these chemicals (some secondary alcohols) may form peroxides more slowly than others. These chemicals have a 12-month storage and use limit from the date opened and 18 months from date received in the lab. Alternatively, category B PFs maybe stored and used for longer than 12 months if they are tested for peroxide formation every six months, as described below in "7.8.1 Testing for Peroxides and Removing Peroxides."

**Chemicals that form explosive levels of peroxides on concentration** (list not all inclusive)

| | | |
|---|---|---|
| Acetal | Cumene (isopropylbenzene) | Cyclopentene |
| Cyclooctene | Cyclohexene | Diethylene glycol dimethyl ether |
| Diaacetylene | Dicylopentadiene | Ethylene glycol dimethyl ether |
| Diethyl ether | 1,4 dioxane | Methyl-isobutyl ketone |
| Furan | Isopropanol* | Vinyl ethers |
| Tetrahydrofuran | Tetrahydronaphthalene | |

*dilutions of isopropanol do not accumulate peroxides readily

**Class C** – Polymerization Hazard. These chemicals may form peroxides with the potential to initiate rapid, explosive polymerization. Many are monomers of common plastics. Inhibitors are usually added to prevent polymerization. Uninhibited Class C PFs should be used within 24 hours. If inhibited, chemicals may be stored and used for 12 months from the date opened or within 18 months from date received by the lab. Do not test for peroxides and do not treat to remove peroxides.

**Chemicals that may autopolymerize upon peroxide concentration**

| | | |
|---|---|---|
| Acrylic acid | Butadiene | Chlorotrifluoroethylene |
| Methyl methacrylate | Styrene | Vinyl acetate |
| Vinyl chloride | Ethyl acrylate | Vinyl pyridine |

The following are safe practices for working with peroxide forming materials:

- Always know what PFs are in your research and teaching laboratories.
- Only purchase PFs which contain a peroxide formation inhibitor (or polymerization inhibitor for Class C) when presence of inhibitor does not interfere with procedures. Important Note: The inhibitors will slow down – but not stop – peroxide formation.
- Purchase, store, and use the minimum quantity necessary. Limit purchase to what you expect to use within the manufacturer's expiration date or disposal timeframes described above.
- Store PFs away from heat and light in sealed airtight containers. Store in amber glass.
- Protect PFs from physical damage, heat, and light.
- Do not concentrate, distill, or evaporate PFs unless absence of peroxides has been shown.
- Do not store PFs at such a low temperature that the peroxide may freeze or precipitate. The material is very dangerous (extremely shock and heat-sensitive) in this form.
- Immediately rinse empty containers that once held PFs with a compatible solvent. Do not let residues evaporate.
- Label all containers of PFs as follows:
    - the words "peroxide forming chemical"
    - the date received
    - the date opened
    - the expiration date (if given by manufacturer)
    - the date tested and quantity of peroxide
- Visually inspect containers before handling. Do not handle or open containers that show evidence of peroxide formation. Contact the Chemical Hygiene Officer for removal/disposal. Visual indicators of peroxide formation include:
    - Whitish crystals around the cap and/or in the bottle
    - A stuck lid
    - Visible precipitate or an oily viscous layer present in the material
    - Evidence of surface crust or discoloration
    - Residue after evaporation of a sample
- Use or dispose of opened and unopened containers before the manufacturer's expiration date or the recommended shelf life listed below, whichever date comes first.

**Recommended Shelf Life of Peroxide Formers**

| | Class A | Class B* | Class C |
|---|---|---|---|
| From Date Opened | 3 months | 12 months | 24 hours (uninhibited)<br>12 months (inhibited) |
| From Date Received | 18 months | 18 months | 18 months |

*Alternatively, class B PFs can be tested for the presence of peroxides on a schedule (see section 7.8.1 below)

### *7.8.1 Testing for Peroxides and Removing Peroxides*

It is important to determine whether peroxides are present in PFs. The goal is to keep peroxides from accumulating to a hazardous level. Generally, a level of < 25 ppm is considered safe. Unfortunately, there are inconsistencies in published values indicating what level of peroxide is hazardous. Consequently, the practice of testing for and removing peroxides that accumulate does not eliminate the risk of using PFs beyond the recommended disposal date. Another consideration is the fact that the waste vendor contracted to remove hazardous waste from the Messiah campus does not accept PFs containing detectable levels of peroxides. Therefore, keeping a PF past the recommended shelf life requires diligence and knowledge of procedures to remove peroxides.

In general, you should use, dispose, or test for safety within 6 months of opening the container. Once a container is opened, testing should continue, as follows:

- Every 3 months for Class A

- Every 6 months for Class B

Testing may be done using peroxide test strips (dip strips) such as Quantofix Peroxide Test sticks, following the manufacturer's instructions, or by the following American Chemical Society recommended procedure:

1. Mix a 1-3 mL aliquot of the solution with an equal volume of glacial acetic acid.
2. Add a few drops of aqueous potassium iodide solution and shake.
3. The appearance of a yellow/brown color indicates the presence of peroxides.

Be sure to test only if:

- The identity of the chemical is known
- The age of the chemical is known
- Evaporation is less than 10%

Compounds contaminated with peroxides must be treated chemically to eliminate the peroxides

- before they can be distilled or evaporated to less than 10-20% residue
- before they are disposed
- before peroxides accumulate to a hazardous level

Two methods, the Activated Alumina Method and the Ferrous Salt Method, may be used to remove peroxides. Compounds must be retested after the procedure. Additional information on peroxide removal can be obtained from the Chemical Hygiene Officer.

## *7.9 Corrosive Materials*

For this Standard Operating Procedure, corrosive materials are considered to be any material (solid, liquid, or gas) that can rapidly damage human tissue, metal, or other compounds by chemical action. The primary considerations when using corrosive materials are the use of personal protective equipment, and compatible containers and materials for procedures. Individuals using corrosives must wear rubber or neoprene gloves, chemical splash goggles, and a rubber apron. Corrosive materials must only be used in areas with eye wash and safety shower stations. In case of exposure, flush with water and seek medical attention immediately.

## *7.10 Mercury and Mercury Compounds*

### *7.10.1 Use*

In order to prevent mercury exposure, one should use supplies and equipment that do not contain mercury when possible. Metallic mercury has been almost completely eliminated in laboratory instruments; however, some still exists. Mercury compounds are used in many laboratory experiments. Mercury thermometers must not be used where alcohol thermometers are satisfactory.

### *7.10.2 Toxicology*

Metallic mercury and mercury compounds can be absorbed into the body by inhalation, ingestion, or skin or eye contact. It is a subtle poison, the effects of which are cumulative and not readily reversible. The maximum exposure level (Time-Weighted Average) for metallic mercury compounds is 0.05 $mg/m^3$. The TWA for organic mercury compounds is 0.001 ppm. Even at very low levels, chronic mercury exposure can be a serious risk.

Chronic exposure to mercury through any route can produce central nervous system damage. Skin contact with mercury compounds produces irritation and various degrees of corrosion. Absorption into the body through the skin may be great enough to produce mercury poisoning. Rapid absorption of dimethylmercury through disposable gloves onto skin has caused a laboratory fatality at another university.

### *7.10.3 Storage, Use and Spill Prevention*

Every effort must be made to prevent spills, since spilled mercury is extremely difficult and time-consuming to pick up. Droplets get into cracks and crevices, under table legs, and under and into equipment. If spills are frequent and mercury is added to the general air level, the combined concentration may exceed the allowable limits.

Containers of mercury must be kept closed and stored in a well-ventilated area. If the container is glass, a secondary container must be provided. Waste mercury must be stored under water or in a special reclamation vessel. When using instruments or apparatus containing mercury and when breakage is a possibility, the equipment must be placed in a metal or plastic tray or pan which can be easily cleaned and is large enough to contain the mercury. Transfers of mercury from one container to another must be carried out in a hood, over a tray or pan to confine any spills.

Only employees trained to work with the materials can clean up an elemental mercury spill. If you spill mercury or discover a spill, isolate the spill area to keep people from walking through the area. Then call Dispatch and/or contact: Lauri Norbeck, (Chemistry Department), Laurie de la Riva (Biology Department), or John Meyer (Engineering Department). Further information is found in the "Emergency Procedures for Mercury Spills" in the Messiah University Hazard Communication Program: Chemical Safety Manual.

## *7.11 Ethidium Bromide*

Ethidium bromide is a carcinogen commonly used in the staining of electrophoresis gels. Precautions to limit exposure must be taken when handling ethidium bromide solutions and electrophoresis gels containing ethidium bromide. Appropriate personal protective equipment is adequate in most cases. However, concentrated ethidium bromide solutions must only be handled in a fume hood. Used staining solutions and electrophoresis gels are hazardous wastes and must be disposed of according to Section 13 Chemical Waste Disposal.

## *7.12 Allergens*

Certain laboratory chemicals can cause individuals to develop allergic reactions after repeated exposure. Common laboratory allergens include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, and many phenolic compounds. As with all hazardous substances, skin exposure must be minimized.

## *7.13 Compounds with Specific Health Risks*

Many compounds used in the laboratory pose health risks to specific organs or body systems. These compounds include: (a) hepatotoxic (substances that produce liver damage such as nitrosamines and carbon tetrachloride), (b) nephrotoxins (agents causing damage to the kidneys such as certain halogenated hydrocarbons), (c) neurotoxins (substances which produce their primary toxic effects on the nervous system such as mercury, acrylamide, and carbon disulfide), (d) agents which act on the hematopoietic system (such as carbon monoxide and cyanides, which decrease hemoglobin function and deprive the body tissues of oxygen), and (e) agents which damage lung tissue such as asbestos and silica.

*Source: Massachusetts Institute of Technology Chemical Hygiene Plan Template Revision 2*

## *7.14 Compounds with Acute Toxicity*

29 CFR 1910.1200 Appendix A of the OSHA regulations provides the classifications for toxic and acutely toxic substances as follows:

| **Test** | **Toxic** | **Highly Toxic** |
|---|---|---|
| Oral $LD_{50}$ (albino rats) | 50-500 mg/kg | <50 mg/kg |

| | | |
|---|---|---|
| Skin Contact $LD_{50}$ (albino rabbits) | 200-1000 mg/kg | <200 mg/kg |
| Inhalation $LC_{50}$ (albino rats) | 200-2000 ppm/air | <200 ppm/air |

Several compounds in use in the laboratory setting may be classified as having a high degree of acute toxicity. Some examples include:

abrin
acrolein
arsine
chlorine
diazomethane
diborane (gas)
hydrogen cyanide
hydrogen fluoride
methyl fluorosulfonate
nickel carbonyl
nitrogen dioxide
osmium tetroxide
ozone
phosgene
ricin
sodium azide
sodium cyanide (and other cyanide salts)
strychnine

The above list is not exhaustive, and as with all laboratory procedures, it is the responsibility of the faculty member, laboratory instructor, or researcher to investigate the specific hazards associated with the chemicals in use in the laboratory.

### *7.15 Perchloric Acid*

Perchloric acid is a very strong acid that reacts violently with organic solvents and other substances. Hoods and bench tops are not designed for working with perchloric acid. This substance has been removed from inventory and is not within SEH.

### *7.16 Nitric Acid*

Special care must be taken with nitric acid since it an extremely strong oxidizer. Numerous explosions have occurred in organic waste bottles when nitric acid waste was inappropriately added. In labs where there are both organic waste and solutions containing nitric acid present, extra precautions must be taken to ensure those waste streams are not mixed. For example, waste bottles could be segregated in designated hoods. Instructors must make a special effort in those labs to point out this hazard and closely monitor the disposal of waste.

### *7.17 Guidelines for Implementing Standard Operating Procedures*

As noted throughout the *Chemical Hygiene Plan*, it is the responsibility of faculty members, laboratory instructors, or researchers to investigate and plan for potential hazards in the laboratory for which they are responsible. Prior to commencing any laboratory procedure, the following steps must be completed:

1. Determine the specific hazards and toxicities of the chemicals to be used in the laboratory.
2. Determine the most likely routes of exposure (i.e. inhalation, skin exposure, ingestion, etc.) based on the intended use and/or chemical properties of the materials to be used.
3. Determine necessary controls (i.e. the use of fume hoods, personal protective equipment, etc.).
4. Plan for disposal of hazardous materials.
5. Prepare for accidents and/or emergencies.

The *Chemical Hygiene Plan* includes guidelines for use of the most common classes of hazardous materials used in the laboratory. If additional assistance is required to determine what Standard Operating Procedures are necessary for the materials being used in your laboratory, the Chemical Hygiene Officer and/or the Office of Human Resources and Compliance are available for consultation.

# 8 Signs

## 8.1 Safety Signage

All laboratories requiring personal protective equipment are marked with safety signs. Signs may read "Goggles Required" or "Gloves Required" and are not intended to be exhaustive in terms of what PPE may be necessary for a given procedure. Laboratory instructors will give specific instructions regarding PPE that may not be included on posted signs. Certain areas with specific hazards, such as those around autoclaves, are also marked with signs warning of the dangers and indicating what safety equipment is necessary.

## 8.2 Designated Areas

Certain chemicals, such as select carcinogens, reproductive and embryo toxins, and radioactive materials require special signs indicating areas where these chemicals may be in use. These signs are necessary for alerting individuals, who may or may not be directly involved with the current procedure, of potential dangers.

Signs within the School of Science, Engineering and Health also designate areas for Hazardous Waste Accumulation and Chemical Storage Areas in fume hoods. Areas that are not designated for waste accumulation or chemical storage must not be used for those purposes.

## 8.3 Emergency Signs

In the event of a fire or other incident requiring the evacuation of a laboratory, evacuation maps and plans can be found posted by the door on the inside of each laboratory. Emergencies must be reported immediately to the Department of Safety by calling Dispatch (x6005). The emergency number for 3E Company, which provides SDS information, is posted on every phone.

# 9 Spills

It is the policy of Messiah University to respond safely and appropriately to an accidental release or spill of hazardous materials. Any spill within the School of Science, Engineering and Health must be responded to as set forth in Section 8 of *the Hazard Communication Program: Chemical Safety Manual*. A copy of is also available in all chemistry labs within Kline/Jordan.

# 10 Emergency Procedures

Emergency procedures for the School of Science, Engineering and Health are governed by the Office of Human Resources and Compliance. The Messiah University Emergency Action Plan can be found in the *Safety Manual.*

# 11 Employee Information and Training

The Office of Human Resources and Compliance shall oversee the training and retraining of employees. Training and retraining for students and new faculty that is specific to the School of Science, Engineering and Health will be coordinated by the appropriate departmental chair, the Chemical Hygiene Officer, and the appropriate departmental laboratory manager or lab coordinator, who will also maintain a record of student assistant training. Laboratory specific training, and recording thereof, for student research assistants is the responsibility of the applicable research director.

# 12 Personal Protective Equipment (PPE)

## 12.1 Chemical Splash Goggles and Safety Glasses

As noted in "General Laboratory Safety Rules", chemical splash goggles or a chemical face shield must be worn where there is a risk of splashes from toxic, corrosive, infectious, or otherwise dangerous chemicals. Chemical splash goggles must cover the eyes completely, have indirect ventilation, and have impact resistant lenses to prevent debris from damaging the eyes in the event of an explosion.

Safety glasses must be worn in laboratories where chemicals are not in use but laboratory procedures (such as dissection or engineering work) would create a physical hazard to the eyes. Safety glasses do not provide splash protection, and therefore do not meet lab safety requirements in wet chemistry laboratories. In laboratories where both wet chemistry work is being conducted and equipment is being used which would preclude the wearing of goggles (i.e. microscope), then the wet chemistry must be restricted to a specified area of the room and chemical splash goggles must be worn in that area.

## *12.2 Gloves*

### *12.2.1 Scope*

This section provides information and guidance for the selection and use of chemical resistant gloves. It does not apply to gloves for mechanical or electrical work, or thermal protection.

### *12.2.2 Selection*

No single glove material will effectively resist all chemicals. In selecting the proper glove for a specific use, several factors must be considered.

1. Chemical and physical properties of the chemical
2. Toxicological effects on the skin
3. Nature and severity of the exposure
4. Required duration of protection
5. Physical performance requirements
6. Length of glove needed

In many small-scale laboratory operations carried out in Messiah University chemical laboratories, chemicals of limited hazard by skin absorption are handled for a short time and no skin contact will occur if recommended procedures are followed. Gloves are worn for protection in case some contact does occur, and the chemical can be washed off immediately. In such cases, use of non-reusable gloves of poly(vinyl chloride), chloroprene, or latex may be acceptable even though they would not be recommended for long term contact with the chemical. Such gloves are not acceptable for chemicals which are highly hazardous by skin absorption. Whenever a chemical is spilled on non-reusable gloves, the gloves must be removed immediately, and the hands washed well with soap and water.

Each faculty member or laboratory instructor responsible for a laboratory will make a judgment of what type of glove is needed for the application. If disposable latex gloves are used, another type must be available for any worker who is allergic to natural rubber latex.

In case of possible contact with a chemical highly hazardous by skin absorption, potential long-term contact with a chemical, or cleanup of a significant spill, gloves recommended for that particular chemical must be used. Provision of gloves for these situations is the responsibility of the professor overseeing the laboratory work. In most of the cases encountered in Messiah University laboratories, neoprene gloves will be satisfactory for these situations.

### *12.2.3 Care of Gloves*

Before putting on gloves, the user must examine them for punctures or tears. If defects are found, they must be replaced. Periodically, reusable gloves must be tested for leaks by inflating with air and immersing in water. Bubbles will indicate leakage. An alternate test involves spinning the gloves by holding the cuff between the hands and, when full of air, twisting the cuff to seal. Loss of pressure will indicate leakage.

Reusable gloves which are impervious to water must be cleaned after each use, and before removing, by rinsing thoroughly with water. Reusable gloves must always be stored in a clean and accessible area. Never store contaminated gloves.

# 13 *Chemical Waste Disposal*

## *13.1 Policy*

The Messiah University *Waste Manual* governs the disposal of all unwanted material including chemical waste generated by the School of Science, Engineering and Health. Below are items of particular concern to laboratories operating under this *Chemical Hygiene Plan*. However, all personnel involved must be familiar with the policies for all types of waste. The *Waste Manual* also contains the latest version of local township regulations pertaining to what unwanted material may be placed in the sanitary sewage system.

## *13.2 Hazardous Waste Identification*

Unwanted chemicals may or may not be hazardous waste. A person generating unwanted chemicals must first consider if the material can be reused or neutralized; if so, it is not considered waste. If the material is waste, the generator must determine which waste stream is appropriate for the material. Faculty should provide this determination for students. The process for making this determination must include consideration of all applicable regulations, including local waste regulations (i.e., what can go in the regular trash, what can go down the sink drains, etc.) For some types of chemical waste, the local regulation(s) prohibit the material from entering a local waste stream even though the federal (EPA) regulation does not define the waste as hazardous. In these cases, the chemical waste should either be treated as hazardous waste or be disposed by the hazardous waste vendor as non-hazardous material.

Hazardous waste (as defined by the EPA) is waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment. This waste is subject to specific RCRA Subtitle C regulation. The EPA website provides information to help identify if unwanted chemicals are hazardous waste and, therefore, subject to hazardous waste regulations.
Learn the Basics of Hazardous Waste | US EPA
Defining Hazardous Waste: Listed, Characteristic and Mixed Radiological Wastes | US EPA

Each hazardous waste accumulated for disposal must be assigned an EPA hazardous waste code as outlined by the Resource Conservation and Recovery Act (RCRA). These codes identify the characteristic and/or source of the waste. RCRA numbers will be assigned by the chemical waste vendor prior to disposal of the waste. The RCRA number will be assigned based on the hazardous waste label and/or the hazardous waste log that is maintained at the point of generation for each waste container. Therefore, it is important that each container is accurately labeled with the information needed by the chemical waste vendor.

## *13.3 Hazardous Waste Labels*

Every container used to accumulate or store hazardous waste must have:

- a red label with the words "**Hazardous Waste**."
- the label must **indicate the container's contents**. Each time waste is added to the container, the generator (person generating the waste) must record it in a hazardous waste log or ensure it is indicated on the hazardous waste label. Abbreviations and/or chemical formulas must not be used to record the contents.
- the container must be labeled with the **hazards of the contents** (i.e., ignitable, corrosive, reactive, toxic). Each time waste is added to the container, the hazards of the contents must be re-evaluated and updated, as needed.
- the **accumulation start date** (not the date when contents are first added to the container) indicating when waste is moved to a Central Accumulation Area (CAA).

Containers for chemicals that are intended to be reused must not be labeled as waste.

## *13.4 Containers*

Hazardous waste generated by the School of Science, Engineering and Health is predominately stored in two liter or four-liter glass bottles. Solid hazardous waste is often stored in plastic jars. All waste containers must be sealable and always remain closed except when adding waste to them. Containers and lids must be

constructed of material compatible with the waste being stored and separated from one another according to chemical compatibility.

### *13.5 Accumulation and Storage*

Hazardous waste must be accumulated at or near the point of generation in properly designated areas with signs labeled "Hazardous Waste Satellite Accumulation Area (SAA)." Only one container per waste stream is permitted at an SAA. The laboratory managers or lab coordinator must be contacted immediately to pick up a filled container, a container that is no longer needed, or a container that has been in a SAA for one year. The lab managers and lab coordinator can provide new containers, if necessary. It is important that hazardous waste containers are not filled all the way to the top; some space must be left in the top of the container. The laboratory managers or lab coordinator will arrange with the Waste Coordinator for the transportation of hazardous waste containers to the Central Accumulation Area in Kline 301A or Lenhert.

SAA locations are to be inspected by the laboratory managers or laboratory coordinator on a weekly basis to ensure that all containers are labeled, sealed properly, and that contents of the waste container are documented. It is the ultimate responsibility of the person in charge of the laboratory where the accumulation area is located to oversee its daily use. The Chemical Hygiene Officer is available for consultation regarding accumulation areas and their proper use and will assist in correcting issues if an area is not used or maintained properly.

### *13.6 Incompatible Wastes*

Chemical waste must be segregated according to category and special care must be taken to prevent mixing of incompatible waste by segregating into separate containers which are separated by distance. Mixing incompatible waste could result in a serious explosion or fire. Examples of incompatible waste are given in the non-exhaustive list below (adapted from 40 CFR Part 264 Appendix V.

| Waste Type | Incompatible With | Potential Consequences |
|---|---|---|
| Group 1: Acidic aqueous waste<br>Examples include<br>Acid sludge, acid and water, battery acid, chemical cleaners, electrolyte acid, etching acid liquid or solvent, pickling liquid and other corrosive acids, spent acid, spent mixed acid, spent sulfuric acid | Group 2, 3 | Fire, explosion, or heat generation; generation of flammable or toxic gas |
| Group 2: Basic aqueous waste<br>Examples include<br>Acetylene sludge, alkaline caustic liquids, alkaline cleaner, alkaline corrosive liquids, alkaline corrosive battery fluid, caustic wastewater, lime sludge and other corrosive alkalis, lime wastewater, lime and water | Group 1, 3 | Fire, explosion, or heat generation; generation of flammable or toxic gas |
| Group 3: Reactive metals and metal hydrides<br>Examples include<br>Aluminum, beryllium, calcium, lithium, magnesium, potassium, sodium, zinc powder, other reactive metals and metal hydrides | All other groups | Fire, explosion, or heat generation; generation of flammable or toxic gas |
| Group 4: Alcohols and water | Groups 1 and 2 (if concentrated), calcium, lithium, metal hydrides, potassium, other | Fire, explosion, or heat generation; generation of flammable or toxic gas |

| | | |
|---|---|---|
| | water-reactive waste | |
| Group 5: Organic compounds<br>Examples include<br>Alcohols, aldehydes, halogenated hydrocarbons, nitrated hydrocarbons, unsaturated hydrocarbons, other organic compounds and solvents | Groups 1 and 2 (if concentrated), 3 | Fire, explosion, or violent reaction |
| Group 6: Cyanide and sulfide solutions | Group 1 | Generation of toxic hydrogen cyanide or hydrogen sulfide gas |
| Group 7: Oxidizers<br>Examples include<br>Chlorates, chlorine, chlorites, chromic acid, hypochlorites, nitrates, fuming nitric acid, perchlorates, peroxides, other oxidizers | Group 3, 5, acetic acid, other organic acids, mineral acids, flammable or combustible waste | Fire, explosion, or violent reaction |

## *13.7 Wastes Requiring Special Procedures*

### *13.7.1 Unknown Waste*

By law, unknown waste must not be disposed of without first performing an analysis to determine the composition of the waste and any associated hazards. If the generator of the unknown waste is unable to determine its composition the generator must contact the Chemical Hygiene Officer to arrange for analysis.

### *13.7.2 Gas Cylinders*

Compressed gas cylinders are to be returned to the supplier. Lecture bottles are not accepted for return by many compressed gas suppliers, and therefore, the purchase of these items is discouraged.

### *13.7.3 Radioactive Waste*

The disposal of radioactive materials is the responsibility of the Radiation Safety Officer. Contact the Radiation Safety Officer for assistance with disposal.

### *13.7.4 Broken Glassware*

Broken glassware (bottles, burettes, beakers, test tubes, etc.) that is chemically contaminated is considered hazardous waste. These materials must be packaged in a puncture proof container and disposed of as hazardous waste. Broken glassware that is not chemically contaminated must be disposed of in the broken glass disposal boxes provided in each laboratory. Sealed broken glass disposal boxes must be disposed of in the municipal waste dumpsters. Broken glassware that is also biohazard waste must be disposed of as sharps waste (see below).

### *13.7.5 Sharps Waste*

Policies for sharps waste are found in the *Waste Manual,* Section II H 6: Hazardous Waste Generated in the School of Science, Engineering and Health, and *Waste Manual,* Section V Infectious Waste/Biohazard Waste. In these policies, "contaminated" refers to biohazard contamination (contamination with infectious agents) and "chemically contaminated" refers to hazardous waste contamination. Sharps are defined as any discarded items that can induce sub-dermal inoculation of infectious agents, or any item that can easily penetrate the skin, and puncture waste bags and cardboard boxes. Sharps are considered biohazard (infectious) waste whether they are contaminated with infectious agents or not. SEH laboratories commonly use sharps such as syringes, lancets, slides, coverslips, scalpels, and pipet tips. Used sharps must be placed in a sharps biohazard container for disposal as biohazard waste.

Sharps that are chemically contaminated are considered to be both hazardous waste and biohazard waste, a type of mixed waste. They must be placed in a sharps biohazard container and labeled properly as both hazardous waste and biohazard (infectious) waste. They must be disposed of as hazardous waste.

# 0 *Definitions*

The following list is largely from 1910.1450 Occupational exposure to hazardous chemicals in laboratories (Lab Standard)

***Action level*** means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

***Assistant Secretary*** means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

***Carcinogen*** (**see select carcinogen**).

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

***Chemical Hygiene Plan*** means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

***Combustible liquid*** means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

***Compressed gas*** means:
(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or
(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or
(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

***Designated area*** means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

***Emergency*** means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

***Employee*** means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of their assignments.

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

***Flammable*** means a chemical that falls into one of the following categories:
(i) **Aerosol, flammable** means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
(ii) **Gas, flammable** means:
(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or
(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.
(iii) **Liquid, flammable** means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C or higher, the total of which make up 99 percent or more of the total volume of the mixture.
(iv) **Solid, flammable** means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

***Flashpoint*** means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:
(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or
(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C ), or that contain suspended solids, or that have a tendency to form a surface film under test; or
(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).
Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

***Hazardous chemical*** means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

***Laboratory*** means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

***Laboratory scale*** means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale"

excludes those workplaces whose function is to produce commercial quantities of materials.

***Laboratory-type hood*** means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.
Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

***Laboratory use of hazardous chemicals*** means handling or use of such chemicals in which all of the following conditions are met:
(i) Chemical manipulations are carried out on a "laboratory scale;"
(ii) Multiple chemical procedures or chemicals are used;
(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and
(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

***Medical consultation*** means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

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

***Oxidizer*** means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

***Physical hazard*** means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

***Protective laboratory practices and equipment*** means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

***Reproductive toxins*** means chemicals which affect the reproductive chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

***Select carcinogen*** means any substance which meets one of the following criteria:
(i) It is regulated by OSHA as a carcinogen; or
(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or
(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be

carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);
(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or
(C) After oral dosages of less than 50 mg/kg of body weight per day.

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

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

*Source: http://www.osha.gov*

## 0 *Appendix A OSHA PEL's and ACGIH TLV's*

Monitoring for air quality and toxic substance exposure is regulated by 29 CFR 1910.1000 Subpart Z. The complete regulations for exposure monitoring, including limits, procedures, and a list of regulated substances can be found here:
eCFR :: 29 CFR Part 1910 Subpart Z -- Toxic and Hazardous Substances
(https://www.ecfr.gov/current/title-29/subtitle-B/chapter-XVII/part-1910/subpart-Z?toc=1)

## 0 *Appendix B Table of Known and Suspected Carcinogens*

For the most up-to-date information on known and suspected carcinogens, consult the following agencies.

- International Agency for Research of Cancer (IARC): http://monographs.iarc.fr/ENG/Classification/index.php.
- National Institute of Occupational Health (NIOSH): http://www.cdc.gov/niosh/npg/nengapdxa.html

For a list of OSHA regulated select carcinogens, consult www.osha.gov.

## 0 *Appendix C OSHA Laboratory Safety Standard 29 CFR 1910.1450*

The complete OSHA laboratory safety standard may be viewed here:
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106

# 0 *Appendix D Inspection Checklists*

**Laboratory Weekly Inspection Checklist**

**Inspector** _____

**Date** _____

| | **Access** | *Eye Wash* | *Exits* | *Fire Blanket* | *Fire Extinguisher* | *First Aid* | *Safety Shower* | **Function** | *Eye Wash* | *Fume Hoods* | *Safety Shower* | **PPE** | *Latex Gloves* | *Neoprene Gloves* | *Nitrile Gloves* | *Extra Goggles* | **SAA** | *Containers Closed* | *Labels* | *Sec. Containment* | *Waste Log* | **House Keeping** | *Benchtops* | *Chemical Storage* | *Hoods* | *Sinks* | *Storage Areas* | **Comments** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **K302** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **K313** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **K314** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **K318** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **J359** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **J363** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Corrective Actions:**

**Date of Completion:**

**Key** √ No Correction Necessary
X Needs Correction
N/A Not Applicable

# 0 *Appendix E Safety Guidelines for Chemical Demonstrations*

**American Chemical Society Division of Chemical Education**
Appropriate physical and chemical demonstrations in the classroom or in a public venue have both educational and motivational value and are a long-standing pedagogy in chemical education. Individuals planning chemical demonstrations have a responsibility to follow and document safe laboratory practices for each demonstration. These guidelines have been created based on current best practices and provide a checklist of key issues for demonstrators to assure that chemical demonstrations are conducted safely and without incident. **Because no such set of guidelines can address all possible issues, only persons who have appropriate education and experience in chemistry and chemical safety may perform chemical demonstrations. Accordingly, these guidelines are intended for use only by experienced chemical practitioners.**

**Before the Demonstration**

1. Always follow a **tested, written procedure** that includes comprehensive safety precautions. Plan the demonstration at the smallest scale possible for the location and viewers.
2. **Review the safety precautions** which will help you identify the potential hazards involved in the demonstration and understand the risks due to exposure and/or improper handling of a chemical, process, or procedure. Effective safety precautions provide easy-to-follow instructions to minimize risk and prevent unplanned incidents that could result in injury or property damage.
3. If a written procedure is not available, or safety precautions are not clear, perform an independent **hazard and risk assessment** to identify the possible hazards and evaluate the risks. In the risk assessment, consider the pedagogical value compared to the risk. Write the demonstration procedure with appropriate safety precautions to protect against the hazards and reduce risk. Refer to these guidelines as you write the demonstration procedure and retain the procedure on file for future use.
4. Always **practice** a demonstration before presenting it before students or an audience for the first time.
5. Ensure that all **demonstrations are appropriate for the room** being used and the available safety equipment. Keep all exit paths clear. Check the **ventilation** in the demonstration area to ensure that participants and audience members will not be exposed to harmful quantities of toxic gases or chemical vapors. The use of a **fume hood** is required for any demonstration that uses or produces a substance with a TLV less than 50 ppm (check the SDS for the TLVs of all chemicals).
6. Consult current **Safety Data Sheets** (SDS) and review the safe handling information for all chemicals used in the demonstration.
7. Prepare and follow a safety checklist for all **combustion demonstrations** involving the use of a flammable liquid. Dispense only the amount of the liquid required BEFORE beginning the demonstration. Cap the solvent bottle and REMOVE it from the demonstration area before applying the ignition source. NEVER add more flammable liquid to a combustion demonstration once it is underway.
8. Ensure that observers will be a **safe distance** (10 feet or more) or are protected by a physical barrier, such as a polycarbonate shield, from the demonstration area when working with flammable, corrosive or toxic substances. In a small setting such as a classroom or lab, all participants and observers must wear **appropriate eye protection** at all times.
9. Ensure there is an appropriate **fire extinguisher** on hand whenever the slightest possibility of fire exists and that you have the knowledge, experience and training to use it properly in the event of an emergency.
10. Keep a **spill kit** nearby to contain, absorb, and neutralize any spilled chemicals.
11. **Plan for appropriate handling or disposal** of reaction byproducts or excess chemicals in accordance with institutional policies.

**During the Demonstration**

1. Wear appropriate **personal protective equipment** (PPE) for the level of risk as determined by the assessment, such as chemical splash goggles, chemical-resistant gloves, and a lab coat, to protect against the hazards. Active participants must also wear appropriate PPE.
2. Provide **safety shield** protection whenever there is the slightest possibility that a container, its fragments or the contents could be propelled with sufficient force to cause exposure and/or personal injury.
3. **Warn** members of the audience to cover their ears if a loud noise is anticipated.

4. Participants and spectators must **not taste** any food or non-food substances used in the demonstration.
5. Do not perform demonstrations in which parts of the **human body** will be placed in danger (such as placing dry ice in the mouth or dipping hands into a hazardous liquid).

**Special Notes for Outreach or Public Demonstrations**

1. Ensure proper packaging and secondary containment for the **safe transport** of all chemicals to and from off-site locations. Materials of Trade (MOT) exceptions to Department of Transportation requirements allow for the transport of certain hazardous materials without a license or shipping papers provided certain guidelines are met. There are strict limits on the amounts of material, depending on the hazard. Visit the links below for more information about hazard classes, packaging requirements, and restrictions on the amounts of chemicals.
https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2023-06/MOTs-Brochure-0202-0523.pdf
https://www.acs.org/content/acs/en/about/governance/committees/chemical-safety/publications-resources.html

2. **Notify** security and/or administrators that you will be performing demonstrations. If public space will be used for demonstrations involving fire, **contact the local fire department** to determine if the demonstrations meet local fire and building use codes.
3. Provide a **written demonstration procedure,** including comprehensive safety precautions and risk assessments, whenever the audience will be encouraged to conduct the demonstration at another time.

**References**
NFPA 45: Standard On Fire Protection For Laboratories Using Chemicals https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=45
U.S. Chemical Safety Board: Key Lessons for Preventing Incidents from Flammable Chemicals in Educational Demonstrations
https://www.csb.gov/key-lessons-for-preventing-incidents-from-flammable-chemicals-in-educational-demonstrations/

Prudent Practices in the Laboratory http://www.nap.edu/catalog/12654/prudent-practices-in-the-laboratory-handling-and-management-of-chemical


October, 2016

**Reviewed**: 1/11, 1/12, 5/13, 6/14, 7/16, 6/17, 6/18, 5/19, 7/20, 7/21, 7/22, 7/23, 7/24
Revisions: 7/2024
Revise several sections for clarity and consistency
Update 5.1 Service Animals
Update 7.8 Explosive Materials and Peroxide Formers
Update 13 Chemical Waste Disposal

Revisions: 7/2023
Revise several sections to clarify roles and responsibilities for updating 3E Protect
Change contents of Section 13.7.4 from "Sharps Waste – Chemically Contaminated" to "Broken Glassware", and update Section 13.7.5 from "Sharps Waste- Clean" to "Sharps Waste"
Update Section 13.5 "Accumulation and Storage" to be consistent with the Waste Manual
Add Winding Hill to 2.2 Exclusions

Revisions 7/2022
Revise section 6.2 Receiving Chemicals to include Slingshot
Revise section 7.10 Mercury and Mercury Compounds to include some details of Spill Procedure

Revisions 7/2021
Revise "Safety Rules for Laboratories" and other sections to be consistent across all covered SEH laboratories
Revise "First Aid" to current policy
Delete "Baker Storage Color Code System" And "Appendix E Cross Reference Baker System to GHS"
Revise table "Incompatible Waste"

Revisions 7/2020
Change "College" to "University" as appropriate throughout document
Change "Compliance Coordinator" to "Office of Human Resources & Compliance" throughout document
Change "safety goggles" to "chemical splash goggles" throughout document
Combine sections 3.1 Compliance Coordinator and 3.5 Department of Human Resources, and renumber sections accordingly
Update 4.13 Fire Blankets to include instructions on proper use
Update 5.0 Additional Messiah University Policies to include the *Waste Manual*