

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY SAFETY MANUAL AND CHEMICAL HYGIENE PLAN



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Purpose of This Manual

The purpose of this manual is to meet the basic regulatory requirements of the OSHA Laboratory Standard for the development of a Chemical Hygiene Plan and to provide laboratories with useful recommendations that can help achieve compliance with the intent of the OSHA Lab Standard. Throughout this document, areas where regulatory or University requirements exist will be clearly identified using words such as “must”, “required”, “shall”, and “it is the responsibility”, etc. All other information provided within this document are recommendations that New Mexico Tech Safety encourages laboratories to follow as best management practices. **Departments and individual laboratories are free to establish the guidelines found within this document as required policies for their units or laboratories.**

Introduction

New Mexico Tech Safety outlines safety responsibilities and training requirements to ensure individual and institutional compliance with relevant environmental health and safety laws, regulations, policies, and guidelines. This Laboratory Safety Manual includes the University’s Chemical Hygiene Plan and recommendations for good laboratory practices to serve as a useful resource and to assist laboratories in designing their own site-specific laboratory safety procedures to meet these requirements.

The Occupational Safety and Health Administration (OSHA) regulation 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories", mandates health and safety practices and procedures in laboratories that use hazardous chemicals. The Standard became effective May 1, 1990 and requires that a Chemical Hygiene Plan be developed for each laboratory workplace. The purpose of the Laboratory Standard is to protect laboratory employees from harm due to chemicals while they are working in a laboratory. This regulation applies to all employers engaged in the laboratory use of hazardous chemicals, which OSHA defines as:

"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 safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

“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, skins, eyes, or mucous membranes 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 the purposes of this standard.

A complete description of definitions applicable to laboratories can be found in the OSHA Laboratory Standard.

In all other areas that use chemicals, but do not fall under the OSHA definition of a “laboratory”, the OSHA regulation 29 CFR 1910.1200 – “Hazard Communication Standard” applies.

Most laboratories at New Mexico Tech Safety using chemicals are subject to the requirements of the Laboratory Standard. In addition to employees who ordinarily work full-time within a laboratory space, other employees (such as office, custodial, maintenance and repair personnel) who regularly spend a significant amount of their time within a laboratory environment as part of their duties, also may fall under the requirements of the Laboratory Standard. OSHA considers graduate students who get paid for working in a lab as employees who are subject to the requirements of the Laboratory Standard.

The OSHA Laboratory Standard requires employers to develop a Chemical Hygiene Plan (CHP), designate a Chemical Hygiene Officer, and ensure laboratory employees are provided with the proper information and training, including knowing the location of the Chemical Hygiene Plan, and how to work safely in their labs. The main goals of the OSHA Laboratory Standard and the requirement to develop a chemical Hygiene plan are; to protect employees from health hazards associated with use of hazardous chemicals in the laboratory, and keep exposures below the permissible exposure limits as specified in 29 CFR Part 1910, subpart Z – Toxic and Hazardous Substances and other resources such as NIOSH and ACGIH. In addition to other requirements, the OSHA Lab Standard specifies the Chemical Hygiene Plan to include “criteria the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices etc; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous.”

New Mexico Tech Safety has taken responsibility for maintaining an institutional Chemical Hygiene Plan. Each college, center, department, or laboratory may adopt or modify this plan or write their own chemical hygiene plan as long as the requirements of the OSHA Laboratory Standard are met. It is assumed if a college, center, department, or laboratory has not developed their own chemical hygiene plan, then that unit or laboratory has adopted the New Mexico Tech Chemical Hygiene Plan. The New Mexico

Tech Safety CHP is maintained by New Mexico Tech Safety. The campus CHP is designed to supplement department and laboratory specific safety manuals and procedures that already address chemical safety in laboratories.

1.1 Chemical Hygiene Plan Accessibility

The OSHA Laboratory Standard requires the CHP to be readily available to employees, employee representatives and, upon request, to the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee. This means laboratory employees working with hazardous chemicals in a laboratory must know the location of the CHP, be familiar with the contents, and be able to produce the CHP for any state or federal regulatory inspectors upon request. While New Mexico Tech recommends a hard copy be kept in the laboratory, electronic access is acceptable and encouraged. The CHP can be found in Appendix A of this manual.

*****It is the responsibility of Principal Investigators and laboratory supervisors to ensure that personnel working in laboratories under their control are familiar with the contents and location of the Chemical Hygiene Plan, including any lab specific standard operating procedures and any department or college level laboratory safety manuals, policies, and procedures.**

1.2 Laboratory Safety Responsibilities

The ultimate responsibility for health and safety within laboratories lies with each individual who works in the laboratory; however, it is the responsibility of the Principal Investigator, Faculty, and laboratory supervisor to ensure that employees (including visiting scientists, fellows, volunteers, temporary employees, and student employees) have received all appropriate training, and have been provided with all the necessary information to work safely in laboratories under their control. Principal investigators, Faculty, and Lab Supervisors have numerous resources at their disposal for helping to ensure a safe and healthy laboratory that is compliant with state and federal regulations. A listing of New Mexico Tech staff, responsibilities, and services available to campus personnel can be found on the New Mexico Tech Safety Website.

It is the responsibility of the Principal Investigator and individual supervisors (and individuals working under their supervision) to be in compliance with the components of the University Chemical Hygiene Plan, the Environment, Health & Safety Policy 8.6, and any other department or University specific policies.

1.2.1 New Mexico Tech Safety

New Mexico Tech Safety (New Mexico Tech Safety) will provide technical information and program support to assist in compliance with the OSHA Laboratory Standard. This includes developing policies, recommendations and guidelines (as found in this

Laboratory Safety Manual), developing and providing training programs designed to meet regulatory requirements, and serving as consultants in providing health and safety information to laboratory personnel. New Mexico Tech will maintain the campus Chemical Hygiene Plan and the institutional Chemical Hygiene Officer responsibilities.

1.2.2 Director of Hazardous Materials

The role of the Director of Hazardous Materials is to facilitate the implementation of the campus CHP and this Laboratory Safety Manual in laboratories across campus and outlying facilities, and to serve as a technical resource to the campus laboratory community.

Lindsay Candelaria
Director of Hazardous Materials
NMT
(575)-835-5842

The major duties are:

- Work with campus stakeholders to evaluate, implement, review annually, and make updates as needed to the Chemical Hygiene Plan and Laboratory Safety Manual.
- Provide technical expertise to the laboratory community in the area of laboratory safety and health, and serve as a point of contact to direct inquiries to other appropriate resources.
- Ensure that guidelines are in place and communicated for particularly hazardous materials regarding proper labeling, handling, use, and storage, selection of proper personal protective equipment, and facilitating the development of standard operating procedures for laboratories using these substances.
- Serve as a resource to review academic research protocols and standard operating procedures developed by Principal Investigators and department personnel for the use, disposal, spill cleanup, and decontamination of hazardous chemicals, and the proper selection and use of personal protective equipment.
- Coordinate the acquisition, testing and maintenance of fume hoods and emergency safety showers and eyewashes in all laboratories where hazardous chemicals are used.
- Conduct laboratory safety training sessions for laboratory personnel and upon request, assist laboratory supervisors in developing and conducting hands-on training sessions with employees.
- Review reports for laboratory incidents, accidents, chemical spills, and near misses and recommend follow up actions where appropriate.
- Stay informed of plans for renovations or new laboratory construction projects and serve as a resource in providing code citations and internal standards to assist with the design and construction process.
- Keep the senior administration informed on the progress of continued implementation of the Chemical Hygiene Plan and Laboratory Safety Manual and bring campus-wide issues affecting laboratory safety to their attention.

1.2.3 Deans, Directors, and Department Chairpersons

The Deans, Directors, and Department Chairpersons are responsible for laboratory safety within their department(s) and must know and understand the New Mexico Tech Safety Policy and know and understand the guidelines and requirements of the Laboratory Safety Manual. In addition to the responsibilities outlined within the New Mexico Tech Safety Policy, the laboratory safety responsibilities of Deans, Directors, and Department Chairpersons - which can be delegated to other authorized personnel within the department such as a Department Safety Representative (DSR) - are:

- Be familiar with and implement the University Health & Safety Policy within units under their control or designate a person in the department (such as the DSR) with the authority to carry out these requirements.
- Communicate and implement the University Health and Safety Policy and its requirements to faculty, staff (including temporary employees), visiting scholars, volunteers and students working in laboratories within their units.
- Assist the Director of Hazardous Materials with implementation of the Chemical Hygiene Plan and Laboratory Safety Manual.
- Ensure laboratory personnel develop and adhere to proper health and safety protocols.
- Direct individuals under their supervision, including but not limited to - Principal Investigators, supervisors, regular and temporary employees, visiting professors, and students employees - to obtain any required safety and health training before working with hazardous chemicals, biohazardous agents, radiation, and/or other physical/mechanical hazards found within their working or learning environments.
- Determine and ensure that safety needs and equipment for units/departments are met (e.g., engineering controls, training, protective equipment) and ensure corrective measures for noncompliance items identified in safety audits are corrected promptly.
- Encourage the formation of a college and/or department safety committee(s).
- Keep the DSR, Building Coordinator, and Director of Hazardous Materials informed of plans for renovations or new laboratory construction projects.
- Ensure college and departmental procedures are established and communicated to identify and respond to potential accidents and emergency situations.
- Notify the Director of Hazardous Materials before a faculty member retires or leaves the University so proper laboratory decommissioning occurs.
- Establish college and departmental priorities, objectives, and targets for laboratory safety and health performance. Obtain assistance and guidance from New Mexico Tech Safety when necessary.
- Ensure college and departmental laboratory participation in Research Area Inspections as a means to regularly check performance against regulatory requirements and identify opportunities for improvement.
- Ensure that research areas within their departments and units are registered using HASP in a timely manner upon notification by New Mexico Tech Safety and updated annually.

1.2.4 Principal Investigators, Faculty, and Laboratory Supervisors

Principal Investigators, faculty, and laboratory supervisors are responsible for laboratory safety in their research or teaching laboratories. In addition to the responsibilities outlined within the New Mexico Tech Safety Policy, the laboratory safety duties of Principal Investigators, faculty, and laboratory supervisors (which can also be delegated to other authorized personnel within the laboratory) are:

- Implement and communicate New Mexico Tech Safety Policy and all other University safety practices and programs, including the guidelines and procedures found within the Laboratory Safety Manual, in laboratories under your supervision or control.
- Establish laboratory priorities, objectives and targets for laboratory safety, health and environmental performance.
- Communicate roles and responsibilities of individuals within the laboratory relative to environmental, health, and safety according to this Laboratory Safety Manual.
- Conduct hazard evaluations for procedures conducted in the laboratory and maintain a file of SOP documenting those hazards.
- Ensure that specific operating procedures for handling and disposing of hazardous materials used in their laboratories are written, communicated, and followed and ensure laboratory personnel have been trained in these operating procedures and use proper control measures.
- Attend required health and safety training.
- Require all staff members and students under their direction to obtain and maintain required health and safety training commensurate with their duties and/or department requirements.
- Participate in New Mexico Tech Research Area Inspections with their laboratory employees or designate someone in the laboratory to conduct these inspections.
- Ensure that all items identified during annual New Mexico Tech Safety research area inspections are corrected in a timely manner.
- Ensure that all appropriate engineering controls including chemical fume hoods and safety equipment are available and in good working order in their laboratories. This includes notifying New Mexico Tech Safety when significant changes in chemical use may require a re-evaluation of the laboratory ventilation.
- Ensure procedures are established and communicated to identify the potential for, and the appropriate response to accidents and emergency situations.
- Ensure that all incidents and near misses occurring in their laboratories are reported to their Director or Department Chairperson and/or Department Safety Representative and that a written Injury/Illness Report is filed with New Mexico Tech Safety for each injured person.
- Ensure laboratory personnel under your supervision know and follow the guidelines and requirements contained within the Laboratory Safety Manual.
- Follow the guidelines identified within this manual as Principal Investigator and laboratory supervisor responsibilities.
- Keep the Department Safety Representative, Department Chairperson, and the Director of Hazardous Materials informed of plans for renovations or new laboratory

- construction projects.
- Ensure that research areas under their supervision are registered using HASP in a timely manner upon notification by New Mexico Tech Safety and updated annually.

1.2.5 Laboratory Employees

Laboratory employees are those personnel who conduct their work in a laboratory and are at risk of possible exposure to hazardous chemicals on a regular or periodic basis. These personnel include laboratory technicians, instructors, researchers, visiting researchers, administrative assistants, graduate assistants, student aides, student employees, and part time and temporary employees.

In addition to the responsibilities outlined within the New Mexico Tech Safety Policy, the laboratory safety duties of laboratory employees are:

- Comply with New Mexico Tech Safety Policy and all other health and safety practices and programs by maintaining class, work, and laboratory areas safe and free from hazards.
- Know the location of the CHP and how to access safety data sheets (SDS).
- Attend health and safety training as designated by your supervisor.
- Inform your supervisor or instructor of any safety hazards in the workplace, classroom, or laboratory, including reporting any unsafe working conditions, faulty fume hoods, or other emergency safety equipment to the laboratory supervisor.
- Ensure an SDS is present for all new chemicals you purchase (either sent with the original shipment or available online. Review the SDSs for chemicals you are working with and check with your laboratory supervisor or principal investigator if you ever have any questions.
- Conduct hazard evaluations with your supervisor for procedures conducted in the laboratory and maintain a file of standard operating procedures documenting those hazards.
- Be familiar with what to do in the event of an emergency situation.
- Participate in laboratory self inspections and annual New Mexico Tech Safety Research Area Inspections.
- Follow the standard operating procedures for your laboratory and incorporate the guidelines and requirements outlined in this Laboratory Safety Manual into everyday practice.

1.2.6 Department Safety Representatives

The Department Safety Representative (DSR) serves a very important function in implementing the Chemical Hygiene Plan and Laboratory Safety Manual within the department. The role of the DSR is to assist the director, unit head, and/or department chairperson meet their responsibilities for safety and compliance as described in the

Environment, Health & Safety Policy 8.6. A detailed description of DSR roles and responsibilities can be found in the separate document – Department Safety Representative Program.

Laboratory safety responsibilities of DSRs include:

- Comply with the New Mexico Tech Safety Policy and all other University health and safety practices and programs.
- Request and coordinate assistance from New Mexico Tech Safety and other organizations that can provide guidance, training, and other services to assist laboratory personnel.
- Assist directors, unit heads, department chairpersons, supervisors, and individuals within the areas they represent to establish departmental, unit, or facility-wide safety programs, priorities, objectives and targets for safety, health, and environmental performance.
- Assist directors, unit heads, department chairpersons, supervisors, and individuals to identify (with assistance and guidance from New Mexico Tech Safety) if the safety needs for the areas they represent are met (e.g., training, protective equipment, acquisition of safety equipment, and corrective measures including noncompliance items identified in safety inspections).
- Encourage the formation of, and participate on college, unit, departmental, and/or facility-wide safety committee(s).
- Collaborate with unit Emergency Coordinator(s) on emergency planning efforts, response, and implementation of University Policy 8.3 - Emergency Planning.
- Work with New Mexico Tech Safety to stay knowledgeable about safety, health, and environmental services available, the University health and safety policies and procedures that apply to, and the health and safety issues that occur within the areas they represent.
- Communicate to individuals working within the areas they represent about health and safety policies and procedures, including this Laboratory Safety Manual, and the safety, health, and environmental services available to them.
- Conduct and/or facilitate routine inspections of work areas in the areas they represent using tools and resources provided by New Mexico Tech Safety, including participation in New Mexico Tech Safety Research Area Inspections. Facilitate corrective actions for any issues identified with the support and participation of New Mexico Tech Safety, including bringing issues of noncompliance to the attention of directors, unit heads and department chairpersons.
- Promote safety, health, and environmental training program and workshops (particularly New Mexico Tech Safety trainings) throughout the areas they represent by distributing fliers and New Mexico Tech Safety newsletters, and forwarding New Mexico Tech Safety training announcements and other announcements via email or hardcopy. Inform individuals working in areas they represent about the requirements to obtain necessary training as identified by their supervisor, department, college and New Mexico Tech Safety.
- Serve as a “conduit for information exchange” through facilitation and dissemination of safety, health and environmental information (particularly information sent out by New Mexico Tech Safety) to all personnel, including visiting faculty and researchers, and student employees, within the areas they represent.

- Communicate with supervisors in the areas they represent that all incidents and near misses should be reported and that a written Injury/Illness Report is completed.
- Attend New Mexico Tech Safety training programs (and other safety, health, and environmental training programs and workshops) to increase and maintain knowledge about safety, health, and environmental issues that are applicable to the areas they represent.
- Attend University DSR meetings and other college or unit level safety, health, and environmental related meetings and serve as the liaison for the areas they represent at these meetings.
- Be aware that changes in chemical use in a particular laboratory may require a re-evaluation of the laboratory ventilation.

Notify New Mexico Tech Safety before a faculty member retires or leaves the University or laboratory groups move so proper laboratory decommissioning can occur.

2.0 Engineering Controls

Engineering controls are considered the first line of defense in the laboratory for the reduction or elimination of the potential exposure to hazardous chemicals. Examples of engineering controls used in laboratories at New Mexico Tech include dilution ventilation, local exhaust ventilation, chemical fume hoods, glove boxes and other containment enclosures, as well as ventilated storage cabinets.

The OSHA Laboratory Standard requires that "fume hoods and other protective equipment function properly and that specific measures are taken to ensure proper and adequate performance of such equipment." General laboratory room ventilation is not adequate to provide proper protection against bench top use of hazardous chemicals. Laboratory personnel need to consider available engineering controls to protect themselves against chemical exposures before beginning any new experiment(s) involving the use of hazardous chemicals.

The proper functioning and maintenance of fume hoods and other protective equipment used in the laboratory is the responsibility of a variety of service groups. Facilities Services and Engineering, Building Coordinators, New Mexico Tech Safety, and other groups service equipment such as fire extinguishers, emergency eyewash and showers, and mechanical ventilation. Periodic inspections and maintenance by these groups ensure proper functioning and adequate performance of these important pieces of protective equipment.

However, it is the responsibility of laboratory personnel to immediately report malfunctioning protective equipment, such as fume hoods, or mechanical problems to their Building Coordinator as soon as any malfunctions are discovered.

2.1 Chemical Fume Hoods

Fume hoods and other capture devices are used to contain the release of toxic chemical vapors, fumes, and dusts. Bench top use of chemicals that present an inhalation hazard is strongly discouraged. Fume hoods are to be used when conducting new experiments with unknown consequences from reactions or when the potential for a fire exists.

To achieve optimum performance, the greatest personal protection and reduce energy usage when using a fume hood:

- Ensure the fume hood is working by checking the tell-tale (crepe paper hanging from hood sash) and air monitoring device if the hood is equipped with one. DO NOT use an improperly working fume hood.
- If the fume hood is not working properly, let other people in the lab know by hanging up a Do Not Use Sign on the hood.
- Work several inches inside the hood. This provides for the greatest amount of capture and removal of airborne contaminants. Also, do not place items on the airfoil or work with chemicals at the face of the hood.
- Do not block the baffles at the back of the hood. These allow for proper exhausting of contaminants from the hood.
- Keeping the hood sash lowered improves the performance of the fume hood by maintaining the internal vortex and containment. It also helps to conserve energy.
- Keep the fume hood sash closed all of the way whenever the fume hood is not being used. Shut the Sash!
- Do not use fume hoods to evaporate hazardous waste. Evaporating hazardous waste is illegal.
- For work involving particularly hazardous substances or chemicals that can form toxic vapors, fumes, or dusts, the hood or equipment within the hood may need to be fitted with condensers, traps, or scrubbers in order to prevent the vapors, fumes, and dusts from being released into the environment.
- Do not exhaust items, such as vacuum pumps, through the face of the fume hood as this will disrupt the airflow into the hood and may cause contamination. This will also not allow for the sash to be fully closed.
- As with any work involving chemicals, always practice good housekeeping and clean up all chemical spills immediately. Be sure to wash both the working surface and hood sash frequently and always maintain a clean and dry work surface that is free of clutter.

In addition to annual fume hood inspection, face velocity testing, and dry ice capture testing, New Mexico Tech also offers an online training program on the safe use of fume hoods. Additional information can be found in the Safe Fume Hood Use Guide.

2.1.1 Heating Perchloric Acid

DO NOT use heated Perchloric acid in a regular fume hood. If heated Perchloric acid is used in a regular fume hood (without a wash down function), shock sensitive metallic perchlorate crystals can form inside the duct work, and could result in causing an explosion during maintenance work on the ventilation system. Use of heated Perchloric acid requires a special perchloric acid fume hood with a wash down function. If you suspect your fume hood has perchlorate contamination or would like more information on perchloric acid fume hoods, then contact New Mexico Tech Safety 757-835-5842.

2.1.2 Fume Hood Inspection and Testing Program

New Mexico Tech Safety and Facilities Services share the responsibility for the annual testing and inspection of fume hoods on campus. After each inspection, an inspection sticker is affixed to the fume hood. If your fume hood does not have an inspection sticker or if the existing inspection sticker on your fume hood indicates a year or more has passed since the hood was last inspected or for other questions please see NEW MEXICO TECH SAFETY.

Fume hood testing and inspection consists of the following:

- The face velocity will be tested for compliance with American National Standards Institute (ANSI) and American Industrial Hygiene Association (AIHA) standard Z9.5-2012.
- A visual inspection using the dry ice technique from the ANSI/American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) standard 110-1995, will be performed in conjunction with face velocity measurements.
- Hoods will be classified as acceptable or unacceptable based on the average face velocity measurement and result of the dry ice test.
- If a hood is found to be unacceptable, a warning sign indicating the hood did not pass inspection and does not provide optimum protection will be attached in a conspicuous location. This information will be provided to the building coordinator who will follow through with the repair arrangements with other laboratories for the use of a different hood.
- A score will be taken based on the proper use and cleanliness of the hood.

Hood Housekeeping Score (HHS)	Reason for Concern
1	Hood decommissioned
2	Hood on, used for a single chemical process or well organized multiple purpose
3	Hood on, but empty or being used for storage
4	Hood on, crowded or used for competing multiple chemical uses
5	Hood on and contamination evident

The higher the Hood Housekeeping Score, the more serious the concern

2.1.3 Installation of New Fume Hoods

Installation of a new fume hood requires careful planning and knowledge of the existing building ventilation systems and capabilities. Improperly installed fume hoods or other capture devices can seriously disrupt the existing ventilation system and have a negative impact in the immediate room, other fume hoods, and the ventilation system throughout the building.

All fume hoods and other capture devices must be installed in consultation with Facilities Services, New Mexico Tech Safety. All new installations of fume hoods must comply with NMT Design approval and be commissioned by New Mexico Tech Safety to be included in the inspection and testing program.

New Mexico Tech Safety can provide information regarding the selection, purchase, and inspection requirements for laminar flow clean benches, biosafety cabinets, and portable fume hoods.

2.1.4 Removal of Existing Fume Hoods

Any removal of fume hoods and capture devices requires prior consultation with your Building Coordinator, Facilities Services, and New Mexico Tech Safety. This is necessary to ensure building ventilation systems are not affected by removal of fume hoods and capture devices, and so utility services such as electrical lines, plumbing systems, and water and gas supply lines are properly disconnected. For more information about decommissioning of fume hoods, go to the Laboratory Ventilation page.

There is an additional concern for the presence of asbestos within the fume hood itself, and potentially in any pipe insulation associated with the ductwork and/or Mercury in cup sinks. Any asbestos must be properly removed and disposed of by a certified asbestos removal company. New Mexico Tech Safety can assist laboratories with the cleanup of any Mercury contamination. Contact New Mexico Tech Safety at 575-835-5842 for more information or questions about potential asbestos or Mercury contamination.

2.2 Other Capture Devices

Engineering controls beside the fume hood include compressed gas cabinets, vented storage cabinets and local exhaust ventilation (LEV) such as capture hoods (canopy and slot), and snorkels. These work to capture and entrain chemical vapors, fumes and dusts at the point of generation. Examples where these devices would be appropriate are welding operations, atomic absorption units, vacuum pumps, work with dry nanomaterials and many other operations in the laboratory. Installation of any of these must be in the consultation of New Mexico Tech Safety and may include an engineering design to ensure the proper connection into the ventilation systems ductwork.

2.3 Glove Boxes

Glove boxes are sealed enclosures that are designed to protect the user, the process or both, by providing total isolation of the contents from the outside environment. They are usually equipped with at least one pair of gloves attached to the enclosure. The user manipulates the materials inside using the gloves. Typically, a glove box has an antechamber that is used to take materials in and out of the box.

Types of Gloveboxes:

1) Controlled Environment (dry box) - These create oxygen and moisture free conditions by replacing the air within the box with an inert gas, such as nitrogen, argon or helium, depending on the type of materials to be worked with. A "rotary vane vacuum pump" is used to remove the atmosphere. Additional accessories may be used, such as a gas purifier, to further reduce oxygen and moisture levels for particularly sensitive operations. There are 4 types of this type of glovebox based on their leak tightness. Class 1 having the lowest hourly leak rate. This should be inspected by a service company during commissioning, when the gloves are changed, or when there appears to be a problem with the functioning of the glovebox.

2) Ventilated Glovebox (filtered glovebox) - These have filters, either HEPA or ultra low particulate, on the inlet and outlet ends of the box and a blower to circulate the air. These provide protection to the user through this filtration and also if the exhaust is connected to building exhaust through a thimble connection. These can have serve in cleanroom applications by reversing the airflow in the chamber to positive pressure.

Regular maintenance and inspection is essential to ensure that a glove box is adequately protecting the user, the environment and/or the product/process. Routine maintenance procedures and the frequency of inspection (or certification) should follow the manufacturers and regulatory recommendations.

There are various tests that can be performed on glove boxes, the suitability of which depends on the glove box and the application. Tests may include pressure decay (for positive pressure), rate of rise (for negative pressure), oxygen analysis, containment integrity, ventilation flow characterization, and cleanliness. The source of a leak can be identified using a Mass Spectrometer Leak Detector, ultrasound, the soap bubble method or use of an oxygen analyzer. For an in-depth discussion of glove boxes and testing, see: AGS (American Glove Box Society) 2007 Guide for gloveboxes – Third Edition. AGS-G001-2007.

2.4 Water Protection in Labs

Laboratory personnel must ensure that any piece of equipment or laboratory apparatus connected to the water supply utilizes backflow protection or is connected to a faucet with a vacuum breaker. The purpose of backflow prevention and vacuum breakers is to prevent water used in an experimental process or with a piece of equipment from back flowing and contaminating the laboratory's and building's water supply system. Examples of situations that can result from improper backflow protection include chemical contamination and/or temperature extremes (i.e. hot water coming from a drinking water fountain).

3.0 Personal Protective Equipment

Personal Protective Equipment (PPE) should be considered as the second line of defense in protecting laboratory personnel against chemical hazards after the use of engineering controls. PPE is not a substitute for good engineering, or administrative controls, or good work practices, but should be used in conjunction with these controls to ensure the safety and health of university employees and students.

The OSHA Personal Protective Equipment standard, 29 CFR 1910 Subpart I has the following requirements:

- Hazard assessment and equipment selection
- Employee training
- Record keeping requirements
- Guidelines for selecting PPE
- Hazard assessment certification

New Mexico Tech has developed a written Personal Protective Equipment Program in compliance with the OSHA standard. More information on PPE can be found in the OSHA Safety and Health topics page on Personal Protective Equipment.

3.1 Laboratory Responsibilities for Personal Protective Equipment

Laboratory personnel need to conduct hazard assessments of specific operations occurring in their laboratories to determine what PPE is necessary to safely carry out the operations. PPE must be made available to laboratory workers to reduce exposures to hazardous chemicals in the lab. Proper PPE includes items such as gloves, eye protection, lab coats, face shields, aprons, boots, hearing protection, etc. PPE must be readily available and most equipment is provided at no cost to the employee.

When deciding on the appropriate PPE to wear when performing any operations or experiments, a number of factors must be taken into consideration such as:

- The chemicals being used, including concentration and quantity.
- The hazards the chemicals pose.
- The routes of exposure for the chemicals.
- The material the PPE is constructed of.
- The permeation and degradation rates specific chemicals will have on the material.
- The length of time the PPE will be in contact with the chemicals.

Careful consideration should be given to the comfort and fit of PPE to ensure that it will be used by laboratory personnel.

All personal protective equipment and clothing must be maintained in a sanitary and reliable condition. Only those items that meet NIOSH (National Institute of Occupational Safety and Health) or ANSI standards should be purchased or accepted for use.

There are a number of safety equipment suppliers who sell a wide variety of personal

protective equipment. Be sure to check with the Purchasing department first to find out which supplier is the NMT preferred vendor to take advantage of discounted pricing. If you have questions about what PPE is most appropriate for your applications, then contact New Mexico Tech Safety at 575-835-5842

Please Note: Principal Investigators, laboratory supervisors, departments and colleges are free to set policies that establish minimum PPE requirements for personnel working in and entering their laboratories. Check with your DSR to see if there are any department or college specific requirements for PPE.

3.2 Training for Personal Protective Equipment

Laboratory personnel must be trained in the selection, proper use, limitations, care, and maintenance of PPE. Training requirements can be met in a variety of ways including videos, group training sessions, and handouts. Periodic retraining should be offered to both the employees and supervisors as appropriate. Examples of topics to be covered during the training include:

- When PPE must be worn.
- What PPE is necessary to carry out a procedure or experiment.
- How to properly put on, take off, adjust, and wear PPE.
- The proper cleaning, care, maintenance, useful life, limitations, and disposal of the PPE.

As with any training sessions, PPE training must be documented, including a description of the information covered during the training session and a copy of the sign-in sheet. Training records must be kept of the names of the persons trained, the type of training provided, and the dates when training occurred. New Mexico Tech Safety will maintain records of employees who attend New Mexico Tech Safety training sessions.

Information on the specific PPE required to carry out procedures within the laboratory using hazardous chemicals must also be included in the laboratory's Standard Operating Procedures.

Please note: while New Mexico Tech can provide information, training, and assistance with conducting hazard assessments and the selection and use of proper PPE, the ultimate responsibility lies with the Principal Investigator or laboratory supervisor.

It is the responsibility of the Principal Investigator or laboratory supervisor to ensure laboratory staff have received the appropriate training on the selection and use of proper PPE, that proper PPE is available and in good condition, and laboratory personnel use proper PPE when working in laboratories under their supervision.

3.3 Eye Protection

Eye protection is one of the most important and easiest forms of PPE to wear. Laboratory personnel should use eye protection for many of the chemical and physical hazards found in laboratories including flying particles, broken glass, molten metal, acids or caustic liquids, chemical liquids, chemical gases or vapors, or potentially injurious light radiation.

New Mexico Tech Safety strongly encourages Principal Investigators and laboratory supervisors to make use of eye protection a mandatory requirement for all laboratory personnel, including visitors, working in or entering laboratories under their control.

All laboratory employees and visitors should wear protective eyewear while in laboratories where chemicals are being handled or stored, at all times, even when not working directly with chemicals.

3.3.1 Eye Protection Selection

All protective eye and face devices must comply with ANSI Z87.1-2003, "American National Standard Practice for Occupational and Educational Eye and Face Protection" and be marked to identify the manufacturer. When choosing proper eye protection, be aware there are a number of different styles of eyewear that serve different functions.

Prescription Safety Eyewear

OSHA regulations require that employees who wear prescription lenses while engaged in operations that involve eye hazards shall wear eye protection that incorporates the prescription in its design, or must wear eye protection that can be worn over the prescription lenses (goggles, face shields, etc.) without disturbing the proper position of the prescription lenses or the protective lenses. Any prescription eyewear purchase must comply with ANSI Z87.1-1989.

Note: Contact lenses by themselves are not considered as protective eyewear.

Safety Glasses

Safety glasses provide eye protection from moderate impact and particles associated with grinding, sawing, scaling, broken glass, and minor chemical splashes, etc. Side protectors are required when there is a hazard from flying objects. Safety glasses are available in prescription form for those persons needing corrective lenses. Safety glasses do not provide adequate protection for processes that involve heavy chemical use such as stirring, pouring, or mixing. In these instances, splash goggles should be used.

Splash Goggles

Splash goggles provide adequate eye protection from many hazards, including potential chemical splash hazards, use of concentrated corrosive material, and bulk chemical transfer. Goggles are available with clear or tinted lenses, fog proofing, and vented or non-vented frames. Be aware that goggles designed for woodworking are not appropriate

for working with chemicals. These types of goggles can be identified by the numerous small holes throughout the face piece. In the event of a splash, chemicals could enter into the small holes, and result in a chemical exposure to the face. Ensure the goggles you choose are rated for use with chemicals.

Welder's/Chippers' Goggles

Welder's goggles provide protection from sparking, scaling, or splashing metals and harmful light rays. Lenses are impact resistant and are available in graduated lens shades. Chippers'/Grinders' goggles provide protection from flying particles. A dual protective eyecup houses impact resistant clear lenses with individual cover plates.

Face Shields

Face shields provide additional protection to the eyes and face when used in combination with safety glasses or splash goggles. Face shields consist of an adjustable headgear and face shield of tinted or clear lenses or a mesh wire screen. They should be used in operations when the entire face needs protection and should be worn to protect the eyes and face from flying particles, metal sparks, and chemical/biological splashes. Face shields with a mesh wire screen are not appropriate for use with chemicals. Face shields must not be used alone and are not a substitute for appropriate eyewear. Face shields should always be worn in conjunction with a primary form of eye protection such as safety glasses or goggles.

Welding Shields

Welding shields are similar in design to face shields but offer additional protection from infrared or radiant light burns, flying sparks, metal splatter, and slag chips encountered during welding, brazing, soldering, resistance welding, bare or shielded electric arc welding, and oxyacetylene welding and cutting operations.

Equipment fitted with appropriate filter lenses must be used to protect against light radiation. Tinted and shaded lenses are not filter lenses unless they are marked or identified as such.

LASER Eye Protection

A single pair of safety glasses is not available for protection from all LASER outputs. The type of eye protection required is dependent on the spectral frequency or specific wavelength of the laser source. If you have questions on the type of eyewear that should be worn with your specific LASER, contact the LASER Safety Officer at New Mexico Tech Safety at 575-835-5842.

3.4 Hand Protection

Most accidents involving hands and arms can be classified under four main hazard categories: chemicals, abrasions, cuts, and heat/cold. Gloves must be worn whenever significant potential hazards from chemicals, cuts, lacerations, abrasions, punctures, burns, biologicals, or harmful temperature extremes are present. The proper use of hand protection can help protect from potential chemical and physical hazards. Gloves must be

worn when using chemicals that are easily absorbed through the skin and/or particularly hazardous substances (such as “select carcinogens”, reproductive toxins, and substances with a high degree of acute toxicity).

***There is not one type of glove that offers the best protection against all chemicals or one glove that totally resists degradation and permeation to all chemicals. All gloves must be replaced periodically, depending on the type and concentration of the chemical, performance characteristics of the gloves, conditions and duration of use, hazards present, and the length of time a chemical has been in contact with the glove.

All glove materials are eventually permeated by chemicals; however, they can be used safely for limited time periods if specific use and other characteristics (i.e., thickness, permeation rate, and time) are known. New Mexico Tech can provide assistance with determining the resistance to chemicals of common glove materials and determining the specific type of glove material that should be worn for use with a particular chemical.

3.4.1 Selecting the Proper Gloves

Before working with any chemical, always read manufacturer instructions and warnings on chemical container labels and SDSs. Recommended glove types are sometimes listed in the PPE section MSDSs. If the recommended glove type is not listed on the SDS, then laboratory personnel should consult with the manufacturers’ glove selection charts. These charts typically include commonly used chemicals that have been tested for the manufacturers’ different glove types. Different manufacturers use different formulations so check the glove chart of the specific manufacturer for the glove you plan to use.

If the manufacturers’ glove chart does not list the specific chemical you will be using, then call the manufacturer directly and speak with their technical representatives to determine which glove is best suited for your particular application.

It is important to know that not all chemicals or mixtures have been tested by glove manufacturers. It is especially important in these situations to contact the glove manufacturer directly.

In some cases, you may need to consider hiring a testing laboratory that specializes in determining which glove material will be most resistant to the chemical you are using. There is a local company that is capable of testing gloves for chemical resistance for a modest fee. For more information, contact New Mexico Tech at 575-835-5842.

Some general guidelines for glove use include:

- Wear appropriate gloves when the potential for contact with hazardous materials exists. Laboratory personnel should inspect gloves for holes, cracks, or contamination before each use. Any gloves found to be questionable should be discarded immediately.

- Gloves should be replaced periodically, depending on the frequency of use and permeability to the substance(s) handled. Reusable Gloves should be rinsed with soap and water and then carefully removed after use. Discard disposable gloves after each use and whenever they become contaminated.
- Due to potential chemical contamination, which may not always be visible, gloves must be removed before leaving the laboratory. Do not wear gloves while performing common tasks such as answering the phone, grabbing a door handle, using an elevator, etc.

3.4.2 Double Gloving

A common practice to use with disposable gloves is “double-gloving”. This is accomplished when two pairs of gloves are worn over each other to provide a double layer of protection. If the outer glove becomes contaminated, starts to degrade, or tears open, the inner glove continues to offer protection until the gloves are removed and replaced. The best practice is to check outer gloves frequently, watching for signs of degradation (change of color, change of texture, tears, etc.). At the first sign of degradation or contamination, always remove and dispose of the contaminated disposable gloves immediately and double-glove with a new set of gloves. If the inner glove appears to have any contamination or degradation, remove both pairs of gloves, and double glove with a new pair.

Another approach to double gloving is to wear a thin disposable glove (4 mil Nitrile) under a heavier glove (8 mil Nitrile). The outer glove is the primary protective barrier while the under glove retains dexterity and acts as a secondary barrier in the event of degradation or permeation of the chemical through the outer glove. Alternately, you could wear a heavier (and usually more expensive and durable) 8 mil Nitrile glove as an under glove and wear thinner, disposable 4 mil Nitrile glove as the outer glove (which can help improve dexterity). However, remember to change the thinner outer gloves frequently.

When working with mixtures of chemicals, it may be advisable to double glove with two sets of gloves made from different materials. This method can offer protection in case the outer glove material becomes permeated by one chemical in the mixture, while allowing for enough protection until both gloves can be removed. The type of glove materials selected for this type of application will be based on the specific chemicals used as part of the mixture. Check chemical manufacturers glove selection charts first before choosing which type of glove to use.

To properly remove disposable gloves, grab the cuff of the left glove with the gloved right hand and remove the left glove. While holding the removed left glove in the palm of the gloved right hand, insert a finger under the cuff of the right glove and gently invert the right glove over the glove in the palm of your hand and dispose of them properly. Be sure to wash your hands thoroughly with soap and water after the gloves have been removed.

3.4.3 Types of Gloves

As with protective eyewear, there are a number of different types of gloves that are available for laboratory personnel that serve different functions:

Fabric Gloves

Fabric gloves are made of cotton or fabric blends and are generally used to improve grip when handling slippery objects. They also help insulate hands from mild heat or cold. These gloves are not appropriate for use with chemicals because the fabric can absorb and hold the chemical against a user's hands, resulting in a chemical exposure.

Leather Gloves

Leather gloves are used to guard against injuries from sparks, scraping against rough surfaces, or cuts from sharp objects like broken glass. They are also used in combination with an insulated liner when working with electricity. These gloves are not appropriate for use with chemicals because the leather can absorb and hold the chemical against a user's hands, resulting in a chemical exposure.

Metal Mesh Gloves

Metal mesh gloves are used to protect hands from accidental cuts and scratches. They are most commonly used when working with cutting tools, knives, and other sharp instruments.

Cryogenic Gloves

Cryogenic gloves are used to protect hands from extremely cold temperatures. These gloves should be used when handling dry ice and when dispensing or working with liquid nitrogen and other cryogenic liquids.

Chemically Resistant Gloves

Chemically resistant gloves come in a wide variety of materials. The recommendations given below for the specific glove materials are based on incidental contact. Once the chemical makes contact with the gloved hand, the gloves should be removed and replaced as soon as practical. Often a glove specified for incidental contact is not suitable for extended contact, such as when the gloved hand can become covered or immersed in the chemical in use. Before selecting chemical resistant gloves, consult the glove manufacturers' recommendations or their glove selection charts, or contact New Mexico Tech at 575-835-5842 for more assistance.

Some general guidelines for different glove materials include:

- Natural Rubber Latex*** - Resistant to ketones, alcohols, caustics, and organic acids.
See note below.
- Neoprene - Resistant to mineral acids, organic acids, caustics, alcohols, and petroleum solvents.
- Nitrile - Resistant to alcohols, caustics, organic acids, and some ketones.

- Norfoil - Rated for chemicals considered highly toxic and chemicals that are easily absorbed through the skin. These gloves are chemically resistant to a wide range of materials that readily attack other glove materials. These gloves are not recommended for use with Chloroform. Common brand names include: Silver Shield by North Hand Protection, 4H by Safety4, or New Barrier by Ansell Edmont.
- Polyvinyl chloride (PVC) - Resistant to mineral acids, caustics, organic acids, and alcohols.
- Polyvinyl alcohol (PVA) - Resistant to chlorinated solvents, petroleum solvents, and aromatics.

*** A note about latex gloves

The use of latex gloves, especially thin, disposable exam gloves, for chemical handling is discouraged because latex offers little protection from commonly used chemicals. Latex gloves can degrade severely in minutes or seconds, when used with common lab and shop chemicals. Latex gloves also can cause an allergic reaction in a percentage of the population due to several proteins found in latex. Symptoms can include nasal, eye, or sinus irritation, hives, shortness of breath, coughing, wheezing, or unexplained shock. If any of these symptoms become apparent in personnel wearing latex gloves, discontinue using the gloves and seek medical attention immediately.

The use of latex gloves is only appropriate for:

- Most biological materials.
- Nonhazardous chemicals.
- Clean room requirements.
- Medical or veterinary applications.
- Very dilute, aqueous solutions containing <1% for most hazardous chemicals or less than 0.1% of a known or suspected human carcinogen.

Staff required to wear latex gloves should receive training on the potential health effects related to latex. Hypoallergenic, non-powdered gloves should be used whenever possible. If a good substitute glove material is available, then use nonlatex gloves. A general purpose substitute for disposable latex gloves are disposable Nitrile gloves.

See the appendix for a list of recommended gloves for specific chemicals, definitions for terms used in glove selection charts, glove materials and characteristics, and a list of useful references.

3.5 Protective Clothing

Protective clothing includes lab coats or other protective garments such as aprons, boots, shoe covers, Tyvek coveralls, and other items, that can be used to protect street clothing from biological or chemical contamination and splashes as well as providing additional body protection from some physical hazards.

New Mexico Tech strongly recommends that Principal Investigators and laboratory

supervisors discourage the wearing of shorts and skirts in laboratories using hazardous materials (chemical, biological, and radiological) by laboratory personnel, including visitors, working in or entering laboratories under their supervision.

The following characteristics should be taken into account when choosing protective clothing:

- The specific hazard(s) and the degree of protection required, including the potential exposure to chemicals, radiation, biological materials, and physical hazards such as heat.
- The type of material the clothing is made of and its resistance to the specific hazard(s) that will be encountered.
- The comfort of the protective clothing, which impacts the acceptance and ease of use by laboratory personnel.
- Whether the clothing is disposable or reusable - which impacts cost, maintenance, and cleaning requirements.
- How quickly the clothing can be removed during an emergency. It is recommended that lab coats use snaps or other easy to remove fasteners instead of buttons.

Laboratory personnel who are planning experiments that may require special protective clothing or have questions regarding the best protective clothing to choose for their experiment(s) should contact New Mexico Tech at 575-835-5842 for recommendations.

3.6 Respirators

Respiratory protection includes disposable respirators (such as N95 filtering facepieces, commonly referred to as “dust masks”), air purifying, and atmosphere supplying respirators. Respirators are generally not recommended for laboratory workers. Engineering controls, such as dilution ventilation, fume hoods, and other devices, which capture and remove vapors, fumes, and gases from the breathing zone of the user are preferred over the use of respirators in most laboratory environments. There are certain exceptions to this general rule, such as the changing out of cylinders of toxic gases and emergency response to chemical spills.

The use of all types of respiratory protection at New Mexico Tech is governed by the OSHA standards and the New Mexico Tech Respiratory Protection Program. A laboratory worker at New Mexico Tech may not purchase a respirator and bring it to their lab for personal use without prior consultation with NEW MEXICO TECH SAFETY.

The following are situations where respiratory protection would be appropriate for laboratory workers (after consultation with NEW MEXICO TECH SAFETY):

- The use of disposable respirators (e.g., N95 filtering face pieces/dust masks) for weighing powdery or dusty materials. Note: Most disposable respirators do not offer protection against chemical vapors and fumes; they are for use of nuisance dust only. The use of disposable respirators may or may not be regulated by OSHA depending upon the circumstances of use. In order to determine if OSHA regulations apply, please contact New Mexico Tech at 575-835-5842 to schedule a hazard assessment prior to using a disposable respirator.

- The voluntary use of N-95 respirators in the laboratory is permitted. OSHA requires the following reading: (Mandatory) Information for Employees Using Respirators When not Required Under Standard – 29 CFR 1910.134 D
- The use of large volumes of certain hazardous chemicals, such as formaldehyde in a room where dilution ventilation or capture devices will not be able to offer adequate protection.
- Changing out cylinders of hazardous gases. (Additional training is required).
- Cleaning up hazardous chemical spills. (Additional training is required.)
- To reduce exposure to some chemicals which certain individuals may be or become sensitive.
- When mixing chemicals that may result in more hazardous vapors from the combination of chemicals versus the exposure to each chemical alone or when the potential for an unknown exposure exists. However, laboratory staff should try to conduct such experiments in a fume hood.

Please note, as a measure of coworker protection, when weighing out dusty materials or powders, consider waiting until other coworkers have left the room to prevent possible exposure and thoroughly clean up and decontaminate working surfaces.

There are some situations in which the use of a respirator would be prohibited:

- When the air in a laboratory is severely contaminated and immediately dangerous to life and health (IDLH).
- When the air in a room does not have enough oxygen to support life (less than 19.5%).
- When dangerous vapors are present that have inadequate warning properties (such as odor) should the respirator fail.
- When the air contaminants can penetrate or damage skin and eyes unless other suitable protection is worn.

3.6.1 Respiratory Protection Program

New Mexico Tech has established a program for the use of respirators on campus. The program is designed for those University personnel who, during their normal duties are, or could be, exposed to hazardous substances or atmospheres that may affect their health and safety.

The New Mexico Tech Respiratory Protection Program includes the following:

- You will receive a medical evaluation by NMT Health Center to ensure you are physically fit to wear a respirator. Wearing any type of respirator puts a large amount of stress on the body.
- You will be given a fit test to determine which size respirator fits you best. Due to the differences in the sizes and shapes of faces, there is no one respirator that fits all sizes and shapes of faces.
- You will be shown how to properly put on and take off the respirator, and how to check to make sure it is functioning properly.
- You will be shown how to properly clean and care for your respirator, including proper maintenance.
- You will be shown how to choose the right respirator or respirator cartridge for the specific processes and types of chemicals you will be using. NOTE: As with

chemical protective gloves, there is no one universal respirator cartridge that can be used with every chemical.

For more information about the use of respirators at New Mexico Tech, call New Mexico Tech at 575-835-5842. If you are approved for the use of a respirator after meeting the requirements of the OSHA Standards and the New Mexico Tech Respiratory Protection Program, then you may purchase a respirator from the PDC Warehouse on Palm Road. If the use of a respirator is required to perform your job duties, then your department will pay for the respirator.

3.7 Hearing Protection

Hearing protective devices includes earplugs, earmuffs, or similar devices designed to protect your hearing. If occupational noise exposures exceed permissible levels and cannot be reduced through engineering or other controls, then hearing protective devices must be worn. The New Mexico Tech University Hearing Conservation Program protects employees who, during their normal duties experience an Occupational Noise Exposure as defined by the Occupational Safety and Health Administration (OSHA) General Industry Standard "Occupational Exposure to Noise" Part 1910.95 and the Hearing Conservation Amendment. If you have questions about whether you are receiving an occupational noise exposure, or would like to request workplace monitoring or information about the New Mexico Tech University Hearing Conservation Program, then contact New Mexico Tech at 575-835-5842.

Additional information can be obtained from the OSHA Health and Safety Topics page for Noise and Hearing Conservation.

3.8 Foot Protection

Laboratory personnel (and other personnel) must wear foot protection at all times in laboratories, laboratory support areas, and other areas with chemical, biological and physical hazards are present. Laboratory personnel should not wear sandals or similar types of perforated or open toes shoes whenever working with or around hazardous chemicals or physical hazards. This is due to the potential exposure to toxic chemicals and the potential associated with physical hazards such as dropping pieces of equipment or broken glass being present. In general, shoes should be comfortable, and leather shoes are preferable to cloth shoes due to the better chemical resistance of leather compared to cloth. Leather shoes also tend to absorb fewer chemicals than cloth shoes. However, leather shoes are not designed for long term exposure to direct contact with chemicals. In such instances, chemically resistant rubber boots are necessary.

New Mexico Tech strongly encourages Principal Investigators and laboratory supervisors to require the use of closed toed shoes for all laboratory personnel, including visitors, working in or entering laboratories and laboratory support areas under their supervision.

In some cases, the use of steel-toed shoes may be appropriate when heavy equipment or other items are involved. Chemically resistant boots or shoe covers may be required when working with large quantities of chemicals and the potential exists for large spills to occur. New Mexico Tech sponsors a “Shoe-Mobile” every three months on campus for campus personnel to purchase a variety of steel-toed shoes for both work AND personal use at discounted prices. Contact New Mexico Tech at 575-835-5842 for more information on chemically resistant boots, or to find out when the “Shoe-Mobile” will be on campus.

4.0 Administrative Controls

Administrative controls include policies and procedures that result in providing proper guidance for safe laboratory work practices and set the standard for behavior within the laboratory. Once developed, administrative controls must be implemented and adhered to by all personnel working in the laboratory.

Colleges and departments are responsible for developing policies and written guidelines to ensure laboratory workers are protected against exposure to hazardous chemicals as outlined in the OSHA Laboratory Standard and physical hazards that may be present, including the development of a written Chemical Hygiene Plan or adoption of this Laboratory Safety Manual.

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that personnel working in laboratories under their supervision are informed and follow laboratory specific, departmental, and campus wide policies and procedures related to laboratory safety – such as the guidelines and requirements covered in this Laboratory Safety Manual.

***In addition to meeting regulatory requirements identified within this Laboratory Safety Manual, colleges and departments are strongly encouraged to incorporate the recommendations and guidelines identified within this manual. While this Laboratory Safety Manual provides the minimum requirements and recommendations to meet the intent of the OSHA Laboratory Standard, colleges, departments, Principal Investigators, and laboratory supervisors have the authority to implement more stringent policies within laboratories under their supervision and are encouraged to do so.

4.1 Standard Operating Procedures

The OSHA Laboratory Standard requires that Chemical Hygiene Plans include specific elements and measures to ensure employee protection in the laboratory. One such requirement is Standard Operating Procedures (SOPs) “relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals.”

SOPs can be stand-alone documents or supplemental information included as part of research notebooks, experiment documentation, or research proposals. The requirement

for SOPs is to ensure a process is in place to document and addresses relevant health and safety issues as part of every experiment.

At a minimum, SOPs should include details such as:

- The chemicals involved and their hazards.
- Special hazards and circumstances.
- Use of engineering controls (such as fume hoods).
- Required PPE.
- Spill response measures.
- Waste disposal procedures.
- Decontamination procedures.
- Description of how to perform the experiment or operation.
-

While the OSHA Laboratory Standard specifies the requirement for SOPs for work involving hazardous chemicals, laboratories should also develop SOPs for use with any piece of equipment or operation that may pose any physical hazards. Examples include:

- Safe use and considerations of LASERSs.
- Use of cryogenic liquids and fill procedures.
- Connecting regulators to gas cylinders and cylinder change outs.
- Use of equipment with high voltage.
- Etc...

SOPs do not need to be lengthy dissertations and it is perfectly acceptable to point laboratory personnel to other sources of information. Some examples of what to include as part of SOPs are:

“To use this piece of equipment, see page 4 in the operator’s manual (located in file cabinet #4).” “The chemical and physical hazards of this chemical can be found in the SDS – located in the SDS binder. Read the SDS before using this chemical.” “When using chemical X, wear safety goggles, nitrile gloves, and a lab coat.”

New Mexico Tech can assist laboratories with developing general and specific SOPs.

Due to the variety of research and the large number of laboratories on the New Mexico Tech campus, it is the responsibility of each laboratory, department and college to ensure that SOPs are developed and the practices and procedures are adequate to protect lab workers who use hazardous chemicals.

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure written SOPs incorporating health and safety considerations are developed for work involving the use of hazardous chemicals in laboratories under their supervision and that PPE and engineering controls are adequate to prevent overexposure. In addition, Principal Investigators and laboratory supervisors must ensure that personnel working in laboratories under their supervision have been trained on those SOPs.

Examples of Standard Operating Procedures and blank SOP templates include:

- How to write an SOP - Sample 1
- Blank SOP Form - Sample 1
- Blank SOP Form - Sample 2
- How to Prepare an SOP Form - Sample 2
- Chemical User Authorization Form

- Example of completed SOPs

4.2 SOP Approval Form

The form should be completed by the Principal Investigator and submitted with all proposals. Of particular note for laboratory personnel, compliance certifications are required for the following areas:

- Human Subjects
- Animal Use
- Recombinant DNA
- Genetically Modified Organisms
- Radiation
- Biological Agents and Toxins
- Hazardous Materials

As part of this process New Mexico Tech Safety will be notified upon submittal of the Form 10 to OSP when one or more of the following compliance items have been checked: animals, rDNA, GMOs, radiation, hazardous materials, or biological agents or toxins. Once New Mexico Tech receives the form, staff members within New Mexico Tech will contact the Principal Investigator listed to discuss general aspects of the grant proposal and to ensure health and safety aspects have been taken into account. During the review process, New Mexico Tech staff members will identify any special issues that may need to be addressed to ensure compliance with state or federal regulatory requirements.

4.3 Procedural Controls

Procedural controls incorporate best management practices for working in a laboratory. These practices serve not only to protect the health and safety of personnel, but are a common sense way of increasing productivity in a laboratory. Through implementation of good practices, laboratories can expect an increase in the efficient use of valuable lab space, in the reliability of experiments due to less potential contamination, and an increase in the awareness of health and safety issues by laboratory personnel. Following the practices outlined in this Lab Safety Manual should also result in a decrease in the number of accidents, injuries, and spills. This will result in a decrease in the overall liability for the Principal Investigator, laboratory supervisor, and the University. Procedural controls are fundamental to instilling safe work behaviors and helping to create a culture of safety within the laboratory environment.

4.4 Housekeeping

Housekeeping refers to the general condition and appearance of a laboratory and includes:

- Keeping all areas of the lab free of clutter, trash, extraneous equipment, and unused chemical containers. Areas within the lab that should be addressed include

benches, hoods, refrigerators, cabinets, chemical storage cabinets, sinks, trash cans, etc.

- Keep all containers of chemicals closed when not in use.
- Cleaning up all chemical spills immediately, regardless if the chemical is hazardous or not. When cleaning up a chemical spill, look for any splashes that may have resulted on nearby equipment, cabinets, doors, and counter tops. For more information on cleaning up spills, see the Chemical Spill Procedures section.
- Keeping areas around emergency equipment and devices clean and free of clutter. This includes items such as eyewash/emergency showers, electric power panels, fire extinguishers, and spill cleanup supplies.
- Keeping a minimum of three feet of clearance (as required by fire codes) between benches and equipment. Exits must be clear of obstacles and tripping hazards such as bottles, boxes, equipment, electric cords, etc. Combustible materials may not be stored in exits (including corridors and stairways), exit enclosures, boiler rooms, mechanical rooms, or electrical equipment rooms.
- When storing items overhead, keep heavier and bulkier items closer to the floor. New York State (NYS) Building Code prohibits the storage of combustible material (such as paper, boxes, plastics, etc.) within 24" of the ceiling in unsprinklered rooms. In sprinklered rooms, All storage, including both combustible and non-combustible materials, must be kept at least 18" below the level of the sprinkler head deflectors to ensure that fire sprinkler coverage is not impeded.
- Always use a stepladder when reaching for overhead items, do not stand on chairs or countertops. If you do not have a stepladder available, then contact your Building Coordinator.

In summary, good housekeeping has obvious health and safety benefits and can have a positive mental effect on laboratory personnel who work in a clean environment, which can lead to increased productivity. Also keep in mind that during an inspection by a state or federal regulatory agency, the general condition of the laboratory observed in the first few minutes of the inspection (the housekeeping of the lab) can have a significant impact (positive or negative) on the rest of the inspection process.

It is the responsibility of Principal Investigators and laboratory supervisors to ensure laboratories under their supervision are maintained in a clean and orderly manner and personnel working in the lab practice good housekeeping.

4.5 Personal Hygiene

Good chemical hygiene practices include the use of personal protective equipment (PPE) and good personal hygiene habits. Although PPE can offer a barrier of protection against chemicals and biological materials, good personal hygiene habits are essential to prevent chemical exposure, even when using PPE.

Some general guidelines that should always be followed include:

- Do not eat, drink, chew gum, or apply cosmetics in a lab or other area where chemicals are used.
- Do not store food or drink in refrigerators that are used to store chemicals.

- Do not ever try starting a siphon or pipette by mouth, doing so can result in ingestion of chemicals or inhalation of chemical vapors. Always use a pipette aid or suction bulb to start a siphon.
- Always confine long hair, loose clothing, and jewelry.
- Wear a lab coat when working with hazardous materials.
- Shorts and sandals should not be worn in a lab when anyone is using corrosives or other chemicals that present a skin contact hazard or where the potential for physical hazards such as dropping pieces of equipment or broken glass are present.
- Remove laboratory coats, gloves, and other PPE immediately when chemical contamination occurs. Failure to do so could result in chemical exposure.
- After removing contaminated PPE, be sure to wash any affected skin areas with soap and water for at least 15 minutes.
- Always remove lab coats, scrubs, gloves, and other PPE before leaving the lab. Do not wear lab coats, scrubs, or other PPE (especially gloves) in areas outside the lab, particularly not in areas where food and drink are served, or other public areas.
- Always wash hands with soap and water after removing gloves and before leaving the lab or using items such as the phone, turning doorknobs, or using an elevator.
- Always wash lab coats separately from personal clothing. Be sure to identify contaminated lab coats to commercial laundry facilities to help protect their workers by placing the contaminated lab coat in a separate plastic bag and clearly identifying the bag with a note or label indicating the lab coat is contaminated.
- Smoking is prohibited in all lab areas at New Mexico Tech

4.6 Eating, Drinking, and Applying Cosmetics in the Lab

Chemical exposure can occur through ingestion of food or drink contaminated with chemicals. This type of contamination can occur when food or drinks are brought into a lab or when food or drinks are stored in refrigerators, freezers, or cabinets with chemicals. When this occurs, it is possible for the food or drink to absorb chemical vapors and thus lead to a chemical exposure when the food or drink is consumed. Eating or drinking in areas exposed to toxic materials is prohibited by the OSHA Sanitation Standard, 29 CFR 1910.141(g)(2).

A similar principle of potential chemical exposure holds true with regard to the application of cosmetics (make-up, hand lotion, etc.) in a laboratory setting when hazardous chemicals are being used. In this instance, the cosmetics have the ability of absorbing chemical vapors, dusts, and mists from the air and when applied to the skin and result in skin exposure to chemicals.

To prevent exposure to hazardous chemicals through ingestion, do not eat, drink, chew gum, or apply cosmetics in areas where hazardous chemicals are used.

Wash your hands thoroughly after using any chemicals or other laboratory materials, even if you were wearing gloves, and especially before eating or drinking. To help promote awareness, refrigerators and freezers should be properly labeled:

- Refrigerators for the storage of food should be labeled, “Food Only, No Chemicals” or “No Chemicals or Samples”.
- Refrigerators used for the storage of chemicals should be labeled “Chemicals Only, No Food”.

Keep in mind that some chemical exposure can result in immediate effects (acute exposure) while other effects may not be seen for some time despite repeated exposure (chronic exposure). Consuming food or drink or applying cosmetics in the lab can result in both types of exposure.

4.7 Working Alone

Whenever possible, laboratory personnel should avoid working alone when conducting research, especially when experiments involve hazardous substances and procedures. Laboratories should establish specific guidelines and standard operating procedures specifying when working alone is not allowed and develop notification procedures when working alone occurs. All work to be performed by someone working alone, and the monitoring system that is established, must be approved in advance by the Principal Investigator or laboratory supervisor. Check with your DSR to see if your department has specific requirements for working alone.

If a laboratory person determines it is necessary to work alone, consideration should be given to notifying someone else in the area – in an adjacent room, another lab on the same floor, or a lab on a different floor. It is recommended that a “buddy system” be established for regular, routine checks on personnel working alone, such as every 15 – 30 minutes, to ensure no accidents have occurred. This could be accomplished by physically walking to the room where the lab worker is or through the use of a phone. If the person working alone is doing highly hazardous work, then the person checking on the lab worker should not enter same room. A system of visual checks should be established to indicate there are no problems or to determine if help is needed.

In the event of an emergency that requires the buddy to leave prior to the completion of an experiment involving highly hazardous chemicals, the buddy should notify New Mexico Tech Police at 585-835-5555 of the name, location, and end time of the experiment involved. The buddy should also notify the person conducting the experiment. The person conducting the experiment should make an effort to complete the experiment in a safe manner and notify New Mexico Tech Police upon completion of the experiment. Under no circumstances should the New Mexico Tech Police be used in place of a “lab buddy” as this will seriously undermine the safety of all involved.

Please note: For rooms that are locked due to security needs, prior arrangements are required to allow the designated buddy access. However, please be aware that the University does not have a standardized keying system and the New Mexico Tech Emergency Responders and New Mexico Tech Police may not always have immediate access to locked doors - which could result in a delay in response in the event of an

emergency. Also understand that if the door to the lab does not have a window, or if the window is covered, then there is a chance that if something happened to a person working alone in a locked lab, then they may not be discovered until someone else from the lab goes into the room (which could be a day or more).

Examples of activities where working alone would be permissible include:

- Office work such as writing papers, calculations, computer work, and reading.
- Housekeeping activities such as general cleaning, reorganization of supplies or equipment, etc., as long as no moving of large quantities of chemicals is involved.
- Assembly or modification of laboratory apparatus when no chemical, electrical, or other physical hazards are present.
- Routine lab functions which are part of a standard operating procedure which has been demonstrated to be safe and not involve hazardous materials.

Examples of activities where working using a “buddy system” should be considered include:

- Experiments involving toxic or otherwise hazardous chemicals, especially poison inhalation hazards.
- Experiments involving high-pressure equipment.
- Experiments involving large quantities of cryogenic materials.
- Experiments involving work with unstable (explosives) materials.
- Experiments involving Class 3b or 4 Lasers.
- Transfer of large quantities of flammable materials, acids, bases, and other hazardous materials.
- Changing out compressed gas cylinders containing hazardous materials.

It is the responsibility of Principal Investigators and laboratory supervisors to ensure procedures for working alone are developed and followed by personnel working in laboratories under their supervision.

4.8 Phones in Labs

All labs are strongly recommended to have a means of communication in the event of an emergency. This can include a phone or cell phone (if service is available) or two-way radio within the lab or access to a central phone located in the hallway. If a phone is not available within the lab, it is advisable to post a sign and/or map indicating where the nearest phone is located.

4.9 Unattended Operations

Whenever it is necessary to have unattended operations occurring in a lab, it is important to ensure safeguards are put into place in the event of an emergency. Laboratory personnel are strongly encouraged to adhere to the following guidelines when it is necessary to carry out unattended operations.

For unattended operations involving highly hazardous materials, a light should be left on

and an appropriate warning/explanation sign should be placed on the laboratory door, or in a conspicuous place that could be easily seen without putting someone else in danger in the event of an emergency. The warning sign should list the following information:

- The nature of the experiment in progress.
- The chemicals in use.
- Hazards present (electrical, heat, etc.)
- The name of the person conducting the experiment and a contact number. A secondary name and contact number is also recommended.

When setting up an experiment that will be left unattended, try to take into account potential incidents that could occur if something went wrong. For example:

- Use secondary containment such as trays to contain any spills that may occur.
- Use safety shields and keep the chemical hood sash down low to contain chemicals and glass in case an explosion occurs.
- Remove any chemicals or equipment that are not necessary for the experiment or items that could potentially react with the chemicals or other materials being used in the experiment.
- Whenever possible, use automatic shutoff devices to prevent accidents such as loss of cooling water shutoff, over-temperature shut off, etc.
- Use emergency power outlets for those pieces of equipment that could be negatively affected in the event electric service or other city utilities are interrupted.

It is the responsibility of Principal Investigators and laboratory supervisors to ensure procedures for unattended operations are developed and followed by personnel working in laboratories under their supervision.

4.10 Access to Laboratories

Access to New Mexico Tech University laboratories, workshops and other work areas housing hazardous materials or machinery is restricted to New Mexico Tech faculty, staff, students, or other persons on official business.

It is the responsibility of the Department Chairperson, Principal Investigators, and laboratory supervisors to restrict access of visitors, children and volunteers to areas under their supervision when potential health and physical hazards exist.

4.10.1 Visitors and Children in Labs

Due to the potential hazards and liability issues, other persons, in particular children under the age of 16 are not permitted in hazardous work areas, with the exception of University-sanctioned activity, e.g., tours, open houses, or other University related business as authorized by the Principal Investigator or laboratory supervisor. In these instances, all children under the age of 16 must be under careful and continuous supervision. Check with your DSR to see if your department has specific procedures or policies in place for visitors.

4.10.2 Volunteers in Labs

Volunteers in labs are restricted. Please review this policy for guidance and/or consult with the University's Office of Risk Management and Insurance for more information.

4.10.3 Visiting Scientists and Other Similar Users

There are potential risks associated with allowing access to labs and equipment by visiting scientists. These risks include: theft or questions of ownership for intellectual property, bodily injury, and property damage. Colleges and units should verify that all users of the lab have the required safety and health training prior to allowing access to the lab and/or specialized equipment. It is the user's responsibility to have or obtain the appropriate training. Units are advised to consult with the University's Office of Risk Management and Insurance and/or Office of University Counsel to obtain contracts and agreements to minimize risks associated with the use of labs and equipment by visiting scientists and others.

4.10.4 Pets in Labs

Pets are prohibited "from university-controlled buildings, except for those animals that are specifically exempted by this policy. In addition, while on university-controlled property, animals must be attended and restrained at all times.

4.11 Chemical Purchasing

Before ordering new chemicals, search your existing inventories and use those chemicals currently in stock. An accurate and up-to-date chemical inventory can help to minimize purchase of chemicals already on hand and can facilitate acquisition of Safety Data Sheets (SDS). New Mexico Tech has an institutional requirement to maintain lab inventories with the quartz chemical inventory system that can help facilitate maintaining a chemical inventory. If you are interested in learning more about the Quartz system, then contact New Mexico Hazmat at 575-835-5842.

If it is necessary to purchase new chemicals, laboratory personnel should order the smallest size necessary to carry out the experiment. Avoid ordering extra quantities because the chemical "might be needed in the future". Try to take advantage of chemical vendors "Just-In-Time" delivery rather than stockpiling chemicals in your lab. Before ordering chemicals, be sure to check New Mexico Tech purchasing guidelines for preferred vendors and pricing.

Some chemical purchases may require special approval or permits, such as those chemicals that are Drug Enforcement Agency (DEA) or Alcohol, Tobacco, and Firearms

(ATF) listed substances, select agents (contact the Biosafety Officer at New Mexico Tech for more information), or particularly hazardous substances. There are also building and fire codes that restrict the amount of flammable materials that can be stored in any one room, floors, and buildings at a time. For more information, contact New Mexico Tech at 575-835-5842.

4.12 Ordering New Equipment

Whenever large pieces of equipment are planned to be purchased and installed in laboratories, especially equipment that is required to be hooked up to building utility services such as electric, water, or gas, laboratory personnel must first consult with Facilities Management, New Mexico Tech Safety, and the appropriate shops to ensure the building has the necessary resources to support the new piece of equipment. Lab personnel should not assume they can purchase equipment first and then expect the building to be able to handle the service requirements later. By preplanning and communicating well in advance with appropriate campus groups (such as Facilities Management and New Mexico Tech Safety), any potential issues can be identified ahead of time, which in turn will help make the transition to getting new pieces of equipment up and running quickly after the purchase is made.

Additionally, as with installation of fume hoods, certain pieces of equipment require special installation due to their potential impact on the rest of the building ventilation system and utilities, and cannot be hooked up by laboratory personnel, building managers, or private contractors without first consulting with Facilities Engineering and New Mexico Tech Safety. Laboratory personnel are strongly encouraged to be proactive and to consult with the appropriate departments ahead of time, before purchasing new pieces of large equipment.

Laboratory personnel are strongly encouraged, as responsible campus members, to give consideration to purchasing “Energy Star” energy efficient pieces of equipment to help conserve natural resources and long-term operating costs. When discussing purchases of equipment with vendors and equipment manufacturers, ask about what “Energy Star” alternatives they carry. For more information, see Energy Conservation in Laboratories.

Before ordering new equipment, check the New Mexico Tech purchasing guidelines for preferred vendors and pricing.

4.13 Work Orders and Ticket Requests

In the event of a maintenance issue or if repairs are needed to equipment, laboratory personnel should first consult with their Building Coordinator, who will submit the appropriate paperwork with Customer Service to have repairs initiated. Please note that due to NYS building codes and liability issues, laboratory personnel must not try to repair utility services (such as electrical, plumbing, or gas issues) by themselves. These repairs must be handled by qualified personnel only.

Whenever maintenance workers will be working on your hood system or in your laboratory, please remove all chemicals, laboratory apparatus, and equipment from the area requiring maintenance work. Ensure the work area is clean and inform the maintenance workers of any potential hazards present in the near vicinity either verbally or by leaving a sign with the appropriate information.

4.14 Changes in Lab Occupancy

Changes in laboratory occupancies can occur when faculty retire, new faculty come to campus, new lab staff are hired, students graduate or leave for another university, or when facility renovations take place. When changes in lab occupancy occur, it is important to address any potential issues BEFORE the occupants leave.

Failure to address the change in occupancy can result in:

- Old, unlabeled chemicals, samples, or hazardous waste being left behind in refrigerators, freezers, and cabinets.
- Valuable furniture or equipment being moved or thrown away.
- Unknown chemical spills or contamination being present.

These issues can result in costly remediation efforts and wasted resources for both the department and the University.

If you are planning to leave your laboratory or if you know of a research group or students that are planning to leave, there are a few simple steps that can be followed to ensure a smooth transition:

- Notify your department chairperson, lab supervisor, and DSR well in advance of the planned move.
- Ensure all chemical containers are properly labeled.
- Properly dispose of any hazardous and chemical waste left in the laboratory.
- Ensure all chemical spills and contamination has been cleaned up.

4.15 Ventilation Rates

As part of energy conservation measures, ventilation rates for laboratories are determined based on the occupancy and the type of research being conducted. Please see the Laboratory Ventilation page on this website for further information about the program.

If the function of a room changes due to new researchers coming to campus notify New Mexico Tech Safety. New Mexico Tech will then verify if the ventilation rate for a given room is appropriate for the type of research being conducted.

4.15.1 Room Air Pressure in Labs

Research laboratories should be negative to the hallways and offices. When positive air pressure occurs, more air is being supplied to the room than what is being removed by the fume hood or general exhaust. This can result in air from the laboratory (including

chemical vapors and dusts) being blown out into the hallway outside of the lab and chemical odors permeating the hallways and surrounding rooms.

- Ensure the entrance door to the laboratory is closed.
- If you notice odors that seem to be escaping from a lab, then please contact your Building Coordinator for assistance.

4.16 Energy Conservation in Laboratories

Laboratories are energy intensive facilities, consuming many times the energy use of the average non-lab academic buildings. Laboratories use large quantities of air for ventilation and fume hoods; electricity to operate fans, lighting, and specialized lab equipment; and large quantities of water and process chilled water. Some laboratory facilities also use substantial quantities of natural gas.

There are a number of things that lab occupants can do to reduce the overall consumption of energy:

- Turn off the room lights.
- When possible turn off electrical equipment when not in use.
- Use timers to turn other pieces of equipment on and off automatically.
- Unplug equipment when not in use.
- Turn off your computer's monitor when not in use. The monitor consumes over half of the energy used by the average computer. Put your computer and monitor into "sleep" mode after 10 minutes and cut power use nearly to zero.
- Keep the sash closed on your fume hood. This promotes both energy conservation and safety.
- If you would like to temporarily turn off your fume hood, please submit this form Fume Hood Hibernation Form.
- Rooms that are too hot or too cool may be due to faulty thermostats or other controls that are malfunctioning or have drifted from set points, resulting in wasted energy as well as uncomfortable conditions for you. If you experience these problems, then contact your Building Coordinator for assistance.
- Report drips of water from sink taps, chilled water connections or Reverse Osmosis (RO) faucets.
- Clean out and consolidate freezers and refrigerators at least once per year.
- Set refrigerator and freezer temperatures at necessary levels instead of the lowest set point the equipment can achieve.
- Consolidate incubator use and freezer storage to minimize the number of appliances used.
- Use shades and blinds as provided to help keep your space cool on sunny days. The shade can reduce the amount of cooling required in a south or west facing room by over 30%.
- Use electric smart strips to minimize electricity used by items on the strip (EcoStrips).
- Discourage the use of space heaters.
- Develop maintenance schedules for scientific equipment, such as cleaning compressor coils on cooling devices, to extend the device's life and maintain its energy efficiency.

4.17 Green Labs

Green chemistry, also known as sustainable chemistry, is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, and use.

- Substitute hazardous chemicals with less hazardous alternatives or chemicals that are drain disposable
- Redesign chemical processes to reduce hazardous chemical use and/or exposure to technicians
- Maintain an ongoing inventory of chemicals and dispose of outdated chemicals on a regular basis

Find additional information on Greening your labs at: EPA Pollution Prevention website for Green products

ACS Green Chemistry

Additional information on energy conservation for both work and home can be found on the Department of Energy's website: Energy Efficiency and Renewable Energy. Find energy savings tips for the home, office, and lab by going to the Utilities Department Energy Saving Tips webpage.

4.18 Research Area Inspections

Laboratories and other research areas are regulated by OSHA laboratory safety standards and general industry regulations, EPA and DEC hazardous waste regulations, DOH regulations, NFPA life and fire safety standards, and building codes. Additionally, accreditation and granting agencies such as CDC, NIH, and USDA are increasing scrutiny over researchers and their compliance with state and federal laws. To assist researchers to be in compliance with these regulations and standards, Environmental Health & Safety (New Mexico Tech Safety) will conduct required inspections of all campus research areas.

The purpose of the inspections is to assist responsible faculty and staff members in identifying and correcting potential regulatory compliance issues or other issues that could affect granting activities, and identify potential health and safety hazards that could pose an unreasonable risk to laboratory personnel, students, and the campus community. To facilitate the correction of deficient items, a corrective action process has been implemented and will be tracked. New Mexico Tech will schedule inspections by working with college-level contacts, Department Safety Representatives, Building Coordinators and staff throughout the colleges, departments, and buildings.

Research areas are strongly encouraged to conduct their own self inspections prior to New Mexico Tech conducting an inspection of their research area to address any

potential issues before the New Mexico Tech inspection and to provide a training opportunity for research staff. To facilitate the self inspection process, New Mexico Tech is providing research areas with the following self inspection checklist and explanation key which identify the same topics covered during an New Mexico Tech inspection.

4.19.1 Self Inspections

An important part of any research safety program is implementation of self inspections. Self inspections provide a number of useful benefits and further help to create a culture of safety within the lab. Benefits of self inspections include:

- Raising the level of awareness of laboratory personnel and determining the level of compliance with state and federal regulations.
- Identifying and addressing any potential issues before an inspection by a state or federal regulatory agency.
- Providing an opportunity for lab specific training by identifying potential issues within the lab and then training lab personnel to look for these issues.
- Serving as a regular health and safety check of laboratory facilities.
- Serving as an outlet for faculty, staff, and student concerns.
- New Mexico Tech recommends the following frequency for self inspections:
 - On a daily basis lab personnel should maintain good housekeeping within their lab.
 - Informal weekly lab walkthroughs or “Friday afternoon cleanups”.
 - Ideally, self inspections should occur once per month. These could include participation of research staff, DSRs, and/or safety committee members, and use of an inspection checklist.
- At least once per semester research personnel should perform a formal self inspection utilizing the New Mexico Tech self-inspection checklist and explanation key.

The benefits of conducting inspections of laboratories on a regular basis cannot be overstated. In addition to providing for a healthier and safer work environment, lab inspections can reduce legal liability by identifying potential issues, and training lab personnel to look for and correct potential issues.

4.19.2 Inspections by Regulatory Agencies

Inspections by state and federal regulatory agencies can occur at any time and can result in citations and significant fines for the university. The best way to be prepared for these inspections is to understand what regulations apply to your area and what you need to do to comply with those regulations. You can obtain this information from resources such as this Laboratory Safety Manual, by conducting your own self inspections, and by calling New Mexico Tech at 575-835-5842. You can find additional information on the New Mexico Tech web page on what to do during an OSHA inspection and what to do during an EPA inspection.

If a state or federal inspector shows up in your work area unescorted, ask them to please wait and contact New Mexico Tech immediately at 575-835-5842.

4.20 Research Area Space Registration Using HASP

All research spaces are required to be registered with the Department of New Mexico Tech Safety (New Mexico Tech Safety) using the online Hazard Assessment Signage Program (HASP). While Facilities Services Space Inventory accounts for room function and type, Research Area Space Registration accounts for hazards present in rooms to facilitate regulatory compliance, identify training requirements, communicate hazards, and improve emergency response.

Research areas must be reviewed and registered on an annual basis, when roster or hazard information changes and upon notification by New Mexico Tech Safety. The registration process consists of using the online HASP tool and entering contact information, hazards present in the room, risk levels of hazards, access limitations, warning messages, and emergency response information. The entire process of completing HASP for one room should only take a few minutes for each room. Once a research area has been initially entered into the system, annual updates can be completed in less time. Only certain research area rooms types are required to be registered. The list of space inventory room types of interest that will be required to complete annual Research Space Registration using the online HASP tool can be found on the Research Area Space Registration webpage.

The following outlines responsibilities for implementation of Research Area Space Registration using HASP:

The Department of New Mexico Tech Safety is responsible for:

- Providing information and assistance with the HASP system.
- Granting access to the users for their locations within the HASP system.
- Providing guidance and assistance on the identification of hazard types.
- Providing information, training, notifications, reports, and updates from the information provided.

Deans and Department Chairpersons are responsible for:

- Ensuring that research areas within their departments and units are registered in a timely manner upon notification by New Mexico Tech and updated annually.

Principal Investigators and Research Area Supervisors are responsible for:

- Registering (or designating someone to register) their research areas using HASP in a timely manner upon notification by New Mexico Tech Safety.
- Updating their Research Area Space Registration using HASP when any new hazards or significant change of existing hazards occurs.
- Updating their Research Area Space Registration annually in a timely manner upon notification to New Mexico Tech Safety.

New Mexico Tech will work with Department Safety Representatives (DSRs) and Building Coordinators to facilitate the implementation of Research Area Space

Registration. Before getting started, persons completing the registration process (DSRs, Building Coordinators, Principal Investigators, research staff, or other college and department designated personnel) will first need to be given authorization to the HASP system for their organization, building, department, and/or specific rooms. To obtain authorization for specific areas, please contact NMT Safety For more information on using the online HASP tool and how to get started with the program, see the online training program for using HASP.

It is the responsibility of the Principal Investigator and individual supervisors to ensure research areas under their supervision have been registered using the online HASP program.

4.21 Laboratory Security

Laboratories need to take specific actions in order to provide security against theft of highly hazardous materials, valuable equipment, and to ensure compliance with state and federal regulations. New Mexico Tech encourages each unit (college, department, and research group) to review and develop procedures to ensure the security of all hazardous materials in their area of responsibility.

Many laboratories already implement various means of security, including requirements to lock up controlled substances, syringes and needles, and radioactive materials. New Mexico Tech recommends you review and assess the hazardous materials in your laboratory and consider security issues in protecting those materials. The intent is to minimize the risk of theft, especially targeting the five-minute window when the lab is left unattended.

***One easy way to increase security is to make sure that your laboratory door is locked whenever the lab is left unattended, even for a few minutes.

4.21.1 Security Guidelines

The following are guidelines designed to minimize opportunities for intentional removal of any hazardous materials from your laboratory:

Recognize that laboratory security is related to, but different from laboratory safety. Security is preventing intrusion into the laboratory and the theft of equipment or materials from the lab.

Develop a site-specific security policy. Make an assessment of your laboratory area for hazardous materials and particular security issues. Then develop and implement lab security procedures for your lab group and train lab group members on security procedures and assign responsibilities.

Control access to areas where hazardous chemicals are used and stored. Limit laboratory access to only those individuals who need to be in the lab and restrict off-hours access only to individuals authorized by the Principal Investigator.

- Be sure to lock freezers, refrigerators, storage cabinets, and other containers where stocks of biological agents, hazardous chemicals, or radioactive materials are stored when they are not in direct view of workers (for example, when located in unattended storage areas).
-
- Do not leave hazardous materials unattended or unsecured at any time. Most importantly, close and lock laboratory doors when no one is present.
-

Note: If staff work alone and use the buddy system with someone outside of the research group, allowing access for that individual will need to be addressed prior to the initiation of working alone.

5.0 Emergency Preparation

IN CASE OF AN EMERGENCY: CALL 911 from any campus phone or dial 585-835-5555 from any cell phone, or off campus phone to reach New Mexico Tech Police.

Emergencies can occur at any time, without warning. Careful planning, with an emphasis on safety, can help members of the New Mexico Tech community handle crises and emergencies with appropriate responses, and could save lives. Every member of the New Mexico Tech community shares responsibility for emergency preparedness. Unit heads are responsible for ensuring that their units have emergency plans in place, and that all persons – including faculty, staff and students – are familiar with those emergency plans.

Unit heads are also responsible for assigning emergency preparedness and response duties to appropriate staff members.

5.1 New Mexico Tech Emergency Plan

New Mexico Tech University organizes, coordinates, and directs available resources toward an effective response to, and recovery from emergencies under the NMT Contingency plan. The effectiveness of this effort is dependent on the development of a comprehensive central plan and individual college/unit plans. The university, therefore, expects colleges, divisions and individual departments to develop detailed emergency plans. This policy includes a chain of command establishing the authority and responsibilities of campus officials and staff members, and requires that colleges, divisions, and individual departments designate emergency coordinators with the authority to make modifications in emergency procedures and to commit resources for emergency preparedness and recovery, as necessary.

5.1.1 Unit Emergency Planning

The Emergency Planning and Recovery system provides tools and guidance to colleges, divisions, and individual departments in developing detailed unit emergency plans. Policy 8.3 – Emergency Planning requires that every college and major administrative unit have designated emergency coordinators. The emergency coordinator should be a full-time member of the administrative team, and preferably an experienced employee who is thoroughly familiar with College/ Administrative Unit and University procedures. Knowledge of programs and physical facilities in their College/ Administrative Unit is also imperative. This person will coordinate their College's/Administrative Unit emergency plan as well as oversee that the College's/Administrative Unit each prepares a unit emergency plan. Each College/ Administrative Unit leader (e.g. Dean or Vice President) is responsible for designating an Emergency Coordinator. This person is responsible for gathering and communicating emergency information, coordinating and assisting in evacuations, maintaining emergency response forms and other emergency plan materials.

The Emergency Coordinator must be familiar with the programs and physical facilities, and should be a person with the management experience and authority to:

- Collaborate with departments to develop and maintain the information in the Unit Emergency Plan.
- Recruit a core "Emergency Preparedness Committee" that represents staff, faculty, and principal investigators from the unit's major sub-divisions or locations.
- Arrange related staff safety education and training.
- Coordinate resources for emergency preparedness and recovery.
- Purchase emergency supplies and equipment.
- Be ready to support managers during an emergency incident (and be called back to New Mexico Tech if necessary).
- Be ready to help prepare post-emergency impact summaries and insurance claims.

5.1.2 Fire Safety Plans

Fire safety planning is very important to the New Mexico Tech University community. The University has developed campus-wide procedures to follow in the event of an emergency that must be posted in elevator lobbies, stairwells, and assembly spaces. .

5.2 Emergency Evacuation Procedures

Information about Emergency Evacuation Procedures can be found in the Fire Safety Plan document.

5.3 Emergency Procedures

Emergencies can include both fire and non-fire emergencies. Fires are an "expected" emergency in all lab situations and almost all lab staff are trained on emergency steps in the event of a fire. "Non-fire" emergencies can include:

- Loss of electricity, heat, AC, water or other essential utilities.
- Failure of mechanical equipment such as HVAC systems and emergency generators.
- Flooding, tornadoes, earthquakes, or other natural disasters.
- Nearby chemical releases of hazardous materials to the environment (from the lab down the hall or a ruptured tank car one-half mile away).
- Terrorist actions or civil unrest.

5.3.1 Laboratory Emergency Shutdown Procedures

Each laboratory facility should develop a non-fire emergency plan or incorporate non-fire emergencies into a master emergency response plan. Employees must be trained on the contents of the plan and how to respond in a non-fire emergency. New Mexico Tech has devised a set of simple steps for the shutdown of labs in non-fire emergency situations. These and other steps, based on the requirements of the facility, should be included in the emergency response plan of each unit or facility. This list is by no means complete, but it gives laboratory personnel simple steps to ensure a safe lab shutdown.

- Close fume hood sashes.
- Be certain that the caps are on all bottles of chemicals.
- Turn off all non-essential electrical devices. Leave refrigerators and freezers on and make sure the doors are closed. Check the disconnects of large LASERS, radio frequency generators, etc. It may be necessary to check to ensure that essential equipment is plugged in to the power receptacles supplied by the emergency generator (usually orange or red).
- Turn off all gas cylinders at the tank valves. Note: If a low flow of an inert gas is being used to "blanket" a reactive compound or mixture, then the lab worker may want to leave the flow of gas on. This should be part of a pre-approved, written, posted standard operating procedure for this material or process.
- Check all cryogenic vacuum traps (Nitrogen, Carbon dioxide, and solvent). The evaporation of trapped materials may cause dangerous conditions. Check all containers of cryogenic liquids to ensure that they are vented to prevent the buildup of internal pressure.
- Check all pressure, temperature, air, or moisture sensitive materials and equipment. This includes vacuum work, distillations, glove boxes used for airless/moistureless reactions, and all reactions in progress. Terminate all reactions that are in progress, based on the known scope of the emergency.
- If experimental animals are in use, special precautions may need to be taken to secure those areas such as emergency power, alternative ventilation, etc.
- All non-essential staff/students must leave the building. Depending on the nature of the emergency, some staff may need to stay behind to facilitate the start-up of essential equipment once the lab is reopened.
- It is important to remember that some equipment does not shut down automatically –

such as large cryogenic magnets, sources of radioactivity, and other pieces of equipment. Be sure to check any special operating procedures for your equipment before an emergency occurs.

5.3.2 Medical Emergency Procedures

Call 911 (or 585-835-5555 from a cell phone) in any emergency that requires immediate police, fire or medical response to preserve a life.

- Protect the victim from further injury or harm by removing any persistent threat to the victim or by removing the victim to a safe place if needed, however do not move the victim unnecessarily. Do not delay in obtaining trained medical assistance if it is safe to do so.
- Notify New Mexico Tech Police of the location, nature and extent of the injury by calling 911 or using a Blue Light or Emergency Telephone. Always call from a safe location.
- Provide first aid until help arrives if you have appropriate training and equipment, and it is safe to do so.
- Send someone outside to escort emergency responders to the appropriate location, if possible.

5.3.3 First Aid Kits

Although there are areas at New Mexico Tech where people work that could be considered hazardous, Cornell's main campus has no legal requirements to have first aid kits in work spaces within the campus buildings. This reasoning is addressed by OSHA (29 CFR 1910.151) and cited in the ANSI standard (Z308.1-1998) that states if medical attention can be reached within a reasonable time, or distance, to rely on the professionals and make that part of an emergency plan. Cornell's New Mexico Tech department has fully training emergency responders on call 24 hours a day, 7 days a week. Injured personnel are encouraged to take advantage of this service by calling 911 from a campus phone or 585-835-5555 from a cell phone.

If you choose to have a first aid kit in your work space, then there are some additional requirements to address. There has to be the appropriate items in the kit to mediate an injury that could happen in your work area. There needs to be a responsible person in your work space that is trained - with their contact information posted on the kit. The kit should be maintained and complete at all times. An Injury/Illness Exposure Reporting should be completed when a first aid kit is used due to an injury/illness in a New Mexico Tech University laboratory.

New Mexico Tech can provide information on where to obtain the appropriate training if you choose to keep a first aid kit in your work space.

The ANSI Standard lists the following minimum fill requirements for a first aid kit:

- 1 - Absorbent compress, 4 x 8 in. minimum
- 5 yard Adhesive Tape
- 10 - Antiseptic applications, 0.14 fl.oz. each

- 1 - Triangular bandage, 40 x 40 x 56 in. minimum
- 16 - Adhesive Bandages, 1 x 3 inch
- 2 - Pair medical exam gloves
- 4 - Sterile pads, 3 x 3 in. minimum
- 6 - Burn treatment applications, 1/32 oz. each

5.3.4 Fire or Explosion Emergency Procedures

All fires must be reported to New Mexico Tech Police, including those that have been extinguished. Do not hesitate to activate the fire alarm if you discover smoke or fire.

- Alert people in the immediate area of the fire and evacuate the room.
- Confine the fire by closing doors as you leave the room.
- Activate a fire alarm by pulling on an alarm box.
- Notify New Mexico Tech Police of the location and size of the fire by calling 911 from a campus phone, or 575-835-5555 from a cell phone or off campus phone, or using a Blue Light or Emergency Telephone. Always call from a safe location.
- Evacuate the building using the Emergency Evacuation Procedure. Do not use elevators to evacuate unless directed to do so by emergency responders.
- Notify emergency responders of the location, nature and size of the fire once you are outside.

If you have been trained and it is safe to do so, you may attempt to extinguish the fire with a portable fire extinguisher. Attempt to extinguish only small fires and make sure you have a clear escape path. If you have not been trained to use a fire extinguisher you must evacuate the area.

If clothing is on fire:

- Stop - Drop to the ground or floor and Roll to smother flames.
- Smother flames using a fire blanket.
- Drench with water from a safety shower or other source.
- Seek medical attention for all burns and injuries.

5.3.5 Fire Extinguishers

- All fire extinguishers are inspected annually and maintained by NMT Facilities Management.
- Laboratory personnel should perform regular visual checks (minimum on a monthly basis) to ensure fire extinguishers present in their labs are fully charged. For those fire extinguishers with a readout dial, labs only need to ensure the indicator arrow on the readout dial is within the green zone. If the indicator arrow is on either side of the green zone, which indicates a problem, then call New Mexico Tech at 575-835-5842 to have the fire extinguisher replaced.
- Any fire extinguisher that has been used at all, even if it wasn't fully discharged, needs to be reported to New Mexico Tech so a replacement fire extinguisher can be

provided in its place. You can also obtain training in using a fire extinguisher by contacting New Mexico Tech at 575-835-5842.

5.3.6 Power Outage Procedures

- Assess the extent of the outage in the unit's area.
- Assist other building occupants to move to safe locations. Loss of power to fume hoods may require the evacuation of laboratories and surrounding areas.
- Implement the unit's power outage plan. Evaluate the unit's work areas for hazards created by a power outage. Secure hazardous materials. Take actions to preserve human and animal safety and health. Take actions to preserve research.
- Turn off and/or unplug non-essential electrical equipment, computer equipment and appliances. Keep refrigerators and freezers closed throughout the outage to help keep contents cold.
- If needed, open windows (in mild weather) for additional light and ventilation (this is not always advisable in BSL2 labs).

5.4 Chemical Spill Procedures

When a chemical spill occurs, it is necessary to take prompt and appropriate action. The type of response to a spill will depend on the quantity of the chemical spilled and the severity of the hazards associated with the chemical. The first action to take is to alert others in your lab or work area that a spill has occurred. Then you must determine if you can safely clean up the spill yourself.

Many chemical spills can be safely cleaned up by laboratory staff without the help of New Mexico Tech Safety. Only attempt to clean up incidental spills if you are trained and have the proper spill cleanup materials available. Note: The following advice is intended for spills that occur within a University building. A release to the outside environment may require the University file a report with the EPA. Calling New Mexico Tech Police will initiate this determination by New Mexico Tech Safety.

5.4.1 Incidental Spills

A spill is considered incidental if the criteria below are met:

Physical:

- The spill is a small quantity of a known chemical
- No gases or vapors are present that require respiratory protection.

Equipment:

- You have the materials and equipment needed to clean up the spill.
- You have the necessary proper personal protective (PPE) equipment available.

Personal:

- You understand the hazards posed by the spilled chemical.
- You know how to clean up the spill.
- You feel comfortable cleaning up the spill.

5.4.1.1 Incidental Spill Cleanup Procedures

- Notify other people in the area that a spill has occurred. Prevent others from coming in contact with the spill (i.e. walking through the spilled chemical). The first priority is to always protect yourself and others.
- Put on the Proper Personal Protective Equipment (PPE) such as goggles, gloves, etc. before beginning cleanup. Do not unnecessarily expose yourself to the chemical.
- Stop the source of the spill if possible, and if safe to do so.
- Try to prevent spilled chemicals from entering waterways by building a dike around access points (sink, cup sinks, and floor drains inside and storm drains outside) with absorbent material if you can safely do so.
- Use the appropriate absorbent material for liquid spills (detailed in the following section).
- Slowly add absorbent material on and around the spill and allow the chemical to absorb. Apply enough absorbent to completely cover the spilled liquid.
- Sweep up the absorbed spill from the outside towards the middle.
- Scoop up and deposit in a leak-proof container.
- For acid and base spills, transfer the absorbed materials to a sink, and complete the neutralization prior to drain disposal.
- For absorbed hazardous chemicals, label the container and dispose of through the hazardous waste management program.
- If possible, mark the area of the spill on the floor with chalk.
- Wash the contaminated surface with soapy water. If the spilled chemical is highly toxic, collect the rinse water for proper disposal.
- Report the spill to your supervisor.
- Restock any spill clean up supplies that you may have used from any spill kits.

5.4.2 Spill Absorbent Materials

Note: The following materials are New Mexico Tech approved/recommended spill absorbent materials, however, they are not appropriate for every possible chemical spill – when in doubt, contact New Mexico Tech at 575-835-5842 for advice.

For acid spills (except Hydrofluoric acid):

- Sodium carbonate
- Sodium bicarbonate (baking soda)
- Calcium carbonate
- Calcium bicarbonate
- Do not use absorbent clay for acid spills

For Hydrofluoric acid (HF) spills:

- Use Calcium carbonate or Calcium bicarbonate to tightly bind the fluoride ion.

For liquid base spills:

- Use Sodium bicarbonate to lower the pH sufficiently for drain disposal.

For oil spills:

- Use ground corn cobs (SlikQwik), vermiculite, or absorbent clay (kitty litter).

For most aqueous solutions:

- Use ground corn cobs (SlikQwik)

For most organic liquid spills:

- Use ground corn cobs (SlikQwik). If the liquid is flammable, be sure to use an excess of SlikQwik.

For oxidizing liquids:

- Use absorbent clay, vermiculite, or some other nonreactive absorbent material. Do not use SlikQwik or paper towels. Note: Most nitrate solutions are not sufficiently oxidizing for this requirement.

For mercury spills:

- Do not dispose of mercury or mercury contaminated spill debris in the regular trash or down the drain.
- There is no absorbent material available. Physical removal processes are best for removing and collecting mercury.
- If you need help collecting Mercury from a spill, contact New Mexico Tech spill responders by calling 575835-5842. Note: While powdered sulfur will help reduce mercury vapors, the sulfur greatly complicates the spill cleanup.

5.4.3 Spill Kits

While commercially available spill kits are available from a number of safety supply vendors, laboratory personnel can assemble their own spill kits to properly clean up chemicals specific to their laboratory. Whether commercially purchased or made in-house, New Mexico Tech strongly encourages all laboratories to obtain a spill kit for their use. Colleges and departments should give serious consideration to distributing basic spill kits to all laboratories within their units.

A useful spill kit can be assembled using a 2.5 or 5 gallon bucket containing the following absorbent materials. Stock only the absorbents appropriate for your space. Each container of absorbent must be labeled as to what it contains and what type of spills it can be used for.

Spill kit absorbent material:

- 1-5 lbs of ground corn cobs (SlikQwik) – for most aqueous and organic liquid spills
- 1-5 lbs of absorbent clay (kitty litter) - for oils or oxidizing liquids.
- 1-5 lbs of Sodium bicarbonate - for liquid acid and base spills.
- 1-5 lbs of Calcium carbonate or Calcium bicarbonate - for HF spills.

Equipment in the spill kit could include:

- Wisk broom and dust pan (available at home improvement stores)
- Sponge
- pH paper
- 1 gallon and 5 gallon bags - for collection of spill cleanup material
- Small and large Ziploc bags – for collection of spill cleanup material or to enclose leaking bottles/containers.
- Safety goggles
- Thick and thin Nitrile gloves
- Hazardous waste labels

The spill kit should be clearly labeled as “SPILL KIT”, with a list of the contents posted on or in the kit. This list should include information about restocking the kit after use and where to obtain restocking materials.

Laboratory personnel must also be properly trained on:

- How to determine if they can or should clean up the spill, or if they should call 911 or New Mexico Tech Safety at 575-835-5842.
- Where the spill kit will be kept within the laboratory.
- What items are in the kit and where replacement items can be obtained.
- How to use the items in the kit properly.
- How to clean up the different types of chemical spills.
- How to dispose of spill cleanup material.

New Mexico Tech Safety can provide assistance in assembling spill kits for laboratories and offers a training class on “Cleaning Up Small Spills”. More information can be obtained by contacting New Mexico Tech Safety at 575-835-5842.

5.4.4 Major Spills

A major spill is any chemical spill for which the researcher determines they need outside assistance to safely clean up a spill. New Mexico Tech is activated to assist with spill cleanup whenever New Mexico Tech Police are notified of a spill by calling 911 from a campus phone or 585-835-5555 from a cell phone or off campus phone.

5.4.4.1 Major Spill Cleanup Procedures

When a spill occurs that you are not capable of handling:

- Alert people in the immediate area of the spill and evacuate the room.
- If an explosion hazard is present, do not unplug, or turn electrical equipment on or off – doing so can result in a spark and ignition source.
- Confine the hazard by closing doors as you leave the room.
- Use eyewash or safety showers as needed to rinse spilled chemicals off people or

yourself.

- Evacuate any nearby rooms that may be affected. If the hazard will affect the entire building, then evacuate the entire building by pulling the fire alarm.
- Notify New Mexico Tech Police by calling 575-835-5555 or using a Blue Light or Emergency Telephone. Always call from a safe location.

Be prepared to provide New Mexico Tech Police with the following information:

- Where the spill occurred (building and room number).
- If there are there any injuries and if medical attention is needed.
- The identity of the spilled material(s) - be prepared to spell out the chemical names.
- The approximate amount of material spilled.
- How the spill occurred (if you know).
- Any immediate actions you took.
- Who first observed the spill and the approximate time it occurred.
- Where you will meet emergency responders, or provide a call back number (if available).

Once outside, notify emergency responders of the location, nature and size of the spill. Isolate contaminated persons and protect yourself and others from chemical exposure.

5.5 Emergency Eyewash and Showers

All laboratories using hazardous chemicals, particularly corrosive chemicals, must have access to an eyewash and/or an emergency shower as per the OSHA standard 29 CFR 1910.151 – Medical Services and First Aid. The ANSI Standard Z358.1-2009 - Emergency Eyewash and Shower Equipment provides additional guidance by stating that emergency eyewash and/or emergency showers be readily accessible, free of obstructions and within 10 seconds from the hazard. The ANSI standard also outlines specific requirements related to flow requirements, use of tempered water, inspection and testing frequencies, and training of laboratory personnel in the proper use of this important piece of emergency equipment.

Due to the flow requirements outlined in the ANSI standard, hand held bottles do not qualify as approved eyewashes.

5.5.1 Testing and Inspection of Emergency Eyewash and Showers

The ANSI Standard provides guidance by stating that plumbed emergency eyewash and safety showers should be activated weekly to verify proper operation and inspected annually. Regular activation (weekly flushing) ensures the units are operating properly, helps to keep the units free of clutter, and helps prevent the growth of bacteria within the plumbing lines, which can cause eye infections. It is recommended to allow the water to run for at least 3 minutes. New Mexico Tech strongly encourages laboratories to post an “Eyewash Testing Sheet” near the eyewash to keep track and document that weekly activation is occurring.


Laboratories are responsible for activating eyewashes in their spaces and ensuring that access to eyewashes and emergency showers are kept free of clutter and ensuring the eyewash nozzle dust covers are kept in place. If nozzle dust covers are not kept on the eyewash nozzles, dust or other particles can clog the nozzles and effect water flow. This could result in dust or other particles being forced into the eyes when the eyewash is used.

Report any malfunctioning eyewashes and emergency showers to your Building Coordinator to have the unit repaired. If either the emergency shower or eyewash is not working properly, post Do Not Use sign on the unit to alert others.

New Mexico Tech performs free annual inspections of eyewashes and emergency showers. New Mexico Tech will test units for compliance with ANSI Z358.1-2009 including:

- Test the water flow for proper quantity, spray pattern, and good water quality.
- Ensure the unit is the proper height from the floor.
- Ensure the unit is not obstructed.
- Ensure the unit has a tempering valve (if the unit does not have a tempering valve, this will be identified as a recommended repair in the inspection report).
- Ensure valves are working properly.
- Ensure signs are posted.
- Ensure the unit is free of corrosion.

5.5.2 Installation of New Emergency Eyewash and Showers

As with installation of other safety equipment, all new eyewashes and emergency showers must be installed in consultation with Facilities Engineering, New Mexico Tech Safety, and the appropriate campus service shops. All new installations of eyewashes and emergency showers must comply with CU Design Standard 15430 – Safety Showers and Eyewashes. Before New Mexico Tech will commission any new emergency shower or eyewash, the project manager or designated representative must complete an  Emergency Shower and Eyewash Commissioning Form and submit it to the program manager.

5.5.3 Maintenance Procedures For Emergency Eyewash and Showers

If assistance is needed contact New Mexico Tech Safety at 575-835-5842

5.5.4 Using Emergency Eyewash and Showers

Preplan your experiments and include emergency procedures. At minimum identify the locations of the nearest emergency shower and eyewash before working with hazardous

chemicals.

In the event of an emergency (chemical spill or splash) where an eyewash or emergency shower is needed, follow these procedures:

Eyewashes

- 1 If you get a chemical in your eyes, yell for help if someone else is in the lab.
- 2 Immediately go to the nearest eyewash and push the activation handle all the way on.
- 3 Put your eyes or other exposed area in the stream of water and begin flushing.
- 4 Open your eyelids with your fingers and roll your eyeballs around to get maximum irrigation of the eyes.
- 5 Keep flushing for at least 15 minutes or until help arrives. The importance of flushing the eyes first for at least 15 minutes cannot be overstated! For accidents involving Hydrofluoric acid, follow the special Hydrofluoric acid precautions.
- 6 If you are alone, call 911 after you have finished flushing your eyes for at least 15 minutes.
- 7 Seek medical attention.
- 8 Complete an Injury/Illness Exposure Report.

If someone else in the lab needs to use an eyewash, assist them to the eyewash, activate the eyewash for them, and help them get started flushing their eyes using the procedures above and then call 911. After calling 911, go back to assist the person using the eyewash and continue flushing for 15 minutes or until help arrives and have the person seek medical attention.

Emergency Showers

- 1 If you get chemical contamination on your skin resulting from an accident, yell for help if someone else is in the lab.
- 2 Immediately go to the nearest emergency shower and pull the activation handle.
- 3 Once under the stream of water, begin removing your clothing to wash off all chemicals.
- 4 Keep flushing for at least 15 minutes or until help arrives. The importance of flushing for at least 15 minutes cannot be overstated! If you spill Hydrofluoric acid on yourself, follow the special Hydrofluoric acid precautions.
- 5 If you are alone, call 911 after you have finished flushing for at least 15 minutes.
- 6 Seek medical attention.
- 7 Complete an Injury/Illness Exposure Reporting.

If someone else in the lab needs to use an emergency shower (and it is safe for you to do so), assist them to the emergency shower, activate the shower for them, and help them get started flushing using the procedures above and then call 911. After calling 911, go back to assist the person using the shower and continue flushing for 15 minutes or until help arrives and have the person seek medical attention.

NOTE: Although an emergency is no time for modesty, if a person is too modest and reluctant to use the emergency shower, you can assist them by using a lab coat or other piece of clothing or barrier to help ease their mind while they undress under the shower.

If you are assisting someone else, you should wear gloves to avoid contaminating yourself. When using an emergency shower, do not be concerned about the damage from flooding. The important thing to remember is to keep flushing for 15 minutes. If there is a large quantity of chemical spilled or washed off, please contact New Mexico Tech at 575-835-5842 to see if the rinsate needs to be collected as hazardous waste.

5.6 Injury/Illness Exposure Reporting

All accidents and injuries, no matter how minor, are required to be reported to University officials through the injury/illness reporting system. The supervisor of an injured employee, the department head, or a designated individual within the department must complete all sections of this form within 24 hours after the injury is first reported. The online Injury/Illness reporting system can be accessed through the New Mexico Tech webpage.

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure all injuries are reported to University officials.

5.7 Medical Consultations

When a chemical exposure occurs, medical consultations and medical examinations will be made available to laboratory workers who work with hazardous chemicals as required. All work related medical examinations and consultations will be performed by or under the direct supervision of a licensed physician and will be provided at no cost to the employee without loss of pay, and at a reasonable time, through the Gannett Health Center.

The opportunity to receive medical attention, including any follow up examinations, will be provided to employees who work with hazardous chemicals under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
- Where airborne exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements. Action level means the airborne concentration of a specific chemical, identified by OSHA, and calculated as an 8-hour time weighted average (TWA).
- Whenever an event such as a spill, leak, explosion or other occurrence takes place and results in the likelihood of a hazardous exposure. Upon such an event, the affected employee shall be provided an opportunity for a medical consultation. The consultation shall be for the purpose of determining the need for a medical examination.

More information on action levels and Permissible Exposure Limits can be found on the

5.7.1 Information Provided to the Physician

The physician shall be provided with the following information:

- The identity of the hazardous chemical(s) to which the employee may have been exposed. Such information can be found in the Safety Data Sheet (SDS) for the chemical(s).
- 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 that the employee is experiencing, if any.

5.7.2 The Physician's Written Opinion

The physician's written opinion for the consultation or examination shall include:

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

All records of medical consultations, examinations, tests, or written opinions shall be maintained at New Mexico Tech Safety Office in accordance with 29 CFR 1910.1020 - Access to employee exposure and medical records. The New Mexico Tech Health Center (575-835-5094). Exposure monitoring records of contaminate levels in laboratories will be maintained at New Mexico Tech Safety office. For more information, contact New Mexico Tech at 575-835-5842.

6.0 Requirements

Federal and state laws and New Mexico Tech University policy require all laboratory workers to receive Laboratory Safety and Chemical Waste Disposal training and be informed of the potential health and safety risks that may be present in their workplace. Documentation must be maintained to demonstrate that such training was provided and received. In order to assist laboratory personnel comply with this requirement, laboratory safety training must be obtained either through New Mexico Tech or documented as having been received from an alternative source.

The OSHA Laboratory Standard requires employers to provide employees with information and training to ensure they are apprised of the hazards of chemicals present in their work area. The Laboratory Standard goes on to state that such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations.

As per the OSHA Laboratory Standard, information that must be provided to employees includes:

- The contents of the Laboratory Standard and its appendices (Appendix A and Appendix B) shall be made available to employees.
- The location and availability of the employer's Chemical Hygiene Plan.
- The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
- The location and availability of identified reference materials listing the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, SDSs received from the chemical supplier.

The Laboratory Standard goes on to state this training shall include:

- Methods and observations that may be used to detect the presence or release of a hazardous chemical.
- The physical and health hazards of chemicals in the work area.
- The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and PPE to be used.

The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

While the OSHA Laboratory Standard is specific to working with hazardous chemicals, as per the University Health & Safety Policy 8.6, laboratory employees must also be provided with the proper training and information related to the other health and physical hazards that can be found in their work environment, including the hazards described within this Laboratory Safety Manual.

It is the responsibility of Principal Investigators and laboratory supervisors to ensure personnel working in laboratories under their supervision have been provided with the proper training, have received information about the hazards in the laboratory they may encounter, and have been informed about ways they can protect themselves.

6.1 Training Options

Principal Investigators and laboratory supervisors have a number of options available to them to ensure laboratory employees under their supervision have received proper training. These options include:

- Training programs provided by
- In-house training programs (provided by the Principal Investigator or laboratory supervisor)
- Training manuals and booklets
- Training by New Mexico Tech Safety

The keys to any training programs are:

- The instructor providing the training is technically qualified to provide training on the particular subject.
- The training program(s) address the hazards present in the laboratory and describe ways employees can protect themselves.
- The training program and attendance must be documented using a sign-in sheet and these records must be readily available and accessible upon request.

Training sessions do not have to be hours or half-day sessions, they can be short, 15 minute, half hour, or how ever long it takes to achieve the training objectives.

Please note that one training class is usually not comprehensive enough to cover all of the hazards found within a laboratory. Principal Investigators and laboratory supervisors will find that it is necessary to use a combination of the options available to ensure their employees are properly trained.

New Mexico Tech Training Programs

New Mexico Tech offers a number of training programs on a regular basis – such as the monthly “Laboratory Safety Training” – and offers a number of programs “Upon Request”. For any “Upon Request” training class, New Mexico Tech can come to your building or laboratory and provide the training program for your laboratory group. All New Mexico Tech provided training programs and attendance sheets are kept on file at the New Mexico Tech office and entered into the New Mexico Tech Learning Management System.

In-House Training Programs

In-house training can include department provided training, and training by Principal Investigators and laboratory supervisors. Training sessions can be stand-alone classes, on-the-job training, or short (15 minute) trainings incorporated as part of a laboratory group meeting. The key is to make sure the training is documented with a sign-in sheet.

Training Manuals and Booklets

Principal Investigators and laboratory supervisors can utilize training manuals, booklets,

webpage downloads, etc., as part of an ongoing training program by simply having laboratory staff review the material, be given an opportunity to ask any questions, and sign off that they read and understood the material.

7.0 Safe Chemical Use

Safe chemical use includes minimizing exposure to chemicals, proper training, understanding chemical hazards, proper labeling, proper storage and segregation, and proper transport.

7.1 Minimize Exposure to Chemicals

The best way laboratory personnel can protect themselves from chemical hazards is to minimize their exposure to them. In order to minimize chemical exposure:

- Substitute less hazardous chemicals in your experiments whenever possible.
- Always use the smallest possible quantity of chemical for all experiments.
Consider microscale experiments and activities.
- Minimize chemical exposures to all potential routes of entry - inhalation, ingestion, skin and eye absorption, and injection through proper use of engineering controls and personal protective equipment
- Be sure to select the proper PPE and regularly inspect it for contamination, leaks, cracks, and holes. Pay particular attention to gloves.
- Do not pipette or apply suction by mouth.
- Do not smell or taste chemicals. When it is necessary to identify a chemical's odor, lab personnel should hold the chemical container away from their face and gently waft their hand over the container without inhaling large quantities of chemical vapor.
- Do not underestimate the risk of exposure to chemicals - even for substances of no known significant hazard.
- In order to identify potential hazards, laboratory personnel should plan out their experiments in advance. These plans should include the specific measures that will be taken to minimize exposure to all chemicals to be used, the proper positioning of equipment, and the organization of dry runs.
- Chemicals that are particularly hazardous substances require prior approval from your supervisor and special precautions to be taken.
- When working with mixtures of chemicals, laboratory personnel should assume the mixture to be more toxic than the most toxic component in the mixture.
- Consider all substances of unknown toxicity to be toxic until proven otherwise.
- Request exposure monitoring to ensure the Permissible Exposure Limits (PELs) of OSHA and the current Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists are not exceeded.
- Promptly clean up all chemicals spills regardless whether the chemical is considered hazardous or nonhazardous. When cleaning up spills, remember to clean up any splashes that may have occurred on the sides of cabinets and doors in the immediate area.

- When working in cold rooms, keep all toxic and flammable substances tightly closed as cold rooms have recirculated atmospheres.
- Be aware of the potential asphyxiation hazard when using cryogenic materials and compressed gases in confined areas such as cold rooms and environmental chambers. If necessary, install an oxygen monitor/oxygen deficiency alarm and/or toxic gas monitor before working with these materials in confined areas. Contact New Mexico Tech at 575-835-5842 for more assistance.
- Do not eat, drink, chew gum, or apply cosmetics in areas where hazardous chemicals are being used.
- Keep all food and drink out of refrigerators and freezers used to store chemicals. Refrigerators used to store chemicals should be labeled as “Chemicals Only – No Food”. Refrigerators used to store food should be labeled as “Food Only – No Chemicals”.
- Always wash hands with soap and water after handling chemicals and especially before leaving the lab and eating – even if gloves were worn during chemical handling.
- Always remove personal protective equipment, such as gloves and lab coats, before leaving the lab.
- Do not attempt to scale up experiments until after you have run the experiment according to published protocols and you are thoroughly familiar with the potential hazards. When scaling up an experiment – change only one variable at a time, i.e. don’t change the heat source, the volumes, and the glassware all at once. It is also advisable to let one of your other lab group members to check your setup prior to each run.

7.2 Understanding Chemical Hazards

Chemicals pose both health and physical hazards. For the purposes of this document, health hazard will be used interchangeably with chemical hazard and health effects on the body will be used interchangeably with chemical effects on the body.

According to OSHA, health hazard 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 system and agents which damage the lungs, skin, eyes, or mucous membranes.”

According to OSHA, 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.” Physical hazards are covered in other sections within this manual.

7.2.1 Chemical Hazard Information

As part of the employers Chemical Hygiene Plan, the OSHA Laboratory Standard requires that “the employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area... Such information shall be provided at the time of an employee’s initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations.”

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students under their supervision are provided with adequate training and information specific to the hazards found within their laboratories.

In addition to required health and safety training as per the OSHA Lab Standard and the University Health and Safety Policy, other sources of information on chemical and physical hazards include:

- This Laboratory Safety Manual
- Known reference materials (New Mexico Tech maintains a reference library)
- Other department’s safety manuals
- Safety Data Sheets (SDSs)
- Websites
- NMT training programs
- Departmental Safety Committees
- Container labels
- Laboratory Standard Operating Procedures
- Laboratory signage and postings
- Publications such as the American Chemical Society – Safety in Academic Chemistry Laboratories

7.3 Safety Data Sheets

Safety Data Sheets (SDSs) are an important part of any laboratory safety program in communicating information to chemical users. SDSs provide useful information such as:

- The identity of the chemical substance.
- Physical and chemical characteristics.
- Physical and health hazards.
- Primary routes of entry.
- OSHA Permissible Exposure Limits (PELs)
- Carcinogenic and reproductive health status.
- Precautions for safe handling and use (including PPE).
- Spill response procedures.
- Emergency and first aid questions.
- Date the SDS was prepared.

Any chemical shipment received should be accompanied by an SDS (unless one has been shipped with a previous order). If you do not receive an SDS with your shipment, check the chemical manufacturers website first (or call the manufacturer directly), or check

Quartz database, or contact New Mexico Tech at 575-835-5842 to request assistance in obtaining the SDS.

If you have questions on how to read SDSs, or questions about the terminology or data used in SDSs, you can contact New Mexico Tech at 575-835-5842 for more information. Additional information, including how to read an SDS, can be found in the SDS FAQ and a glossary of terms used on SDSs can be found in the “Hyper glossary”. Information on the National Fire Protection Association - NFPA diamond and the Hazardous Materials Information Guide and Hazardous Materials Information System – HMIG and HMIS - is also available.

It is the responsibility of Principal Investigators and laboratory supervisors to ensure that staff and students working in laboratories under their supervision have obtained required health and safety training and have access to SDSs (and other sources of information) for all hazardous chemicals used in laboratories under their supervision.

SDSs must be accessible at all times. Access to SDSs can mean access to paper copies or electronic access via the internet. New Mexico Tech maintains links to a number of SDS websites and other sites with chemical health and safety information.

New Mexico Tech strongly encourages paper copies of SDSs be kept in the laboratory, however, having SDS websites bookmarked is acceptable as long as all employees in the workplace know where to find the SDSs and are trained on the use of computers to access SDSs. If a laboratory chooses to use electronic access, then New Mexico Tech recommends the SDS website link be posted on the computer or in another conspicuous location. Some departments maintain three ring binders - “Big Red Books” - with SDSs. Check with your DSR for the location of the departmental SDS collection.

Please note: any accidents involving a chemical will require an SDS being provided to emergency response personnel and to the attending physician so proper treatment can be administered.

The New Mexico Tech “rule of thumb” is that a person working in a laboratory should be able to produce an SDS for any hazardous chemical found in the lab within five minutes.

7.3.1 SDSs and Newly Synthesized Chemicals

Principal Investigators will be responsible for ensuring that newly synthesized chemicals are used exclusively within their laboratories and are properly labeled. If the hazards of a chemical synthesized in the laboratory are unknown, then the chemical must be assumed to be hazardous and the label should indicate the potential hazards of that substance have not been tested and are unknown.

The Principal Investigator must ensure a SDS is prepared for newly synthesized chemicals if:

- The chemical is hazardous according to the OSHA definition of hazardous (if the

hazards are not known, then the chemical must be assumed to be hazardous).

AND

The newly created chemical or intermediate compound is going to be transferred to a different researcher or testing lab on or off of the New Mexico Tech University campus.

OR

The newly created chemical or intermediate compound is going to be kept in the lab for an on-going basis for use by current and/or future researchers in the lab where it was originally made.

OR

The newly created chemical or intermediate compound is going to be provided to another research group at New Mexico Tech University.

7.4 Routes of Chemical Entry

The potential health effects that may result from exposure to chemicals depends on a number of factors. These factors include the properties of the specific chemical (including toxicity), the dose and concentration of the chemical, the route of exposure, duration of exposure, individual susceptibility, and any other effects resulting from mixtures with other chemicals.

In order to understand how chemical hazards can affect you, it is important to first understand how chemicals can get into your body and do damage. The four main routes of entry are inhalation, ingestion, injection, and absorption through the skin and eyes.

7.4.1 Inhalation

Inhalation of chemicals occurs by absorption of chemicals via the respiratory tract (lungs). Once chemicals have entered into the respiratory tract, the chemicals can then be absorbed into the bloodstream for distribution throughout the body. Chemicals can be inhaled in the form of vapors, fumes, mists, aerosols and fine dust.

Symptoms of exposure to chemicals through inhalation include eye, nose, and throat irritation, coughing, difficulty in breathing, headache, dizziness, confusion, and collapse. If any of these symptoms are noted, leave the area immediately and get fresh air. Seek medical attention if symptoms persist and complete and Injury/Illness Report.

Laboratory workers can protect themselves from chemical exposure via inhalation through proper use of a functioning fume hood, use of dust masks and respirators when a fume hood is not available, avoiding bench top use of hazardous chemicals, ensuring chemical containers are kept tightly capped, and ensuring all chemical spills are promptly cleaned up.

7.4.2 Ingestion

Chemical exposure through ingestion occurs by absorption of chemicals through the digestive tract. Ingestion of chemicals can occur directly and indirectly. Direct ingestion can occur by accidentally eating or drinking a chemical; with proper housekeeping and labeling, this is less likely to occur. A higher probability of receiving a chemical exposure can occur by way of indirect ingestion. This can occur when food or drink is brought into a chemical laboratory. The food or drink can then absorb chemical contaminants (vapors or dusts) in the air and result in a chemical exposure when the food or drink is consumed. This can also occur when food or drink is stored with chemicals, such as in a refrigerator. Ingestion can occur when a laboratory worker who handles chemicals does not wear gloves or practice good personal hygiene, such as frequent hand washing, and then leaves the laboratory to eat, drink, or smoke. In all cases, a chemical exposure can result, although the effects of chronic exposure may not manifest itself until years later.

Symptoms of chemical exposure through ingestion include metallic or other strange tastes in the mouth, stomach discomfort, vomiting, problems swallowing, and a general ill feeling. If you think you may have accidentally ingested a chemical, seek medical attention immediately and/or call the Poison Control Center at 1-(800) 222-1222 or New Mexico Tech Police at 585-835-5555 from a cell phone or off campus phone. After seeking medical attention, complete an Injury/Illness Report.

The best protection against ingestion of chemicals is to properly label all chemical containers, never consume food or drink or chew gum in laboratories, always wear PPE (such as gloves), and practice good personal hygiene, such as frequent handwashing.

7.4.3 Injection

Chemical exposure via injection can occur when handling chemically contaminated items such as broken glass, plastic, pipettes, needles, razor blades, or other items capable of causing punctures, cuts, or abrasions to the skin. When this occurs, chemicals can be injected directly into the bloodstream and cause damage to tissue and organs. Due to direct injection into the bloodstream, symptoms from chemical exposure may occur immediately.

Laboratory workers can protect themselves from an injection hazard by wearing proper PPE such as safety glasses/goggles, face shields, and gloves. Inspect all glassware for chips and cracks before use, and immediately discard any glassware or plasticware that is damaged. To help protect coworkers in the lab and building care staff, all broken glass should be disposed of in a puncture resistant container labeled as "Broken Glass". This can be a commercially purchased "broken glass" container or simply a cardboard box or other puncture resistant container labeled as "Broken Glass".

Whenever cleaning up broken glass or other sharp items, always use a broom, scoop or dustpan, or devices such as pliers, before using your hands to pick up broken pieces. If you have to use your hands, it is best to wear leather gloves when handling broken glass.

For other items that can cause cuts or puncture wounds, such as needles and razor blades, never leave these items out in the open where someone could come into contact with them. New Mexico Tech recommends using a device such as a piece of Styrofoam or similar item to secure them for later use. For disposal, use an appropriate “sharps” container.

If you do receive a cut or injection from a chemically contaminated item, if possible, gently try to remove the object and immediately rinse under water while trying to flush the wound and remove any chemical contamination, administer first aid and seek medical attention if necessary, and then complete an Injury/Illness Report.

7.4.4 Eye and Skin Absorption

Some chemicals can be absorbed by the eyes and skin, resulting in a chemical exposure. Most situations of this type of exposure result from a chemical spill or splash to unprotected eyes or skin. Once absorbed by these organs, the chemical can quickly find its way into the bloodstream and cause further damage, in addition to the immediate effects that can occur to the eyes and the skin.

Symptoms of eye exposure can include itchy or burning sensations, blurred vision, discomfort, and blindness. The best way to protect yourself from chemical splashes to the eyes is to always wear safety glasses in the laboratory whenever eye hazards exist (chemicals, glassware, lasers, etc.). If you are pouring chemicals, then splash goggles are more appropriate than safety glasses. Whenever a severe splash hazard may exist, the use of a face shield, in combination with splash goggles is the best choice for protection. Please note, a face shield by itself does not provide adequate eye protection.

If you do get chemicals in your eyes, immediately go to an eyewash station and flush your eyes for at least 15 minutes. The importance of flushing for at least 15 minutes cannot be overstated! Once the eyewash has been activated, use your fingers to hold your eyelids open and roll your eyeballs in the stream of water so the entire eye can be flushed. After flushing for at least 15 minutes, seek medical attention immediately and complete an Injury/Illness Report.

Symptoms of skin exposure to chemicals include dry, whitened skin, redness, swelling, rashes, blisters, itching, chemical burns, cuts, and defatting. Please note that some chemicals can be readily absorbed by the skin.

Laboratory workers can protect their skin from chemical exposure by selecting and wearing the proper gloves, wearing a lab coat and other personal protective equipment for special hazards (such as protective sleeves, face shields, and aprons), and not wearing shorts and sandals in areas where chemicals are being used - even if you are not using chemicals, but someone else in the lab is using chemicals nearby.

For small chemical splashes to the skin, remove any contaminated gloves, lab coats, etc., and wash the affected area with soap and water for at least 15 minutes. Seek medical

attention afterward, especially if symptoms persist.

For large chemical splashes to the body, it is important to get to an emergency shower and start flushing for at least 15 minutes. Once under the shower, and after the shower has been activated, it is equally important to remove any contaminated clothing. Failure to remove contaminated clothing can result in the chemical being held against the skin and causing further chemical exposure and damage. After flushing for a minimum of 15 minutes, seek medical attention immediately and complete an Injury/Illness Report.

Please note that some chemicals, such as Hydrofluoric acid, require use of a special antidote (such as Calcium gluconate gel) and special emergency procedures. Be sure to read SDSs for any chemical you work with to determine if a special antidote is needed when chemical exposure occurs.

7.5 Chemical Exposure Limits

The OSHA Laboratory Standard requires that laboratory employee exposure of OSHA Regulated Substances do not exceed the Permissible Exposure Limits as specified in 29 CFR Part 1010, subpart Z.

The Permissible Exposure Limits (PEL) are based on the average concentration of a chemical to which workers can be exposed to over an 8-hour workday, 5 days per week, for a lifetime without receiving damaging effects. In some cases, chemicals can also have a Ceiling (C) limit, which is the maximum concentration that cannot be exceeded. OSHA has established PELs for over 500 chemicals. Permissible Exposure Limits are legally enforceable.

Another measure of exposure limits are Threshold Limit Values (TLV) which are recommended occupational exposure limits published by the American Conference of Governmental Industrial Hygienists (ACGIH). Similar to PELs, TLVs are the average concentration of a chemical that a worker can be exposed to over an 8-hour workday, 5 days per week, over a lifetime without observing ill effects. TLVs also have Ceiling (C) limits, which are the maximum concentration a worker can be exposed to at any given time. The ACGIH has established TLVs for over 800 chemicals. A main point of difference between PELs and TLVs is that TLVs are advisory guidelines only and are not legally enforceable. Both PELs and TLVs can be found in SDSs. Another good resource for information is the National Institute for Occupational Health and Safety (NIOSH).

Please note, if laboratory personnel follow the guidelines described within this Laboratory Safety Manual – use fume hoods and other engineering controls, use proper PPE, practice good housekeeping and personal hygiene, keep food and drink out of laboratories, and follow good lab practices – the potential for exceeding exposure limits is significantly reduced.

7.6 Chemical Exposure Monitoring

As a laboratory worker, you may use a variety of potentially hazardous materials on a daily basis. Safe use of these materials depends heavily on following proper laboratory work practices and the utilization of engineering controls. In certain circumstances, it is necessary to verify that work practices and engineering controls are effective in limiting exposures to hazardous materials. New Mexico Tech Industrial Hygienists can help evaluate the effectiveness of your controls by monitoring exposures to a variety of laboratory materials. Exposure monitoring is the determination of the airborne concentration of a hazardous material in the work environment. Exposure monitoring data is compared to existing OSHA and ACGIH exposure guidelines and is often used to make recommendations concerning engineering controls, work practices, and PPE.

If you think you are receiving a chemical exposure in excess of OSHA exposure limits, such as feeling symptoms commonly associated with exposure to hazardous materials, or work with any of the chemicals listed below, contact New Mexico Tech at 575-835-5842 and our Industrial Hygienists can use a variety of sampling methods to monitor for any potential exposures.

In some cases, OSHA substance specific standards actually require that the employer conduct initial exposure monitoring. Examples of chemicals that fall into this category include:

- Formaldehyde
- Vinyl chloride
- Methylene chloride
- Benzene
- Ethylene oxide

Other substances that have exposure monitoring requirements include:

- Lead
- Cadmium
- Silica

7.7 Toxicity

Toxicity refers to the ability of a chemical to cause harmful effects to the body. As was described by Paracelsus (1493-1541):

“What is it that is not poison? All things are poison and nothing is without poison. It is the dose only that makes a thing not a poison.”

There are a number of factors that influence the toxic effects of chemicals on the body. These include, but are not limited to:

- The quantity and concentration of the chemical.
-
- The length of time and the frequency of the exposure.
-
- The route of the exposure.
-

- If mixtures of chemicals are involved.
-
- The sex, age, and lifestyle of the person being exposed to the chemical.

7.7.1 Toxic Effects

Toxic effects are generally classified as acute toxicity or chronic toxicity.

- Acute toxicity is generally thought of as a single, short-term exposure where effects appear immediately and are often reversible. An example of acute toxicity relates to the over consumption of alcohol and “hangovers”.
-
- Chronic toxicity is generally thought of as frequent exposures where effects may be delayed (even for years) and are generally irreversible. Chronic toxicity can also result in acute exposures, with long term chronic effects. An example of chronic toxicity relates to cigarette smoking and lung cancer.

7.7.2 Evaluating Toxicity Data

SDSs and other chemical resources generally refer to the toxicity of a chemical numerically using the term Lethal Dose 50 (LD50). The LD50 describes the amount of chemical ingested or absorbed by the skin in test animals that causes death in 50% of test animals used during a toxicity test study. Another common term is Lethal Concentration 50 (LC50), which describes the amount of chemical inhaled by test animals that causes death in 50% of test animals used during a toxicity test study. The LD50 and LC50 values are then used to infer what dose is required to show a toxic effect on humans.

As a general rule of thumb, the lower the LD50 or LC50 number, the more toxic the chemical. Note there are other factors (concentration of the chemical, frequency of exposure, etc.) that contribute to the toxicity of a chemical, including other hazards the chemical may possess.

While exact toxic effects of a chemical on test animals cannot necessarily be directly correlated with toxic effects on humans, the LD50 and LC50 can give a good indication of the toxicity of a chemical, particularly in comparison to another chemical. For example, when making a decision on what chemical to use in an experiment based on safety for the lab worker, a chemical with a high LD50 or LC50 would be safer to work with, assuming the chemical did not possess multiple hazards and everything else being equal.

In general terms, the resource Prudent Practices in the Laboratory lists the following table for evaluating the relevant toxicity of a chemical:

Toxicity Class	Animal LD50	Probable Lethal Dose for 70 kg Person (150 lbs.)	Example
Super Toxic	Less than 5 mg/kg	A taste (7 drops or less)	Botulinum toxin
Extremely Toxic	5 - 50 mg/kg	< 1 teaspoonful	Arsenic trioxide, Strychnine

Very Toxic	50 - 500 mg/kg	< 1 ounce	Phenol, Caffeine
Moderately Toxic	0.5 - 5 g/kg	< 1 pint	Aspirin, Sodium chloride
Slightly Toxic	5 - 15 g/kg	< 1 quart	Ethyl alcohol, Acetone

In addition to having a toxic effect on the body, some chemicals can be carcinogenic, mutagenic, teratogenic, and acutely toxic. These specific chemical hazards are covered in more detail under the Particularly Hazardous Substances section in this manual.

7.8 Chemical Labeling

The simple rule for chemical labeling is - if a container looks like it contains a chemical (even a clear liquid), then it must be labeled with the contents. Proper labeling of chemicals is one way of informing people who work in laboratories of potential hazards that exist, preventing the generation of unknowns, and facilitating emergency responses such as cleaning up spills and obtaining the proper medical treatment.

New chemical containers have the proper labeling information on the chemical label. The OSHA Laboratory Standard requires that labels on all incoming containers must be maintained and not defaced. As part of laboratory good housekeeping and self-inspections, if any chemical labels appear to be falling off, then laboratory personnel should tape the label back on the container or relabel with a permanent label. Laboratory personnel are strongly encouraged to make use of New Mexico Tech Right-To-Know chemical labels.

7.8.1 Non-Original Containers

Non-original containers (secondary use containers) such as wash bottles, squirt bottles, temporary storage containers, beakers, flasks, bottles, vials, etc. or any container that a chemical from an original container is transferred into, must be properly labeled. In general, New Mexico Tech recommends writing out the full chemical name and any hazards associated with that chemical. Laboratory personnel are strongly encouraged to use commercially available pre-labeled containers (such as squirt bottles) for chemicals that get used frequently. However, labs can also choose to label chemical containers in other ways such as:

- New Mexico Tech Right-To-Know labels
- New Mexico Tech strongly encourages laboratories to take advantage of our FREE Right-To-Know chemical labels found on our website for hazardous chemicals in non-original containers, especially for containers that are used for the same purpose repeatedly, or are used slowly over time. There are currently New Mexico Tech Right-To-Know labels for over 900 chemicals. Labels can simply be printed off the web and attached to the chemical container. If a label does not exist for a particular chemical that you have, a request can be submitted to New Mexico Tech to create a label for you.
- Abbreviations – Structures and Formulas

- Use of abbreviations such as structures, formulas, or acronyms is acceptable. However, if you use any abbreviations, you must hang up a “key” to the abbreviations in a visible location (preferably close to the chemicals and/or by the door). The “key” must contain the abbreviation and the name of the chemical. Including the hazards of the chemical on the “key” is also useful information. The abbreviation key must be readily available upon request by visitors, emergency responders, and state and federal regulatory agencies such as EPA, OSHA, or New York State Office of Fire Prevention and Control (OFPC) inspectors.

- Small Containers and Sample Storage

- For small containers, such as vials and eppendorf tubes, which may be too small to write out a chemical name, structure, or formula, laboratories can implement other systems to identify the chemicals such as:

Placing the vial or small container in a Ziploc bag or other type of overpack container (beaker, plastic bottle, etc.) and labeling the overpack container with the chemical name.

Laboratories can use “price tag” style labels in which the chemical name is written out on a tag, and the tag is then attached to the small container with string or a rubber band.

For vials in a test tube rack – laboratory personnel can simply label the rack with the chemical name, and then label the vials with an abbreviation, color, number, or letter code that corresponds to the label on the test tube rack. For example, if a lab had 10 small vials of ethanol in one rack, the rack could be labeled a 1-E = Ethanol. All of the vials would then be labeled as 1-E. Be sure that the number or letter code is clearly identifiable and would not be confused with other chemicals in the lab.

For preserved specimens, bottles should be labeled with the preservative (i.e. ethanol or formaldehyde). A large number of these labels could easily be produced on the computer using Avery style mailing labels.

For sample storage in refrigerators, laboratory personnel should label sample containers with one of the above methods, including labeling boxes that hold the small vials or chemical containers. Laboratories should include a key to any abbreviations on the outside of the refrigerator and label the key as “Sample Storage abbreviation = chemical name”.

- Number, Letter, and Color Codes

- For vials and other small containers, laboratory personnel can make use of number, letter, and color-coded systems as long as a “key” is hung up which clearly identifies the chemical name that the number, letter, or color code represents. While this type of system is available for laboratory personnel to use, New Mexico Tech does not recommend using such a system for hazardous chemicals. Such a system would be more appropriate for non-hazardous compounds such as agar and buffer solutions.

***Please keep in mind that some laboratory workers may be color-blind - red-green and

blue-yellow. This fact needs to be taken into consideration, BEFORE a color-coding system is used.

7.8.2 Labeling Requirements

In all cases, regardless of the labeling system used, the following labeling requirements must be followed:

- All chemical containers (both hazardous and non-hazardous) **MUST** be labeled. Chemical names must be written out in English. If a label is starting to fall off a chemical container or is becoming degraded, then the container needs to be relabeled (using tape, permanent marker, New Mexico Tech Right-To-Know labels, etc.) or the chemical needs to be transferred to another properly labeled container.
- If abbreviations such as formulas, structures, or acronyms are used, then a “key” to the abbreviations must be hung up in a conspicuous location.
- All personnel working in the laboratory must be fully trained on how to label chemicals using the system and how to understand the labeling system. Training must occur when a new person begins working in the laboratory, when new chemicals are introduced, and should occur on a regular basis or annually.

7.9 Chemical Storage

Chemical storage areas in the academic laboratory setting include central stockrooms, storerooms, laboratory work areas, storage cabinets, refrigerators, and freezers. There are established legal requirements as well as recommended practices for proper storage of chemicals. Proper storage of chemicals promotes safer and healthier working conditions, extends the usefulness of chemicals, and can help prevent contamination. Chemicals that are stored improperly can result in:

- Degraded containers that can release hazardous vapors that are detrimental to the health of laboratory personnel.
- Degraded containers that allow chemicals to become contaminated, which can have an adverse effect on experiments.
- Degraded containers that can release vapors, which in turn can affect the integrity of nearby containers.
- Degraded labels that can result in the generation of unknowns.
- Chemicals becoming unstable and/or potentially explosive.
- Citation and/or fines from state and federal regulatory agencies.

7.9.1 General Storage Guidelines

Laboratories should adhere to the following storage guidelines for the proper and safe storage of chemicals. By implementing these guidelines, laboratories can ensure safer storage of chemicals and enhance the general housekeeping and organization of the lab.

Proper storage of chemicals also helps utilize limited laboratory space in a more efficient manner.

- All chemical containers MUST be labeled. Labels should include the name of the chemical constituent(s) and any hazards present. Be sure to check chemical containers regularly and replace any labels that are deteriorating or falling off and/or relabel with another label before the chemical becomes an unknown.
- Keep all containers of chemicals closed when not in use.
- Every chemical should have an identifiable storage place and should be returned to that location after use.
- The storage of chemicals on bench tops should be kept to a minimum to help prevent clutter and spills, and to allow for adequate working space.
- Chemical storage in fume hoods should be kept to a minimum - limited to the experiment being conducted. Excess storage of chemical containers in hoods can interfere with airflow, reduce working space, and increase the risk of a spill, fire, or explosion.
- For chemical storage cabinets, larger chemical bottles should be stored towards the back and smaller bottles should be stored up front where they are visible. Chemical bottles should be turned with the labels facing out so they can be easily read.
- Chemicals should not be stored on the floor due to the potential for bottles to be knocked over and result in a spill. If it is necessary to store bottles on the floor, then the bottles should be placed in secondary containment, such as trays, and the bottles should be placed away from aisle spaces.
- For multiples of the same chemical, older containers should be stored in front of newer chemicals and containers with the least amount of chemical should be stored in front of full containers. This allows for older chemicals to get used up first and helps to minimize the number of chemical containers in the storage area.
- Do not store chemicals in direct sunlight or next to heat sources.
- Laboratories should strive to keep only the minimum quantity of chemicals necessary. When ordering new chemicals, laboratories should only order enough stock needed for the experiment or the quantity that will get used up within 1 or 2 years at most.
- Liquid chemical containers should be stored in secondary containment, such as trays, to minimize the potential for bottle breakage and minimize the potential for spills.
- Always segregate and store chemicals according to compatibility and hazard classes.
- Chemical containers should be dated when they arrive and should be checked regularly and disposed of when they get past their expiration date. Please Note: Due to the potential explosion hazard, peroxide forming chemicals are required to be tested and dated.
- Flammable liquids in excess of quantities for specific flammability classes must be stored in approved flammable liquid storage cabinets.
- Do not store acids in flammable liquid storage cabinets. This can result in serious degradation of the storage cabinet and the containers inside. Corrosive chemicals should be stored in corrosion resistant cabinets. The exceptions to this rule are organic acids, such as Acetic acid, Lactic acid, and Formic acid, which are

considered flammable/combustible and corrosive and can be stored in flammable or corrosive storage cabinets.

- Do not store corrosive or other chemicals that can be injurious to the eyes above eye level. In general and where practical, no chemicals should be stored above eye level.
- Do not store flammable liquids in standard (non-explosion proof) refrigerators or freezers. Due to the potential explosion hazard, only store flammables in refrigerators or freezers approved by the manufacturer for storage of flammables.
- Highly toxic chemicals such as inorganic cyanides should be stored in locked storage cabinets. Always keep the quantities of highly toxic chemicals to an absolute minimum. See Particularly Hazardous Substances section.
- Be aware of any special antidotes or medical treatment that may be required for some chemicals (such as cyanides and Hydrofluoric acid).
- Always keep spill kits and other spill control equipment on hand in areas where chemicals are used. Ensure all personnel working in the lab have been properly trained on the location and use of the spill kit.
- For reagent shelves, it is recommended to use shelves with anti-roll lips, to prevent bottles from falling off. This can also be accomplished using heavy gauge twine or wire to create a lip on the shelf.

7.10 Transporting Chemicals

When transporting chemicals between laboratories or other buildings on campus, the following guidelines should be implemented for protection of people and the environment, and to minimize the potential for spills to occur.

- Whenever transporting chemicals by hand, always use a secondary container such as a rubber acid carrying bucket, plastic bucket, or a 5-gallon pail). If necessary, a small amount of packing material (shipping peanuts, vermiculite, or cardboard inserts), that is compatible with the chemical(s), should be used to prevent bottles from tipping over or breaking during transport. You should have proper PPE accessible in the event of a spill.
- Wheeled carts with lipped surfaces (such as Rubbermaid carts) should be used whenever feasible.
- Whenever possible, do not use passenger elevators when transporting chemicals, only freight elevators should be used. If it is necessary to use a passenger elevator, use should be restricted to low-use times such as early in the morning or late in the afternoon. If this is not possible, be sure to warn passengers, or prohibit passengers from riding with you.
- When transporting compressed gas cylinders, always use a proper gas cylinder hand truck with the cylinder strapped to the cart and keep the cap in place. NEVER roll or drag a compressed gas cylinder.
- Avoid riding in elevators with cryogenic liquids or compressed gas cylinders. If this is necessary, consider using a buddy system to have one person send the properly secured dewars or cylinders on the elevator, while the other person waits at the floor by the elevator doors where the dewars or cylinders will arrive.
- Do not transport chemicals in your personal vehicle. Contact New Mexico Tech for

assistance.

Please note: If you plan on transporting or shipping any hazardous chemicals off the main campus, be aware there are specific procedures, training and other legal requirements that must be followed. For more information, refer to the Shipping Hazardous Materials section.

7.11 Chemical Segregation

Chemicals should be stored according to compatibility and hazard classes. Rather than store chemicals alphabetically, or by carbon number, or by physical state, etc., New Mexico Tech recommends that you segregate them by DOT hazard class first.

The potential hazards of storing incompatible chemicals together, and when an emergency occurs, include:

- Generation of heat.
- Possible fires and explosion.
- Generation of toxic and/or flammable gases and vapors.
- Formation of toxic compounds.
- Formation of shock and/or friction sensitive compounds.
- Violent polymerization.

The benefits of chemical segregation by hazard class include:

- Safer chemical storage.
- Understanding the hazards a chemical exhibits will increase your knowledge about the chemical.
- Identifying potentially explosive chemicals.
- Identifying multiple containers of the same chemical.

There are a number of segregation schemes recommended in the literature by government agencies, chemical manufacturers, safety supply companies, and other universities. However, New Mexico Tech is recommending segregation of chemicals using a modified version of the Department of Transportation (DOT) Hazard Class System. While this modified DOT system results in most common chemicals being segregated properly, there is no one system that solves all problems. The modified DOT system is less complicated than other segregation schemes and the information to make decisions of which hazard classes to use can easily be found in SDSs, container labels, container markings and stickers, and other resources.

Please note that DOT hazard classes segregate chemicals according to the hazards posed during transportation and not necessarily based on health hazards. Keep in mind that chemicals do not always fall neatly into one hazard class and can pose multiple hazards – including both physical and health hazards (such as flammable liquid, corrosive or flammable liquid, poison).

When you are making decisions on how to segregate, keep in mind the following:

- Physical hazards of the chemical.
- Health hazards of the chemical.

- The chemical form (solid, liquid or gas).
- Concentration of the chemical.

Segregation of different chemical hazard classes (such as acids and bases) can occur in the same cabinet as long as there is some form of physical separation, such as using trays with high sides or deep trays. However never store oxidizers and flammables in the same cabinet. Also, do not store compounds such as inorganic cyanides and acids in the same cabinet.

Once chemicals have been segregated, ensure everyone in the lab knows the process and what system is being used. It is best to clearly identify where chemicals in each hazard class will be stored by labeling cabinets with signs, or hazard class labels. These can be purchased from a safety supply company, you can create your own.

If you need assistance with cleaning out your lab of old and excess chemicals, or would like assistance with segregating your chemicals, contact New Mexico Tech Safety

7.11.1 New Mexico Tech Modified DOT Hazard Class System

The basic DOT hazard classes and hazard class numbers are:

DOT Hazard Class Number	Hazard Class
Class 1	Explosives
Class 2	Compressed gases
Class 3	Flammable liquids
Class 4	Flammable solids
Class 5	Oxidizers
Class 6	Poisons
Class 7	Radioactive materials
Class 8	Corrosives
Class 9	Store with Class 6

The DOT hazard class numbers can be found on hazard class labels, in SDSs (under the “Transportation Information Section”), on container labels, and in other reference texts. An explanation of the DOT Hazard Class system can be found in the DOT Training Modules.

The New Mexico Tech chemical segregation scheme modifies the DOT system by breaking down hazard classes into subcategories.

8.0 Chemical Hazards

Chemicals can be broken down into hazard classes and exhibit both physical and health hazards. It is important to keep in mind, that chemicals can exhibit more than one hazard or combinations of several hazards. Several factors can influence how a chemical will behave and the hazards the chemical presents, including the severity of the response:

- Concentration of the chemical.
- Physical state of the chemical (solid, liquid, gas).
- Physical processes involved in using the chemical (cutting, grinding, heating, cooling, etc.).
- Chemical processes involved in using the chemical (mixing with other chemicals, purification, distillation, etc.).
- Other processes (improper storage, addition of moisture, storage in sunlight, refrigeration, etc.).

The following sections describe general information and safety precautions about specific hazard classes. The chemical hazards listed are based on the Department of Transportation (DOT) hazard class system (which will be discussed in the Chemical Segregation section and where appropriate, will be noted as such). A general description of the hazards of various chemical functional groups can be found in the appendix.

It is important to note that the following sections are general guidelines. Laboratory personnel should always review SDSs and other resources FIRST, before working with any chemical.

8.1 Explosives

The OSHA Laboratory Standard defines an explosive as a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. Under the Department of Transportation (DOT) hazard class system, explosives are listed as hazard class 1.

Fortunately, most laboratories do not use many explosives; however, there are a number of chemicals that can become unstable and/or potentially explosive over time due to contamination with air, water, other materials such as metals, or when the chemical dries out.

If you ever come across any chemical that you suspect could be potentially shock sensitive and/or explosive, do not attempt to move the container as some of these compounds are shock, heat, and friction sensitive. In these instances, you should contact

New Mexico Tech at 575-835-5842 immediately.

Explosives can result in damage to surrounding materials (hoods, glassware, windows, people, etc.), generation of toxic gases, and fires. If you plan to conduct an experiment where the potential for an explosion exists, first ask yourself the question; “Is there another chemical that could be substituted in the experiment that does not have an explosion potential?” If you must use a chemical that is potentially explosive, or for those compounds that you know are explosive, (even low powered explosives) you must first obtain prior approval from the Principal Investigator to use such chemicals. After obtaining prior approval from your Principal Investigator, thoroughly read the SDSs and any other chemical resources related to the potentially explosive compound(s) to ensure potential incidents are minimized.

Whenever setting up experiments using potentially explosive compounds:

- Always use the smallest quantity of the chemical possible.
- Always conduct the experiment within a fume hood and use in conjunction with a properly rated safety shield.
- Be sure to remove any unnecessary equipment and other chemicals (particularly highly toxic and flammables) away from the immediate work area.
- Be sure to notify other people in the laboratory what experiment is being conducted, what the potential hazards are, and when the experiment will be run.
- Do not use metal or wooden devices when stirring, cutting, scraping, etc. with potentially explosive compounds. Non-sparking plastic devices should be used instead.
- Ensure other safety devices such as high temperature controls, water overflow devices, etc., are used in combination to help minimize any potential incidents.
- Properly dispose of any hazardous waste and note on the hazardous waste tag any special precautions that may need to be taken if the chemical is potentially explosive.
- Always wear appropriate PPE, including the correct gloves, lab coat or apron, safety goggles used in conjunction with a face shield, and explosion-proof shields when working with potentially explosive chemicals.
- For storage purposes, always date chemical containers when received and opened. Pay particular attention to those compounds that must remain moist or wet so they do not become explosive (ex. Picric acid, 2,4-Dinitrophenyl hydrazine, etc.). Pay particular attention to any potentially explosive compounds that appear to exhibit the following signs of contamination:
 - Deterioration of the outside of the container.
 - Crystalline growth in or outside the container.
 - Discoloration of the chemical.

If you discover a potentially explosive compound that exhibits any of these signs of contamination, contact New Mexico Tech at 255-8200 for more assistance.

Examples of explosive and potentially explosive chemicals include:

- Compounds containing the functional groups azide, acetylide, diazo, nitroso,

- haloamine, peroxide, and ozonide
- Nitrocellulose
- Di- and Tri-nitro compounds
- Peroxide forming compounds
- Picric acid (dry)
- 2,4-Dinitrophenylhydrazine (dry)
- Benzoyl peroxide (dry)

8.2 Flammable and Combustible Liquids

The OSHA Laboratory Standard defines a flammable liquid as any liquid having a flashpoint below 100 degrees F (37.8 degrees C), except any mixture having components with flashpoints of 100 degrees F (37.8 degrees C) or higher, the total of which make up 99% or more of the total volume of the mixture.

Flashpoint is defined as the minimum temperature at which a liquid gives off enough vapor to ignite in the presence of an ignition source. The risk of a fire requires that the temperature be above the flashpoint and the airborne concentration be in the flammable range above the Lower Explosive Limit (LEL) and below the Upper Explosive Limit (UEL).

The OSHA Laboratory Standard defines a combustible liquid as any liquid having a flashpoint at or above 100 degrees F (37.8 degrees C), but below 200 degrees F (93.3 degrees C), except any mixture having components with flashpoints of 200 degrees F (93.3 degrees C), or higher, the total volume of which make up 99% or more of the total volume of the mixture. OSHA further breaks down flammables into Class I liquids, and combustibles into Class II and Class III liquids. Please note this classification is different than the criteria used for DOT classification. This distinction is important because allowable container sizes and storage amounts are based on the particular OSHA Class of the flammable liquid.

Classification	Flash Point	Boiling Point
Flammable Liquid		
Class IA	<73 degrees F	<100 degrees F
Class IB	<73 degrees F	>=100 degrees F
Class IC	>=73 degrees F, <100 degrees F	>100 degrees F
Combustible Liquid		
Class II	>=100 degrees F, <140 degrees F	--
Class IIIA	>=140 degrees F, < 200 degrees F	--
Class IIIB	>=200 degrees F	--

Under the Department of Transportation (DOT) hazard class system, flammable liquids are listed as hazard class 3.

Flammable and combustible liquids are one of the most common types of chemicals used at New Mexico Tech and are an important component in a number of laboratory processes. However, in addition to the flammable hazard, some flammable liquids also may possess other hazards such as being toxic and/or corrosive.

When using flammable liquids, keep containers away from open flames; it is best to use heating sources such as steam baths, water baths, oil baths, and heating mantels. Never use a heat gun to heat a flammable liquid. Any areas using flammables should have a fire extinguisher present. If a fire extinguisher is not present, then contact New Mexico Tech at 575-835-5842 for more assistance.

Always keep flammable liquids stored away from oxidizers and away from heat or ignition sources such as radiators, electric power panels, etc.

When pouring flammable liquids, it is possible to generate enough static electricity to cause the flammable liquid to ignite. If possible, make sure both containers are electrically interconnected to each other by bonding the containers, and connecting to a ground.

Always clean up any spills of flammable liquids promptly. Be aware that flammable vapors are usually heavier than air (vapor density > 1). For those chemicals with vapor densities heavier than air (applies to most chemicals), it is possible for the vapors to travel along floors and, if an ignition source is present, result in a flashback fire.

8.2.1 Flammable Storage in Refrigerators/Freezers

It is important to store flammable liquids only in specially designed flammable storage refrigerators/freezers or explosion-proof refrigerators/freezers. Do not store flammable liquids in standard (non-flammable rated) refrigerators/freezers. Standard refrigerators are not electrically designed to store flammable liquids. If flammable liquids are stored in a standard refrigerator, the build up of flammable vapors can be in sufficient quantities to ignite when the refrigerator's compressor or light turns on, resulting in a fire or an explosion.

Properly rated flammable liquid storage refrigerators/freezers have protected internal electrical components and are designed for the storage of flammable liquids. Explosion-proof refrigerators/freezers have both the internal and external electrical components properly protected and are designed for the storage of flammable liquids. Refrigerators and freezers rated for the storage of flammable materials will be clearly identified as such by the manufacturer.

For most laboratory applications, a flammable storage refrigerator/freezer is acceptable. However, some operations may require an explosion-proof refrigerator/freezer. Flammable storage refrigerators currently cost approximately \$1500 - \$3000 each. In the

case of limited funding where a laboratory cannot purchase a flammable storage refrigerator for the laboratory's own use, New Mexico Tech strongly encourages departments and laboratory groups on each floor to consider purchasing a communal flammable storage refrigerator for the proper and safe storage of flammable liquids.

8.2.2 Flammable Storage Cabinets

The requirements for use of flammable storage cabinets are determined by the classification of the flammable liquids, the quantities kept on hand, the building construction (fire wall ratings), and the floor of the building the flammables are being stored on. As a general rule of thumb, if you have more than 10 gallons of flammable liquids, including materials in use, then you should store the flammable liquids in a properly rated flammable liquid storage cabinet. All flammable liquids not in use should be kept in the flammable liquid storage cabinet. For stand-alone flammable cabinets (as opposed to cabinets underneath fume hoods), there are vent holes on each side of the cabinet (called bung holes) that must have the metal bungs screwed into place for the cabinet to maintain its fire rating. Venting of flammable cabinets is NOT required, however, if a flammable cabinet is vented, it must be vented properly according to the manufacturer's specifications and NFPA 30. Typically, proper flammable cabinet ventilation requires that air be supplied to the cabinet and the air be taken away via non-combustible pipes. If you are planning on venting your flammable storage cabinet, please contact New Mexico Tech at 575-835-5842 for more information.

8.3 Flammable Solids

The OSHA Laboratory Standard defines a flammable solid as a "solid, other than a blasting agent or explosive, 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, burn so vigorously and persistently to create a serious hazard." An example of a flammable solid is gun powder.

Under the DOT hazard class system, flammable solids are listed as hazard class 4. Flammable solids are further broken down into three subcategories:

- Flammable Solids – Class 4.1
- Spontaneously Combustible – Class 4.2
- Dangerous When Wet – Class 4.3

Many of the same principles for handling and storage of flammable liquids apply to flammable solids. Always keep flammable solids stored away from oxidizers, and away from heat or ignition sources such as radiators, electric power panels, etc.

8.4 Spontaneously Combustible

Spontaneously combustible materials are also known as pyrophorics; these chemicals can spontaneously ignite in the presence of air, some are reactive with water vapor, and most are reactive with oxygen. Two common examples are tert-Butyllithium under Hexanes and White Phosphorus. In addition to the hazard of the spontaneously combustible chemical itself, many of these chemicals are also stored under flammable liquids. In the event of an accident, such as a bottle being knocked off a shelf, the chemical can spontaneously ignite and a fire can occur. Extra care must be taken when handling spontaneously combustible chemicals. When transporting these chemicals, it is best to use a bottle carrier and carts.

8.5 Dangerous When Wet

Dangerous when wet compounds react violently with water to form toxic vapors and/or flammable gases that can ignite and cause a fire. Please note, attempting to put out a fire involving dangerous when wet materials with water will only make the situation worse. Special “Class D” fire extinguishers are required for use with dangerous when wet compounds. Common examples include sodium metal and potassium metal.

It is important to note that any paper toweling, gloves, etc., that have come into contact with these materials need to be quenched with water before disposing of in metal trash cans in order to prevent potential fires.

If you are using dangerous when wet compounds and do not have a Class D fire extinguisher present, then please contact New Mexico Tech at 255-8200 for more assistance.

8.6 Oxidizers and Organic Peroxides

The OSHA Laboratory Standard defines an oxidizer as “a chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.” Under the DOT hazard class system, oxidizers are listed as hazard class 5.1 and organic peroxides are listed as hazard class 5.2.

The OSHA Laboratory Standard defines an organic peroxide as “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 have been replaced by an organic radical.”

Oxidizers and organic peroxides are a concern for laboratory safety due to their ability to promote and enhance the potential for fires in labs.

As a reminder of the fire triangle (now referred to as the fire tetrahedron), in order to

have a fire, you need:

- A fuel source.
- An oxygen source.
- An ignition source.
- A chemical reaction.

Oxidizers can supply the oxygen needed for the fire, whereas organic peroxides supply both the oxygen and the fuel source. Both oxidizers and organic peroxides may become shock sensitive when they dry out, are stored in sunlight, or due to contamination with other materials, particularly when contaminated with heavy metals. Most organic peroxides are also temperature sensitive.

As with any chemicals, but particularly with oxidizers and organic peroxides, quantities stored on hand should be kept to a minimum. Whenever planning an experiment, be sure to read the SDS and other reference documents to understand the hazards and special handling precautions that may be required, including use of a safety shield. Also be aware of the melting and autoignition temperatures for these compounds and ensure any device used to heat oxidizers has an overtemperature safety switch to prevent the compounds from overheating.

Laboratory staff should be particularly careful when handling oxidizers (especially high surface area oxidizers such as finely divided powders) around organic materials.

Avoid using metal objects when stirring or removing oxidizers or organic peroxides from chemical containers. Plastic or ceramic implements should be used instead. Laboratory personnel should avoid friction, grinding, and impact with solid oxidizers and organic peroxides. Glass stoppers and screw cap lids should always be avoided and plastic/polyethylene lined bottles and caps should be used instead.

If you suspect your oxidizer or organic peroxide has been contaminated (evident by discoloration of the chemical, or if there is crystalline growth in the container or around the cap), then dispose of the chemical as hazardous waste or contact New Mexico Tech at 575-835-5842. Indicate on the hazardous waste tag that the chemical is an oxidizer or organic peroxide and that you suspect contamination.

8.7 Peroxide Forming Compounds

Many commonly used chemicals; organic solvents in particular, can form shock, heat, or friction sensitive peroxides upon exposure to oxygen. Once peroxides have formed, an explosion can result during routine handling, such as twisting the cap off a bottle – if peroxides are formed in the threads of the cap. Explosions are more likely when concentrating, evaporating, or distilling these compounds if they contain peroxides. When these compounds are improperly handled and stored, a serious fire and explosion hazard exists. The following guidelines should be adhered to when using peroxide forming chemicals:

- Each peroxide forming chemical container MUST be dated when received and opened. A list of common peroxide forming chemicals can be found in the appendix. Those compounds in the appendix listed in Table A should be disposed of within 3 months of opening and those compounds in the appendix listed in Tables B, C, and D should be disposed of within 12 months of opening.
- Each peroxide forming chemical container must be tested for peroxides when opened and at least every 6 months thereafter. The results of the peroxide test and the test date must be marked on the outside of the container. There are sample peroxide labels on the Signs and Labels webpage.
- Peroxide test strips can be purchased from the Chemistry Department stockroom or from a variety of safety supply vendors, such as VWR and Laboratory Safety Supply. An alternative to peroxide test strips is the KI (potassium iodide) test. References such as Prudent Practices in the Laboratory and the American Chemical Society booklet Safety in Academic Chemistry Laboratories outline ways to test for peroxides and ways to remove them if discovered. When using the test strips, if the strip turns blue, then peroxides are present. Light blue test results may be acceptable for use if your procedure does not call for concentrating, evaporating or distilling. Containers with darker blue test results must be deactivated or disposed of. You can test older test strips for efficacy with a dilute solution of hydrogen peroxide.
- Due to sunlight's ability to promote formation of peroxides, all peroxidizable compounds should be stored away from heat and sunlight.
- Peroxide forming chemicals should not be refrigerated at or below the temperature at which the peroxide forming compound freezes or precipitates as these forms of peroxides are especially sensitive to shock and heat. Refrigeration does not prevent peroxide formation.
- As with any hazardous chemical, but particularly with peroxide forming chemicals, the amount of chemical purchased and stored should be kept to an absolute minimum. Only order the amount of chemical needed for the immediate experiment.
- Ensure containers of peroxide forming chemicals are tightly sealed after each use and consider adding a blanket of an inert gas, such as Nitrogen, to the container to help slow peroxide formation.
- A number of peroxide forming chemicals can be purchased with inhibitors added. Unless absolutely necessary for the research, labs should never purchase uninhibited peroxide formers.
- Before distilling any peroxide forming chemicals, always test the chemical first with peroxide test strips to ensure there are no peroxides present. Never distill peroxide forming chemicals to dryness. Leave at least 10-20% still bottoms to help prevent possible explosions.

While no definitive amount of peroxide concentration is given in the literature, a concentration of 50 ppm should be considered dangerous and a concentration of >100 ppm should be disposed of immediately. In both cases, procedures should be followed for removing peroxides or the containers should be disposed of as hazardous waste.

***However, compounds that are suspected of having very high peroxide levels because

of age, unusual viscosity, discoloration, or crystal formation should be considered extremely dangerous. If you discover a container that meets this description, DO NOT attempt to open or move the container. Notify other people in the lab about the potential explosion hazard and notify New Mexico Tech at 575-835-5842 immediately.

For those compounds that must be handled by an outside environmental “bomb squad” company, the cost for such an operation can result in charges of >\$1000 per container. However, if laboratory staff follow the guidelines listed above, the chances for requiring special handling for these types of containers or for an explosion to occur is greatly diminished.

The appendix contains a listing of common peroxide forming chemicals. Please note this list is not all-inclusive, there are numerous other chemicals that can form peroxides. Be sure to read chemical container labels, SDSs, and other chemical references.

8.8 Poisons

For the purpose of this manual the word “Poison” will be used interchangeably with the word “Toxic”. OSHA defines “Toxic” as a chemical falling within any of the following categories:

- A chemical that has a median lethal dose (LD50) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- A chemical that has a median lethal dose (LD50) of more than 200 milligrams per kilogram, but not more than 1000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
- A chemical that has a median lethal concentration (LC50) in air of more than 200 parts per million, but not more than 2000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, dust, when administered by continuous inhalation for one hour (or less if death occurs with in one hour) to albino rats weighing between 200 and 300 grams each.

OSHA draws a distinction between toxic chemicals and acutely toxic chemicals. For more information on acutely toxic chemicals, see Particularly Hazardous Substances. OSHA also provides definitions for other health hazards on their website. Under the DOT hazard class system, poisons are listed as hazard class 6.

As a general rule of thumb, all chemicals should be treated as poisons and proper procedures such as maintaining good housekeeping, use of proper PPE, good personal hygiene, etc., should be followed. When working with known poisons, it is very important to have thought an experiment through, addressing health and safety issues

before working with the poison. Safety Data Sheets (SDS) and other chemical references should be consulted before beginning the experiment. Some questions to ask before working with poisonous chemicals:

- Do I need to use the poisonous chemical or can a less toxic chemical be substituted?
- What are the routes of entry into the body for the poison (inhalation, ingestion, injection, or skin absorption)?
- What are the signs and symptoms of potential chemical exposure?
- What are the proper PPE required (type of glove, safety glasses vs. splash goggles, face shield, etc.)?
- Does the chemical require any special antidote?
- What are the emergency procedures to be followed?

When working with highly toxic chemicals, you should not work alone. Always wear proper PPE and always wash your hands with soap and water when finished, even if gloves were worn. Be aware that poisonous mixtures, vapors, and gases can be formed during an experiment. Be sure to research both the reactants and products of the chemicals you will be working with first. Additional information can be found in the Exposure Monitoring section and Routes of Chemical Entry section.

If you think you may have received an exposure to a poisonous substance, or may have accidentally ingested a chemical, seek medical attention immediately and/or call the Poison Control Center at 1-(800) 222-1222 or the University Police at 911 from a campus phone or 585-835-5555 from a cell phone or off campus phone. If possible, bring a copy of the SDS with you. Upon completion of seeking medical attention, complete an Injury/Illness Report.

8.9 Corrosives

OSHA defines a corrosive as “a chemical that causes visible destruction of, or irreversible alterations in living tissue by chemical action at the site of contact.” Under the DOT hazard class system, corrosives are listed as hazard class 8.

Corrosive chemicals can be further subdivided as acids and bases. Corrosives can be in the liquid, solid, or gaseous state. Corrosive chemicals can have a severe effect on eyes, skin, respiratory tract, and gastrointestinal tract if an exposure occurs. Corrosive solids and their dusts can react with moisture on the skin or in the respiratory tract and result in an exposure.

Whenever working with concentrated corrosive solutions, splash goggles should be worn instead of safety glasses. Splash goggles used in conjunction with a face shield provides better protection. Please note that a face shield alone does not provide adequate protection. Use of rubber gloves such as butyl rubber and a rubber apron may also be required.

Corrosive chemicals should be handled in a fume hood to avoid breathing corrosive

vapors and gases.

When mixing concentrated acids with water, always add acid slowly to the water (specifically, add the more concentrated acid to the dilute acid). Never add water to acid, this can result in a boiling effect and cause acid to splatter. Do not pour the acid directly into the water; it should be poured in a manner that allows it to run down the sides of the container. Never store corrosive chemicals above eye level and always use a protective bottle carrier when transporting corrosive chemicals.

Some chemicals can react with acids and liberate toxic and/or flammable vapors. When working with corrosive materials, ensure spill cleanup material is available for neutralization, such as Calcium carbonate for acids and Citric acid for bases.

Wherever acids and bases are used, an eyewash and emergency shower must be available. If any corrosive chemical gets splashed in the eyes, immediately go to an eyewash station and flush your eyes for at least 15 minutes. The importance of flushing for at least 15 minutes cannot be overstated! Once the eyewash has been activated, use your fingers to hold your eyelids open and roll your eyeballs in the stream of water so the entire eye can be flushed. After flushing for at least 15 minutes, seek medical attention immediately and complete an Injury/Illness Report.

For small splashes of corrosives to the skin, remove any contaminated gloves, lab coats, etc., and wash the affected area with soap and water for at least 15 minutes. Seek medical attention afterward, especially if symptoms persist.

For large splashes of corrosives to the body, it is important to get to an emergency shower and start flushing for at least 15 minutes. Once under the shower, and after the shower has been activated, it is equally important to remove any contaminated clothing. Failure to remove contaminated clothing can result in the chemical being held against the skin and causing further chemical exposure and damage. After flushing for a minimum of 15 minutes, seek medical attention immediately and complete an Injury/Illness Report.

Please note some chemicals, such as Hydrofluoric acid, require the use of a special antidote (such as Calcium gluconate gel) and special emergency procedures. Read the SDSs for any chemical(s) you work with to determine if a special antidote is needed if a chemical exposure occurs.

8.9.1 Hydrofluoric Acid

Hydrofluoric Acid (HF) is one of the most hazardous chemicals at used Cornell. Small exposures to HF can be fatal if not treated properly. The critical minutes immediately after an exposure can have a great effect on the chances of a victim's survival.

HF is a gas that is dissolved in water to form Hydrofluoric acid. The concentration can vary from very low such as in store bought products up to the most concentrated 70%

form (anhydrous), with the most common lab use around 48%. The liquid is colorless, non-flammable and has a pungent odor. The OSHA permissible exposure limit is 3 ppm, but concentrations should be kept as low as possible. HF is actually a weak acid by definition and not as corrosive as strong acids such as Hydrochloric (HCl), however, corrosivity is the least hazardous aspect of HF. The toxicity of HF is the main concern.

HF is absorbed through the skin quickly and is a severe systemic toxin. The fluoride ion binds calcium in the blood, bones and other organs and causes damage to tissues that is very painful and can be lethal. At the emergency room, the victim is often given calcium injections, but pain medication is not generally given since the pain subsiding is the only indication that the calcium injections are working.

Due to the serious hazard of working with HF, the following requirements and guidelines are provided:

- All users of HF must receive New Mexico Tech Hydrofluoric Acid Safety training as well as training by their supervisor. The New Mexico Tech Hydrofluoric Acid Safety training is available online.
- A Standard Operating Procedure (SOP) must be written for the process in which HF is used. This SOP should be posted or readily available near the designated area where HF use will occur.
- HF should only be used in a designated fume hood and the fume hood should be identified by posting a HF Designated Area sign.
- First Aid - A HF first aid kit must be available that includes 2.5% calcium gluconate gel. The Calcium gluconate gel can be obtained at the Gannett Health Services dispensary with a department charge number and should be replaced with new stock annually. The Hydrofluoric Acid First Aid sign should be posted in a prominent place where the Calcium gluconate gel is located.
- Spill Kits - An HF spill kit must be available with calcium compounds such as Calcium carbonate, Calcium sulfate or Calcium hydroxide. Sodium bicarbonate should never be used since it does not bind the fluoride ion and can generate toxic aerosols.
- Prior approval - Before anyone uses HF they must have prior approval from the Principal investigator. The names of lab personnel should be added to an HF Prior Approval form showing that they have are familiar with the following:
 - Has read the SDS for HF
 - Has read the HF Use SOP developed by the lab
 - Has read the Hydrofluoric acid section in this Lab Safety Manual
 - Is aware of the designated area for HF use
 - Knows the first aid procedure in case of an HF exposure
 - Knows what to do incase of an HF spill
- Personal Protective Equipment (PPE) – The following PPE is required for HF use:
 - Rubber or plastic apron
 - Plastic arm coverings
 - Gloves
 - Incidental use - double glove with heavy nitrile exam gloves and re-glove if any exposure to the gloves

Extended use – heavy neoprene or butyl over nitrile or silver shield gloves

Splash goggles in conjunction with a fume hood sash

Closed toed shoes

Long pants and a long sleeve shirt with a reasonably high neck (no low cut)

The following are safe practice guidelines when working with HF:

- Never work alone with HF but have a buddy system.
- Use a plastic tray while working with HF for containment in case of a spill.
- Keep containers of HF closed. HF can etch the glass sash and make it hard to see through (if the hood sash becomes fogged and hard to see though due to etching, then please contact New Mexico Tech at (575)-835-5842 about installing a polycarbonate sash)
- Safety Data Sheet (SDS) – A SDS for HF must be available.
- All containers of HF must be clearly labeled. Secondary labels for all non-original containers can be printed from NMT hazardous waste website
- The stock HF should be stored in plastic secondary containment and the cabinet should be labeled. HF should be stored in lower cabinets near the floor.
- Wash gloves off with water before removing them.

Additional information on the safe use and handling of Hydrofluoric acid (HF) can be found on the Honeywell website - the world's largest producer of Hydrofluoric Acid. This website contains useful information on HF such as:

- Safety Data Sheets
- Technical Data Sheets
- Recommended Medical Treatment for HF exposure
- HF Properties charts
- Online Training

8.9.2 Perchloric Acid

Perchloric acid is a strong oxidizing acid that can react violently with organic materials. Perchloric acid can also explode if concentrated above 72%. For any work involving heated Perchloric acid (such as in Perchloric acid digestions), the work must be conducted in a special Perchloric acid fume hood with a wash down function. If heated Perchloric acid is used in a standard fume hood, the hot Perchloric acid vapors can react with the metal in the hood ductwork to form shock sensitive metallic perchlorates. When working with Perchloric acid, be sure to remove all organic materials, such as solvents, from the immediate work area. Due to the potential danger of Perchloric acid, if possible, try to use alternate techniques that do not involve the use of Perchloric acid. If you must use Perchloric acid in your experiments, only purchase the smallest size container necessary.

Because Perchloric acid is so reactive, it is important to keep it stored separate from other chemicals, particularly organic solvents, organic acids, and oxidizers. All containers of Perchloric acid should be inspected regularly for container integrity and the acid should

be checked for discoloration. Discolored Perchloric acid should be discarded as hazardous waste. Perchloric acid should be used and stored away from combustible materials, and away from wooden furniture. Like all acids, but particularly with Perchloric acid, secondary containment should be used for storage.

9.0 Particularly Hazardous Substances

The OSHA Laboratory Standard requires as part of the Chemical Hygiene Plan that provisions for additional employee protection be included for work involving particularly hazardous substances. These substances include “select carcinogens”, reproductive toxins, and substances which have a high degree of acute toxicity. Each of these categories will be discussed in detail in later sections.

The OSHA Laboratory Standard states for work involving particularly hazardous substances, specific consideration be given to the following provisions where appropriate:

- Establishment of a designated area.
-
- Use of containment devices such as fume hoods or glove boxes.
-
- Procedures for safe removal of contaminated waste.
-
- Decontamination procedures.

New Mexico Tech can assist researchers by providing information on working with particularly hazardous substances. General guidelines and recommendations for the safe handling, use, and control of hazardous chemicals and particularly hazardous substances can be found in SDSs and other references such as Prudent Practices in the Laboratory and Safety in Academic Chemical Laboratories.

9.1 Establishment of a Designated Area

For work involving particularly hazardous substances, laboratories should establish a designated area where particularly hazardous substances can only be used. In some cases, a designated area could be an entire room out of a suite of rooms, or could mean one particular fume hood within a laboratory. The idea is to designate one area that everyone in the laboratory is aware of where the particularly hazardous substances can only be used.

In certain cases of establishing designated areas, Principal Investigators and laboratory supervisors may want to restrict use of a particularly hazardous substance to a fume hood, glove box or other containment device. This information should be included as part of the laboratory’s SOPs and covered during in-lab training.

Establishing a designated area not only provides better employee protection, but can help

minimize the area where potential contamination of particularly hazardous substances could occur. If a designated area is established, a sign should be hung up (on a fume hood for example) indicating the area is designated for use with particularly hazardous substances. Most designated areas will have special PPE requirements and/or special waste and spill cleanup procedures as well. These and other special precautions should be included within the lab's SOPs.

9.2 Safe Removal of Contaminated Materials and Waste

Some particularly hazardous substances may require special procedures for safe disposal of both waste and/or contaminated materials. When in doubt, contact New Mexico Tech to determine proper disposal procedures. Once these disposal procedures have been identified, they should be included as part of the laboratory's SOPs and everyone working in the lab should be trained on those procedures.

9.3 Decontamination Procedures

Some particularly hazardous substances may require special decontamination or deactivation procedures (such as Diaminobenzidine waste or Ethidium bromide) for safe handling. Review MSDSs and other reference materials when working with particularly hazardous substances to identify if special decontamination procedures are required. If they are required, then this information should be included in the laboratory's SOPs and appropriate training needs to be provided to laboratory personnel who work with these chemicals.

9.4 Guidelines for Working with Particularly Hazardous Substances

Laboratory staff should always practice good housekeeping, use engineering controls, wear proper PPE, develop and follow SOPs, and receive appropriate training when working with any chemicals. The following special guidelines should be adhered to when working with particularly hazardous substances:

- Substitute less hazardous chemicals if possible to avoid working with particularly hazardous substances and keep exposures to a minimum.
- Always obtain prior approval from the Principal Investigator before ordering any particularly hazardous substances.
- Plan your experiment out in advance, including layout of apparatus and chemical and waste containers that are necessary.
- Before working with any particularly hazardous substance, review chemical resources for any special decontamination/deactivation procedures and ensure you have the appropriate spill cleanup materials and absorbent on hand.
- Ensure that you have the appropriate PPE, particularly gloves (check glove selection charts or call New Mexico Tech at 575-835-5842).
- Always use the minimum quantities of chemicals necessary for the experiment. If possible, try adding buffer directly to the original container and making dilutions

directly.

- If possible, purchase premade solutions to avoid handling powders. If you have to use powders, it is best to weigh them in a fume hood. If it is necessary to weigh outside of a fume hood (because some particles may be too light and would pose more of a hazard due to turbulent airflow) then wear a dust mask when weighing the chemical. It is advisable to surround the weighing area with wetted paper towels to facilitate cleanup.
- As a measure of coworker protection when weighing out dusty materials or powders, consider waiting until other coworkers have left the room to prevent possible exposure and thoroughly clean up and decontaminate working surfaces.
- Whenever possible, use secondary containment, such as trays, to conduct your experiment in and for storage of particularly hazardous substances.
- Particularly hazardous substances should be stored by themselves in clearly marked trays or containers indicating what the hazard is i.e. "Carcinogens," "Reproductive Toxins", etc.
- Always practice good personal hygiene, especially frequent hand washing, even if wearing gloves.
- If it is necessary to use a vacuum for cleaning particularly hazardous substances, only High Efficiency Particulate Air (HEPA) filters are recommended for best capture and protection. Be aware that after cleaning up chemical powders, the vacuum bag and its contents may have to be disposed of as hazardous waste
- Ensure information related to the experiment is included within any SOPs.

9.5 Prior Approval

The OSHA Laboratory Standard requires Chemical Hygiene Plans to include information on "the circumstances under which a particular laboratory operation, procedure or activity shall require prior approval", including "provisions for additional employee protection for work with particularly hazardous substances" such as "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity.

Prior approval ensures that laboratory workers have received the proper training on the hazards of particularly hazardous substances or with new equipment, and that safety considerations have been taken into account BEFORE a new experiment begins.

While New Mexico Tech can provide assistance in identifying circumstances when there should be prior approval before implementation of a particular laboratory operation, the ultimate responsibility of establishing prior approval procedures lies with the Principal Investigator or laboratory supervisor.

Principal Investigators or laboratory supervisors must identify operations or experiments that involve particularly hazardous substances (such as "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity) and highly hazardous operations or equipment that require prior approval. They must establish the guidelines, procedures, and approval process that would be required. This information should be documented in the laboratory's or department's SOPs. Additionally, Principal

Investigators and laboratory supervisors are strongly encouraged to have written documentation, such as “Prior Approval” forms that are completed and signed by the laboratory worker, and signed off by the Principal Investigator or laboratory supervisor and kept on file.

Examples where Principal Investigators or laboratory supervisors should consider requiring their laboratory workers to obtain prior approval include:

- Experiments that require the use of particularly hazardous substances such as "select carcinogens," reproductive toxins, and substances that have a high degree of acute toxicity, highly toxic gases, cryogenic materials and other highly hazardous chemicals or experiments involving radioactive materials, high powered lasers, etc.
- Where a significant change is planned for the amount of chemicals to be used for a routine experiment such as an increase of 10% or greater in the quantity of chemicals normally used.
- When a new piece of equipment is brought into the lab that requires special training in addition to the normal training provided to laboratory worker
- When a laboratory worker is planning on working alone on an experiment that involves highly hazardous chemicals or operations.

9.6 Campus Prior Approval

There are some circumstances where prior approval from a campus research related committee is required before beginning an operation or activity. These include:

- Research using live vertebrate animals
- Recombinant DNA use –Biosafety at 575-835-5842
- Use of Radioactive Materials – contact the New Mexico Tech Safety at 575-835-5842.
- Use of Human Subjects - contact the NMT IRB at 575-835-5808

Additional information can be obtained from the Office of Research and Integrity Assurance webpage for Compliance with Government Regulations.

9.7 Select Carcinogens

A carcinogen is any substance or agent that is capable of causing cancer – the abnormal or uncontrolled growth of new cells in any part of the body in humans or animals. Most carcinogens are chronic toxins with long latency periods that can cause damage after repeated or long duration exposures and often do not have immediate apparent harmful effects.

The OSHA Lab Standard defines a “select carcinogen” as any substance which meets one of the following criteria:

- (i) It is regulated by OSHA as a carcinogen; or
- (ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

- (iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or
- (iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
 - (A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m³;
 - (B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or
 - (C) After oral dosages of less than 50 mg/kg of body weight per day.

With regard to mixtures, OSHA requires that a mixture "shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of 0.1% or greater, which is considered to be carcinogenic." When working with carcinogens, laboratory staff should adhere to Guidelines for Working with Particularly Hazardous Substances.

Note that the potential for carcinogens to result in cancer can also be dependent on other "lifestyle" factors such as:

- Cigarette smoking
- Alcohol consumption
- Consumption of high fat diet
- Geographic location – industrial areas and UV light exposure
- Therapeutic drugs
- Inherited conditions

More information on carcinogens, including numerous useful web links such as a listing of OSHA regulated carcinogens, can be found on the OSHA Safety and Health Topics for Carcinogens webpage. The State of California has developed an extensive list of "Carcinogens Known to the State of California through Prop 65". Please note, this list is being provided as supplemental information to the OSHA, NTP and IARC chemical lists and is not legally mandated by New York State.

9.8 Reproductive Toxins

The OSHA Lab Standard defines a reproductive toxin as a chemical "which affects the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis)".

A number of reproductive toxins are chronic toxins that cause damage after repeated or long duration exposures and can have long latency periods. Women of childbearing potential should be especially careful when handling reproductive toxins. Pregnant women and women intending to become pregnant, or men seeking to have children, should seek the advice of their physician or New Mexico Tech Gannett Health Services before working with known or suspected reproductive toxins.

It is important to be aware of the threats to reproductive health and prevent potential reproductive hazard exposures for male and female employees and students who work with known and suspected reproductive toxins including chemical, biological, radiological, and physical agents. New Mexico Tech is available to respond to concerns or questions on reproductive hazards, conduct workplace hazard assessments, and provide recommendations to address or eliminate specific reproductive risks. This free service can be requested by completing the confidential Reproductive Hazard Assessment Form. As with any particularly hazardous substance, work involving the use of reproductive toxins should adhere to the Guidelines for Working with Particularly Hazardous Substances. Additionally, Reproductive Hazard Training is available online.

More information on reproductive toxins, including numerous useful web links, can be found on the OSHA Safety and Health Topics for Reproductive Hazards webpage. The State of California has developed an extensive list of "Reproductive Toxins Known to the State of California through Prop 65". Please note, this list is being provided as supplemental information to the OSHA, NTP and IARC chemical lists and is not legally mandated by New York State.

9.9 Acute Toxins

OSHA defines a chemical as being highly toxic if it falls within any of the following categories:

- (a) A chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- (b) A chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
- (c) A chemical that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Information on determining whether or not a chemical meets one of these definitions can be found in SDSs and other chemical references.

As with any particularly hazardous substance, work involving the use of acute toxins should adhere to the Guidelines for Working with Particularly Hazardous Substances. In addition to following the Guidelines for Working with Particularly Hazardous Substances, additional guidelines for working with acute toxins include:

- Consider storing highly toxic materials in a locked storage cabinet.
- Be aware of any special antidotes that may be required in case of accidental exposure (Hydrofluoric acid and inorganic cyanides for example).
- Give particular attention to the selection of gloves and other personal protective equipment.

- Do not work with highly toxic chemicals outside of a fume hood, glove box or ventilated enclosure.

More information on acute toxins, including numerous useful web links, can be found on the OSHA Safety and Health Topics for Hazardous and Toxic Substances webpage.

Please note, in addition to the OSHA definition, New Mexico Tech has a Poison Inhalation Hazard Purchasing Policy – Requisitioning Procedure No. 228.

10.0 Hazardous Chemical Waste Disposal

Hazardous chemical waste storage and disposal is regulated by the U.S. Environmental Protection Agency (EPA). In New York State, the Department of Environmental Conservation (DEC) regulates chemical waste management activities. All University chemical wastes are subject to inspection and enforcement actions by the EPA or the DEC.

New Mexico Tech provides the following chemical waste compliance services:

- Management of University main hazardous waste accumulation area.
- Collection of chemical waste.
- General compliance assistance.

10.1 Hazardous Chemical Waste Container Requirements

Within your work area, the following practices must be followed for proper management of hazardous waste:

- Determine if your unwanted materials pose a significant risk requiring management as hazardous waste.
- Determine if chemical deactivation or drain disposal is an option.
- Label containers of hazardous chemical wastes with the identity of the chemical(s) AND the words “Hazardous Waste” or label with a New Mexico Tech Hazardous Waste label.
- Keep containers of hazardous chemical wastes closed at all times when they are not in use.
- Store hazardous waste containers within the room in which they are generated in.

Recommended practices that should be followed:

- Always maintain a neat and orderly workplace
- Use secondary containment bins or trays to store your chemical waste containers in.
- Store your waste containers in a designated place.

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that personnel working in laboratories under their supervision are familiar with and follow hazardous chemical waste container requirements and have attended New Mexico Tech Chemical Waste Disposal training.

10.2 Hazardous Waste Pickup Procedures

To have your hazardous waste picked up by New Mexico Tech Safety, please complete the following procedures:

- Place an New Mexico Tech Hazardous Waste label on each container.
Labels are available by calling 575-835-5842.
- Fill out the waste label and list all of the ingredients (no trade names or chemical formulas, please). Put a start accumulation date on the tag until you are ready to dispose of the waste through New Mexico Tech Safety.
- Peel off the bottom copy and stick it on the waste container.
- Place the waste containers in a DOT compliant box (has a U/N symbol on it). Place the top copy of the waste label inside the box.
- Request a waste pick up by filling out the online request for chemical waste removal.

The following types of materials have different requirements for disposal:

- Biohazardous materials
- Construction debris (such as asbestos and lead)
- CRTs (computer monitors and televisions)
- Radioactive materials
- Scrap electronics (circuit boards)
- Used oils

Universal Waste (Fluorescent bulbs, batteries)

11.0 Hazardous Material Shipping

The transport of hazardous materials is regulated by the U.S. Department of Transportation (DOT) and the International Civil Aviation Organization. An additional regulatory body formed by the airlines is called the International Air Transport Association (IATA); however, their regulations are only enforceable by the airlines. All University transportation (including shipping) of hazardous materials off University owned property is subject to DOT enforcement.

New Mexico Tech provides the following hazardous material shipping compliance services:

- Compliance training
- Maintenance of training records
- University DOT certification program
- General compliance assistance
- Oversight of shipping stations (where untrained/uncertified individuals may have a hazardous material shipped for them)

11.1 Regulated Hazardous Materials

The following materials are regulated as hazardous materials for transportation:

- Alcohol solutions
- Compressed gases
- Corrosives
- Dry Ice (air shipments only)
- Explosives
- Flammable liquids and solids
- Formaldehyde - solutions between 0.1% and 25% (air shipments only)
- Infectious substances (animals and humans only)
- Oxidizers
- Poisons
- Radioactive materials

11.2 Hazardous Materials Transportation Requirements

The following must be adhered to for all shipments involving hazardous materials:

- All shipments of hazardous materials from the University must be prepared by a trained and New Mexico Tech University certified individuals. Anyone who classifies, packages, marks, or labels hazardous materials for shipment must be a trained and New Mexico Tech University certified individual.
- Transport of hazardous materials by New Mexico Tech University members for University business requires the preparer and the driver to be trained and New Mexico Tech University certified.
- Shipments of hazardous materials received by New Mexico Tech University do not require a trained and New Mexico Tech University certified individual unless they help unload the truck.

It is the responsibility of the Principal Investigator or laboratory supervisor to ensure any employee working under their supervision who ships or prepare shipments of hazardous materials have received the proper training.

12.0 Radiation Hazards

Ionizing radiation is a form of energy. Unlike some other types of energy, such as heat (infrared radiation) or visible light, the human body cannot sense exposure to ionizing radiation. Nonetheless, absorption of ionizing radiation energy by body tissues causes changes to the chemical makeup of living cells.

The type and thickness of material needed to make an effective barrier or shield around a source of ionizing radiation varies a great deal depending on the type of ionizing radiation. Beta radiation is a stream of tiny charged particles that can be stopped by a thin layer of plastic, glass, wood, metal and most other common materials. X-rays and

Gamma rays are very similar to sunlight in that they are not particles, just electromagnetic waves. While sunlight will pass through only a few materials, such as window glass, X-rays and Gamma rays penetrate easily through most materials. However, even they can be blocked by a sufficient thickness of lead.

Ionizing radiation is also similar to other forms of radiation in that the intensity of the radiation exposure decreases very quickly as you move away from the radiation source. Just as moving a short distance closer to or farther from a fireplace causes a large change in how warm you feel; keeping just a few feet away from where someone is handling radioactive material will almost eliminate your exposure.

12.1 Where Ionizing Radiation is Used

Small amounts of radioactive material are used and stored in hundreds of laboratory rooms around the campus. Some of the material is contained in small sealed capsules. Examples of these “sealed sources” include test sources for radiation detectors and ionization detectors in gas chromatographs. Most often radioactive material is found in small vials of radioactively labeled chemicals in solution. These labeled chemicals are widely used in research and in veterinary medicine. With very few exceptions, only very small amounts of radioactive material are used and levels of radiation exposure are quite low.

Ionizing radiation can also be produced by certain electrical equipment, including X-ray machines and particle accelerators. There are approximately one hundred pieces of radiation producing equipment on the campus. Radiation levels produced by this equipment are also very low because of shielding.

You can tell if a room contains a source of ionizing radiation because each entrance is plainly marked by warning labels. Within the room, additional labels and warning tape will be found on each piece of radiation producing equipment and on all areas used to work with or store radioactive material.

12.2 Potential Hazards

Like any form of energy, ionizing radiation can be harmful if a person is exposed to an excessive amount. Exposure to ionizing radiation causes chemical damage to body tissues and can be harmful. Just as with exposure to any toxic chemical, the human body can tolerate exposure to ionizing radiation up to a point without producing any immediate injury. However, just as with toxic chemicals, high levels of exposure can cause serious injuries including skin burns, hair loss, internal bleeding, anemia and immune system suppression. In addition, exposure to high levels of ionizing radiation has been proven to cause an increased lifetime risk of cancer.

12.2.1 How to Protect Yourself

Responsibility for protecting themselves, co-workers and others from exposure to ionizing radiation is delegated by the Radiation Safety Committee to the Principal Investigator or area supervisor and to each of the individual users. Appropriate safety requirements, that are specific to each use and location, are written into each approval granted by the Committee. Every user is trained in radiation safety principles and on the specific safety requirements of their operations before they are allowed to begin working with radioactive material.

Other individuals in these areas, who are not trained to use radioactive material or radiation producing equipment, need to follow the safety procedures established for those working with ionizing radiation. Primarily this means:

- Never operate equipment that produces ionizing radiation.
- Never handle items or containers that are labeled with radioactive material warnings or that are within areas marked as storage or use areas for radioactive material.

12.3 Control of Ionizing Radiation

All use of material or equipment that produces ionizing radiation requires prior approval by the New Mexico Tech University Radiation Safety Committee. This group of faculty members set policies and personally reviews each operation to ensure safety and compliance with state and federal regulations. The University Radiation Safety Officer and the Radiation Safety Group within New Mexico Tech provide training and other services to help individuals work safely. In addition, they perform routine inspections of all use areas and require correction of all violations of radiation safety requirements. Detailed information on the university radiation safety program is available in the New Mexico Tech University Radiation Safety Manual.

The performance of the New Mexico Tech Radiation Safety Program is reviewed continuously. The Radiation Safety Officer keeps policies up-to-date, resolve problems and compliance issues and monitors the level of radiation exposure to individuals on campus. Self-audits are done by New Mexico Tech programs and services (New Mexico Tech Safety). In addition, the New Mexico State Department of Health performs an on campus assessment of our program every two years.

The information presented here is only a brief overview of how sources of ionizing radiation are used at New Mexico Tech University. While New Mexico Tech has demonstrated that it has a solid and consistent safety program, it is important not to take safety for granted. If you have questions or concerns about the use of ionizing radiation where you work, you are entitled to answers and information. The Principal Investigator, area supervisor or any authorized user is willing and able to help you and you should feel free to speak with them. They understand that many individuals have never had formal training about radiation safety. If you need additional assistance or have any other questions, please contact New Mexico Tech at 575-835-5842.

12.4 Radioactive Waste Disposal

Radioactive material cannot be disposed of in the regular trash. New Mexico Tech provides a billable service to pick up radioactive waste every Tuesday morning the University is open. Radioactive waste is divided into several distinct categories and should be separated accordingly. Please read the Radiation Safety Manual, Disposal of Radioactive Material section, for proper procedures in preparing your radioactive waste for pickup. A radioactive waste pickup may be requested by calling 5-8200 by 4:00 PM Monday. For more information or if you have any questions, please contact the New Mexico Tech Director of Hazardous Materials.

15.0 - LASER Hazards

New Mexico Tech University has a Laser Safety Program designed to establish guidelines to protect students and employees from the potential hazards associated with laser devices and systems used to conduct laboratory, educational, or research activities at New Mexico Tech University. To achieve this goal, New Mexico Tech recognizes the American National Standard for the Safe Use of Lasers, ANSI Z136.1-2000 and New York Department of Labor's Part 50, LASER Regulation.

ANSI Z136.1-2007 requires that all class 3b and 4 laser users must attend laser safety training. New Mexico Tech offers training to meet this requirement, which includes topics such as laser hazards, laser classifications, signage/labeling, medical monitoring, safety guidelines, and what to do in case of an exposure incident.. The Laser Safety Training class is offered on a monthly basis by submitting a request to NMT Safety.

Additionally, any class 3b and 4 lasers that are in use must be registered with New Mexico Tech Safety. If your user group has not completed this process, please complete the LASER registration form and return it to New Mexico Tech at Workman 255. Laser safety reviews, control recommendations, and medical monitoring are also available by submitting a request to NMT Safety.

Additional information can be found on the OSHA Safety and Health topics webpage for laser hazards.

It is the responsibility of the Principal Investigator or laboratory supervisor with class 3b or 4 LASERS in laboratories under their supervision to ensure the class 3b or 4 LASERS have been registered with New Mexico Tech and employees using these LASERS have received the appropriate training.

16.0 Physical Hazards

In addition to the chemical hazards found in laboratories, there are also numerous physical hazards encountered by laboratory staff on a day-to-day basis. As with chemical hazards, having good awareness of these hazards, good preplanning, use of personal protective equipment and following basic safety rules can go a long way in preventing accidents involving physical hazards.

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students in laboratories under their supervision are provided with adequate training and information specific to the physical hazards found within their laboratories.

16.1 Electrical Safety

Electricity travels in closed circuits, and its normal route is through a conductor. Shock occurs when the body becomes a part of the electric circuit. Electric shock can cause direct injuries such as electrical burns, arc burns, and thermal contact burns. It can also cause injuries of an indirect or secondary nature in which involuntary muscle reaction from the electric shock can cause bruises, bone fractures, and even death resulting from collisions or falls. Shock normally occurs in one of three ways. The person must be in contact with ground and must contact with:

- Both wires of the electric circuit, or
- One wire of the energized circuit and the ground, or
- A metallic part that has become energized by being in contact with an energized wire.

The severity of the shock received when a person becomes a part of an electric circuit is affected by three primary factors:

- The amount of current flowing through the body (measured in amperes).
- The path of the current through the body.
- The length of time the body is in the circuit.

Other factors that may affect the severity of shock are the frequency of the current, the phase of the heart cycle when shock occurs, and the general health of the person prior to shock. The effects of an electrical shock can range from a barely perceptible tingle to immediate cardiac arrest. Although there are no absolute limits or even known values that show the exact injury from any given amperage, the table above shows the general relationship between the degree of injury and the amount of amperage for a 60-cycle hand-to-foot path of one second's duration of shock.

EFFECTS OF ELECTRIC CURRENT IN THE BODY

Current	Reaction
1 Milliampere	Perception level. Just a faint tingle.
5 Milliamperes	Slight shock felt. Average individual can let go. However, strong involuntary reactions to shocks in this range can lead to injuries.
6-30 Milliamperes	Painful shock. Muscular control lost.

50-150 Milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Individual cannot let go. Death is possible.
1,000-4,300 Milliamperes	Ventricular fibrillation. Muscular contraction and nerve damage occur. Death is most likely.
10,000- Milliamperes	Cardiac arrest, severe burns and probable death.

As this table illustrates, a difference of less than 100 milliamperes exists between a current that is barely perceptible and one that can kill. Muscular contraction caused by stimulation may not allow the victim to free himself/herself from the circuit, and the increased duration of exposure increases the dangers to the shock victim. For example, a current of 100 milliamperes for 3 seconds is equivalent to a current of 900 milliamperes applied for 0.03 seconds in causing fibrillation. The so-called low voltages can be extremely dangerous because, all other factors being equal, the degree of injury is proportional to the length of time the body is in the circuit. Simply put, low voltage does not mean low hazard.

In the event of an accident involving electricity, if the individual is down or unconscious, or not breathing: CALL New Mexico Tech University Police at 585-835-5555 from a cell phone or off campus phone immediately. If an individual must be physically removed from an electrical source, it is always best to eliminate the power source first (i.e.: switch off the circuit breaker) but time, or circumstance may not allow this option - be sure to use a nonconductive item such as a dry board. Failure to think and react properly could make you an additional victim. If the individual is not breathing and you have been trained in CPR, have someone call New Mexico Tech University Police and begin CPR IMMEDIATELY!

16.1.1 Common Electrical Hazards and Preventative Steps

Many common electrical hazards can be easily identified before a serious problem exists.

- Read and follow all equipment operating instructions for proper use. Ask yourself, "Do I have the skills, knowledge, tools, and experience to do this work safely?"
-
- Do not attempt electrical repairs unless you are a qualified electrical technician assigned to perform electrical work by your supervisor. Qualified individuals must receive training in safety related work practices and procedures, be able to recognize specific hazards associated with electrical energy, and be trained to understand the relationship between electrical hazards and possible injury. Fixed wiring may only be repaired or modified by Facilities Services.
- All electrical devices fabricated for experimental purposes must meet state and University construction and grounding requirements. Extension cords, power strips, and other purchased electrical equipment must be Underwriters Laboratories (UL) listed.

- Remove all jewelry before working with electricity. This includes rings, watches, bracelets, and necklaces.
- Determine appropriate personal protective equipment (PPE) based on potential hazards present. Before use, inspect safety glasses and gloves for signs of wear and tear, and other damage.
- Use insulated tools and testing equipment to work on electrical equipment. Use power tools that are double-insulated or that have Ground Fault Circuit Interrupters protecting the circuit. Do not use aluminum ladders while working with electricity; choose either wood or fiberglass.
- Do not work on energized circuits. The accidental or unexpected starting of electrical equipment can cause severe injury or death. Before any inspections or repairs are made, the current must be turned off at the switch box and the switch padlocked or tagged out in the off position. At the same time, the switch or controls of the machine or the other equipment being locked out of service should be securely tagged to show which equipment or circuits are being worked on. Test the equipment to make sure there is no residual energy before attempting to work on the circuit. Employees must follow the New Mexico Tech University lock-out/tag-out procedures.
- If you need additional power supply, the best solution is to have additional outlets installed by Facilities Services. Do not use extension cords or power strips ("power taps") as a substitute for permanent wiring.
- Extension cords and power strips may be used for experimental or developmental purposes on a temporary basis only. Extension cords can only be used for portable tools or equipment and must be unplugged after use. Do not use extension cords for fixed equipment such as computers, refrigerators/freezers, etc.; use a power strip in these cases. In general, the use of power strips is preferred over use of extension cords.
- Power strips must have a built-in overload protection (circuit breaker) and must not be connected to another power strip or extension cord (commonly referred to as daisy chained or piggy-backed). As mentioned above though, extension cords and power strips are not a substitute for permanent wiring.
- Ensure any power strips or extension cords are listed by a third-party testing laboratory, such as Underwriters Laboratory (UL). Make sure the extension cord thickness is at least as big as the electrical cord for the tool. For more information on extension cords, see the Consumer Product Safety Commission - Extension Cords Fact Sheet (CPSC Document #16).
- Inspect all electrical and extension cords for wear and tear. Pay particular attention near the plug and where the cord connects to the piece of equipment. If you discover a frayed electrical cord, contact your Building Coordinator for assistance. Do not use equipment having worn or damaged power cords, plugs, switches, receptacles, or cracked casings. Running electrical cords under doors or rugs, through windows, or through holes in walls is a common cause of frayed or damaged cords and plugs.
- Do not use 2-prong ungrounded electrical devices. All department-purchased electrical equipment must be 3-prong grounded with very limited exceptions.
- Never store flammable liquids near electrical equipment, even temporarily.

- Keep work areas clean and dry. Cluttered work areas and benches invite accidents and injuries. Good housekeeping and a well-planned layout of temporary wiring will reduce the dangers of fire, shock, and tripping hazards.
- Common scenarios that may indicate an electrical problem include: flickering lights, warm switches or receptacles, burning odors, sparking sounds when cords are moved, loose connections, frayed, cracked, or broken wires. If you notice any of these problems, have a qualified electrician address the issue immediately.
- To protect against electrical hazards and to respond to electrical emergencies it is important to identify the electrical panels that serve each room. Access to these panels must be unobstructed; a minimum of 3' of clearance is required in front of every electrical panel. Each panel must have all the circuit breakers labeled as to what they control. Contact your Building Coordinator for assistance.
- When performing laboratory inspections, it is a good idea to verify the location of the power panel and to open the door to ensure any breakers that are missing have breaker caps in its place. If no breaker is present and no breaker cap is covering the hole, contact your Building Coordinator for assistance.
- Avoid operating or working with electrical equipment in a wet or damp environment. If you must work in a wet or damp environment, be sure your outlets or circuit breakers are Ground Fault Circuit Interrupter (GFCI) protected. Temporary GFCI plug adapters can also be used, but are not a substitute for GFCI outlets or circuit breakers.
- Fuses, circuit breakers, and Ground-Fault Circuit Interrupters are three well-known examples of circuit protection devices.

Fuses and circuit breakers are over-current devices that are placed in circuits to monitor the amount of current that the circuit will carry. They automatically open or break the circuit when the amount of the current flow becomes excessive and therefore unsafe. Fuses are designed to melt when too much current flows through them. Circuit breakers, on the other hand, are designed to trip open the circuit by electro-mechanical means.

Fuses and circuit breakers are intended primarily for the protection of conductors and equipment. They prevent overheating of wires and components that might otherwise create hazards for operators.

The Ground Fault Circuit Interrupter (GFCI) is designed to shut off electric power within as little as 1/40 of a second, thereby protecting the person, not just the equipment. It works by comparing the amount of current going to an electric device against the amount of current returning from the device along the circuit conductors. A fixed or portable GFCI should be used in high-risk areas such as wet locations and construction sites.

- Entrances to rooms and other guarded locations containing exposed live parts must be marked with conspicuous warning signs forbidding unqualified persons to enter.

Live parts of electric equipment operating at 50 volts or more must be guarded against accidental contact. Guarding of live parts may be accomplished by:

Location in a room, vault, or similar enclosure accessible only to qualified persons.

Use of permanent, substantial partitions or screens to exclude unqualified persons.

Location on a suitable balcony, gallery, or platform elevated and arranged to exclude unqualified persons, or

Elevation of 8 feet or more above the floor.

For additional information, see the following resources:

- OSHA Pamphlet 3075
- 29 CFR 1910.303 through 29 CFR 1910.335

16.1.2 Safe Use of Electrophoresis Equipment

Electrophoresis units present several possible hazards including electrical, chemical, and radiological hazards. All of these hazards need to be addressed before using the units. New Mexico Tech has prepared these guidelines to assist researchers in safely operating electrophoresis units.

- Hazards associated with particular machines.
- How the safeguards provide protection and the hazards for which they are intended.
- How and why to use the safeguards.
- How and when safeguards can be removed and by whom.
- What to do if a safeguard is damaged, missing, or unable to provide adequate protection.

Hazards to machine operators that can't be designed around must be shielded to protect the operator from injury or death. Guards, decals and labels which identify the danger must be kept in place whenever the machine is operated. Guards or shields removed for maintenance must be properly replaced before use. Moving parts present the greatest hazard because of the swiftness of their action and unforgiving and relentless motion.

16.2 Machine Guarding

Common machine hazards occurring around moving parts include:

- Pinch Points
- Where two parts move together and at least one of the parts moves in a circle; also called mesh points, run-on points, and entry points. Examples include: Belt drives, chain drives, gear drives, and feed rolls.
- When shields cannot be provided, operators must avoid contact with hands or clothing in pinch point areas. Never attempt to service or unclog a machine while it is operating or the engine is running.

- Wrap Points
- Any exposed component that rotates.
- Examples include: Rotating shafts such as a PTO shaft or shafts that protrude beyond bearings or sprockets. Watch components on rotating shafts, such as couplers, universal joints, keys, keyways, pins, or other fastening devices. Splined, square, and hexagon-shaped shafts are usually more dangerous than round shafts because the edges tend to grab fingers or clothing more easily than a round shaft, but round shafts may not be smooth and can also grab quickly. Once a finger, thread, article of clothing, or hair is caught it begins to wrap; pulling only causes the wrap to become tighter.
- Shear Points
- Where the edges of two moving parts move across one another or where a single sharp part moves with enough speed or force to cut soft material.
- Remember that crop cutting devices cannot be totally guarded to keep hands and feet out and still perform their intended function. Recognize the potential hazards of cutting and shear points on implements and equipment that are not designed to cut or shear. Guarding may not be feasible for these hazards.
- Crush Points
- Points that occur between two objects moving toward each other or one object moving toward a stationary object. Never stand between two objects moving toward one another. Use adequate blocking or lock-out devices when working under equipment.
- Pull-In Points
- Points where objects are pulled into equipment, usually for some type of processing. Machines are faster and stronger than people. Never attempt to hand-feed materials into moving feed rollers. Always stop the equipment before attempting to remove an item that has plugged a roller or that has become wrapped around a rotating shaft. Remember that guards cannot be provided for all situations - equipment must be able to function in the capacity for which it is designed. Freewheeling parts, rotating or moving parts that continue to move after the power is shut off are particularly dangerous because time delays are necessary before service can begin. Allow sufficient time for freewheeling parts to stop moving. Stay alert! Listen and Watch for Motion!
- Thrown Objects
- Any object that can become airborne because of moving parts.
- Keep shields in place to reduce the potential for thrown objects. Wear protective gear such as goggles to reduce the risk of personal injury if you cannot prevent particles from being thrown. All guards, shields or access doors must be in place when equipment is operating. Electrically powered equipment must have a lock-out control on the switch or an electrical switch, mechanical clutch or other positive shut-off device mounted directly on the equipment. Circuit interruption devices on an electric motor, such as circuit breakers or overload protection, must require manual reset to restart the motor.

16.3 Lighting

Having a properly lighted work area is essential to working safely. A couple of key points to remember about proper lighting:

- Lighting should be adequate for safe illumination of all work areas (100-200 lumens for laboratories). For more information, see the PDC Design and Construction Standard 16500 – Lighting.
- Light bulbs that are mounted low and susceptible to contact should be guarded.
- If the risk of electrocution exists when changing light bulbs, practice lock-out tag-out.
- For proper disposal of fluorescent bulbs (“universal waste”), see lightbulb recycling.
- As an energy conservation measure, please remember to turn off your lights when you leave your lab.

16.4 Compressed Gases

Compressed gases are commonly used in laboratories for a number of different operations. While compressed gases are very useful, they present a number of hazards for the laboratory worker:

- Gas cylinders may contain gases that are flammable, toxic, corrosive, asphyxiants, or oxidizers.
- Unsecured cylinders can be easily knocked over, causing serious injury and damage. Impact can shear the valve from an uncapped cylinder, causing a catastrophic release of pressure leading to personal injury and extensive damage.
- Mechanical failure of the cylinder, cylinder valve, or regulator can result in rapid diffusion of the pressurized contents of the cylinder into the atmosphere; leading to explosion, fire, runaway reactions, or burst reaction vessels.

16.4.1 Handling Compressed Gas Cylinders

There are a number of ways that compressed gases can be handled safely. Always practice the following when handling compressed gases:

- The contents of any compressed gas cylinder must be clearly identified. Such identification should be stenciled or stamped on the cylinder, or a label or tag should be attached. Do not rely on the color of the cylinder for identification because color-coding is not standardized and may vary with the manufacturer or supplier.
- When transporting cylinders:
 - Always use a hand truck equipped with a chain or belt for securing the cylinder.
 - Make sure the protective cap covers the cylinder valve.
 - Never transport a cylinder while a regulator is attached.
 - Always use caution when transporting cylinders – cylinders are heavy.
- Avoid riding in elevators with compressed gas cylinders. If this is necessary, consider using a buddy system to have one person send the properly secured cylinders on the elevator, while the other person waits at the floor by the elevator doors where the cylinders will arrive
- Do not move compressed gas cylinders by carrying, rolling, sliding, or dragging them across the floor.

- Do not transport oxygen and combustible gases at the same time.
- Do not drop cylinders or permit them to strike anything violently.

16.4.2 Safe Storage of Compressed Gas Cylinders

Procedures to follow for safe storage of compressed gas cylinders include:

- Gas cylinders must be secured to prevent them from falling over. Chains are recommended over clamp-plus-strap assemblies due to the hazards involved in a fire and straps melting or burning. Be sure the chain is high enough (at least half way up) on the cylinder to keep it from tipping over.
- Do not store incompatible gases right next to each other. Cylinders of oxygen must be stored at least 20 feet away from cylinders of hydrogen or other flammable gas, or the storage areas must be separated by a firewall five feet high with a fire rating of 1/2 hour.
- All cylinders should be stored away from heat and away from areas where they might be subjected to mechanical damage.
- Keep cylinders away from locations where they might form part of an electrical circuit, such as next to electric power panels or electric wiring.
- The protective cap that comes with a cylinder of gas should always be left on the cylinder when it is not in use. The cap keeps the main cylinder valve from being damaged or broken.

16.4.3 Operation of Compressed Gas Cylinders

The cylinder valve hand wheel opens and closes the cylinder valve. The pressure relief valve is designed to keep a cylinder from exploding in case of fire or extreme temperature. Cylinders of very toxic gases do not have a pressure relief valve, but they are constructed with special safety features. The valve outlet connection is the joint used to attach the regulator. The pressure regulator is attached to the valve outlet connector in order to reduce the gas flow to a working level. The Compressed Gas Association has intentionally made certain types of regulators incompatible with certain valve outlet connections to avoid accidental mixing of gases that react with each other. Gases should always be used with the appropriate regulator. Do not use adaptors with regulators. The cylinder connection is a metal-to-metal pressure seal. Make sure the curved mating surfaces are clean before attaching a regulator to a cylinder. Do not use Teflon tape on the threaded parts, because this may actually cause the metal seal not to form properly. Always leak test the connection.

Basic operating guidelines include:

- Make sure that the cylinder is secured.
- Attach the proper regulator to the cylinder. If the regulator does not fit, it may not be suitable for the gas you are using.
- Attach the appropriate hose connections to the flow control valve. Secure any tubing with clamps so that it will not whip around when pressure is turned on. Use suitable materials for connections; toxic and corrosive gases require connections made of special materials.

- Install a trap between the regulator and the reaction mixture to avoid backflow into the cylinder.
- To prevent a surge of pressure, turn the delivery pressure adjusting screw counterclockwise until it turns freely and then close the flow control valve.
- Slowly open the cylinder valve hand wheel until the cylinder pressure gauge reads the cylinder pressure.
- With the flow control valve closed, turn the delivery pressure screw clockwise until the delivery pressure gauge reads the desired pressure.
- Adjust the gas flow to the system by using the flow control valve or another flow control device between the regulator and the experiment.
- After an experiment is completed, turn the cylinder valve off first, and then allow gas to bleed from the regulator. When both gauges read “zero”, remove the regulator and replace the protective cap on the cylinder head.
- When the cylinder is empty, mark it as “Empty”, and store empty cylinders separate from full cylinders.
- Attach a “Full/In Use/Empty” tag to all of your cylinders, these tags are perforated and can be obtained from the gas cylinder vendor.

Precautions to follow:

- Use a regulator only with gas for which it is intended. The use of adaptors or homemade connectors has caused serious and even fatal accidents.
- Toxic gases should be purchased with a flow-limiting orifice.
- When using more than one gas, be sure to install one-way flow valves from each cylinder to prevent mixing. Otherwise accidental mixing can cause contamination of a cylinder.
- Do not attempt to put any gas into a commercial gas cylinder.
- Do not allow a cylinder to become completely empty. Leave at least 25 psi of residual gas to avoid contamination of the cylinder by reverse flow.
- Do not tamper with or use force on a cylinder valve.

16.4.4 Return of Cylinders

- Disposal of cylinders and lecture bottles is expensive, especially if the contents are unknown.
- Make sure that all cylinders and lecture bottles are labeled and included in your chemical inventory. Before you place an order for a cylinder or lecture bottle, determine if the manufacturer will take back the cylinder or lecture bottle when it becomes empty. If at all possible, only order from manufacturers who will accept cylinders or lecture bottles for return.

16.4.5 Hazards of Specific Gases

Inert Gases

Examples: Helium, Argon, Nitrogen

- Can cause asphyxiation by displacing the air necessary for the support of life.

- Cryogenics are capable of causing freezing burns, frostbite, and destruction of tissue.
- Cryogenic Liquids
- Cryogenic liquids are extremely cold and their vapors can rapidly freeze human tissue.
- Boiling and splashing will occur when the cryogen contacts warm objects.
- Can cause common materials such as plastic and rubber to become brittle and fracture under stress.
- Liquid to gas expansion ratio: one volume of liquid will vaporize and expand to about 700 times that volume, as a gas, and thus can build up tremendous pressures in a closed system. Therefore dispensing areas need to be well ventilated. Avoid storing cryogenics in cold rooms, environmental chambers, and other areas with poor ventilation. If necessary, install an oxygen monitor/oxygen deficiency alarm and/or toxic gas monitor before working these materials in confined areas.

Oxidizers

Examples: Oxygen, Chlorine

- Oxidizers vigorously accelerate combustion; therefore keep away from all flammable and organic materials. Greasy and oily materials should never be stored around oxygen. Oil or grease should never be applied to fittings or connectors.

Flammable Gases

- Examples: Methane, Propane, Hydrogen, Acetylene
- Flammable gases present serious fire and explosion hazards.
- Do not store near open flames or other sources of ignition.
- Cylinders containing Acetylene should never be stored on their side.
- Flammable gases are easily ignited by heat, sparks, or flames, and may form explosive mixtures with air. Vapors from liquefied gas often are heavier than air, and may spread along ground and travel to a source of ignition and result in a flashback fire.

Corrosive Gases

Examples: Chlorine, Hydrogen Chloride, Ammonia

- There can be an accelerated corrosion of materials in the presence of moisture.
-
- Corrosive gases readily attack the skin, mucous membranes, and eyes. Some corrosive gases are also toxic.
-
- Due to the corrosive nature of the gases, corrosive cylinders should only be kept on hand for 6 months (up to one year maximum). Only order the smallest size needed for your experiments.

Poison Gases

Examples: Arsine, Phosphine, Phosgene

- Poison gases are extremely toxic and present a serious hazard to laboratory staff.
- Poisonous gases require special ventilation systems and equipment and must only be used by properly trained experts. There are also special building code regulations that must be followed with regard to quantities kept on hand and storage.
- The purchase and use of poisonous gases require prior approval from New Mexico Tech Safety.

16.5 Battery Charging

Lead acid batteries contain corrosive liquids and also generate Hydrogen gas during charging which poses an explosion hazard. The following guidelines should be followed for battery charging areas:

- A “No smoking” sign should be posted.
- Before working, remove all jewelry from hands and arms and any dangling jewelry to prevent accidental contact with battery connections (this can cause sparks which can ignite vapors).
- Always wear appropriate PPE such as rubber or synthetic aprons, splash goggles (ideally in combination with a face shield), and thick Neoprene, Viton, or Butyl gloves.
- A plumbed emergency eyewash station must be readily available near the station (please note, hand held eyewash bottles do not meet this criteria.)
- A class B rated fire extinguisher needs to be readily available. If none is available, contact New Mexico Tech at 575-835-5842.
- Ensure there is adequate ventilation available to prevent the buildup of potentially flammable and explosive gases.
- Keep all ignition sources away from the area.
- Stand clear of batteries while charging.
- Keep vent caps tight and level.
- Only use the appropriate equipment for charging.
- Store unused batteries in secondary containment to prevent spills.
- Have an acid spill kit available. The waste from a spill may contain lead and neutralized wastes may be toxic. Contact New Mexico Tech at 575-835-5842 for hazardous waste disposal.
- Properly dispose of your used batteries.

16.6 Heat and Heating Devices

Heat hazards within laboratories can occur from a number of sources; however, there are some simple guidelines that can be followed to prevent heat related injuries. These

guidelines include:

- Heating devices should be set up on a sturdy fixture and away from any ignitable materials (such as flammable solvents, paper products and other combustibles). Do not leave open flames (from Bunsen burners) unattended.
- Heating devices should not be installed near drench showers or other water spraying apparatus due to electrical shock concerns and potential splattering of hot water.
- Heating devices should have a backup power cutoff or temperature controllers to prevent overheating. If a backup controller is used, an alarm should notify the user that the main controller has failed.
- Provisions should be included in processes to make sure reaction temperatures do not cause violent reactions and a means to cool the dangerous reactions should be available.
- Post signs to warn people of the heat hazard to prevent burns.

When using ovens, the follow additional guidelines should be followed:

- Heat generated should be adequately removed from the area.
- If toxic, flammable, or otherwise hazardous chemicals are evolved from the oven, then only use ovens with a single pass through design where air is ventilated out of the lab and the exhausted air is not allowed to come into contact with electrical components or heating elements.
- Heating flammables should only be done with a heating mantle or steam bath.

When using heating baths, these additional guidelines should be followed:

- Heating baths should be durable and set up with firm support.
- Since combustible liquids are often used in heat baths, the thermostat should be set so the temperature never rises above the flash point of the liquid. Check the SDS for the chemical to determine the flashpoint. Compare that flashpoint with the expected temperature of the reaction to gauge risk of starting a fire.

16.6.1 Heat Stress

Another form of heat hazard occurs when working in a high heat area. Under certain conditions, your body might have trouble regulating its temperature. If your body cannot regulate its temperature, it overheats and suffers some degree of heat stress. This can occur very suddenly and, if left unrecognized and untreated, can lead to very serious health affects.

Heat stress disorders range from mild disorders such as fainting, cramps, or prickly heat to more dangerous disorders such as heat exhaustion or heat stroke. Symptoms of mild to moderate heat stress can include: sweating, clammy skin, fatigue, decreased strength, loss of coordination and muscle control, dizziness, nausea, and irritability. You should move the victim to a cool place and give plenty of fluids. Place cool compresses on forehead, neck, and under their armpits.

Heat stroke is a medical emergency. It can cause permanent damage to the brain and vital organs, or even death. Heat stroke can occur suddenly, with little warning. Symptoms of heat stroke may include: no sweating (in some cases victim may sweat profusely), high

temperature (103° or more), red, hot, and dry skin, rapid and strong pulse, throbbing headache, dizziness, nausea, convulsions, delirious behavior, unconsciousness, or coma.

In the case of heat stroke, call 911 & get medical assistance ASAP! In the meantime, you should move the victim to a cool place, cool the person quickly by sponging with cool water and fanning, and offer a conscious person 1/2 glass of water every 15 minutes.

There are a number of factors that affect your body's temperature regulation:

- Radiant heat sources such as the sun or a furnace.
- Increased humidity causes decreased sweat evaporation.
- Decreased air movement causes decreased sweat evaporation.
- As ambient temperature rises, your body temperature rises and its ability to regulate decreases

You should be especially careful if:

- You just started a job involving physical work in a hot environment.
- You are ill, overweight, physically unfit, or on medication that can cause dehydration.
- You have been drinking alcohol.
- You have had a previous heat stress disorder.
-

In order to prevent heat stress, please follow these recommendations:

- Acclimatize your body to the heat. Gradually increase the time you spend in the heat. Most people acclimatize to warmer temperatures in 4-7 days. Acclimatization is lost when you have been away from the heat for one week or more. When you return, you must repeat the acclimatization process.
- Drink at least 4-8 ounces of fluid every 15-20 minutes to maintain proper balance during hot and/or humid environments. **THIRST IS NOT A GOOD INDICATOR OF DEHYDRATION.** Fluid intake must continue until well after thirst has been quenched.
- During prolonged heat exposure or heavy workload, a carbohydrate-electrolyte beverage is beneficial.
- Alternate work and rest cycles to prevent an overexposure to heat. Rest cycles should include relocation to a cooler environment.
- Perform the heaviest workloads in the cooler part of the day.
- There should be no alcohol consumption during periods of high heat exposure.
- Eat light, preferably cold meals. Fatty foods are harder to digest in hot weather.

16.7 Cold Traps

Cold traps:

- Because many chemicals captured in cold traps are hazardous, care should be taken and appropriate protective equipment should be worn when handling these chemicals. Hazards include flammability, toxicity, and cryogenic temperatures, which can burn the skin.
- If liquid nitrogen is used, the chamber should be evacuated before charging the system with coolant. Since oxygen in air has a higher boiling point than nitrogen, liquid oxygen can be produced and cause an explosion hazard.

-
- Boiling and splashing generally occur when charging (cooling) a warm container, so stand clear and wear appropriate protective equipment. Items should be added slowly and in small amounts to minimize splash.
-
- A blue tint to liquid nitrogen indicates contamination with oxygen and represents an explosion hazard. Contaminated liquid nitrogen should be disposed of appropriately.
-
- If working under vacuum see the “reduced pressure” section.
-
- See “cryogenics” for safety advice when working with cryogenic materials.

16.8 Autoclaves

Autoclaves have the following potential hazards:

- Heat, steam, and pressure.
- Thermal burns from steam and hot liquids.
- Cuts from exploding glass.

Some general safety guidelines to follow when using autoclaves:

- All users should be given training in proper operating procedures for using the autoclave.
- Read the owner’s manual before using the autoclave for the first time.
- Operating instructions should be posted near the autoclave.
- Follow the manufacturer’s directions for loading the autoclave.
- Be sure to close and latch the autoclave door.
- Some kinds of bottles containing liquids can crack in the autoclave, or when they are removed from the autoclave. Use a tray to provide secondary containment in case of a spill, and add a little water to the tray to ensure even heating.
- Only fill bottles half way to allow for liquid expansion and loosen screw caps on bottles and tubes of liquid before autoclaving, to prevent them from shattering.
- Do not overload the autoclave compartment and allow for enough space between items for the steam to circulate.
- Be aware that liquids, especially in large quantities, can be superheated when the autoclave is opened. Jarring them may cause sudden boiling, and result in burns.
- At the end of the run, open the autoclave slowly: first open the door only a crack to let any steam escape slowly for several minutes, and then open all the way. Opening the door suddenly can scald a bare hand, arm, or face.
- Wait at least five minutes after opening the door before removing items.
- Large flasks or bottles of liquid removed immediately from the autoclave can cause serious burns by scalding if they break in your hands. Immediately transfer hot items with liquid to a cart; never carry in your hands
- Wear appropriate PPE, including eye protection and insulating heat-resistant gloves.

16.9 Centrifuges

Some general safety guidelines to follow when using centrifuges:

- Be familiar with the operating procedures written by the manufacturer. Keep the operating manual near the unit for easy reference. If necessary contact the manufacturer to replace lost manuals.
- Handle, load, clean, and inspect rotors as recommended by the manufacturer.
- Pay careful attention to instructions on balancing samples -- tolerances for balancing are often very restricted. Check the condition of tubes and bottles. Make sure you have secured the lid to the rotor and the rotor to the centrifuge.
- Maintain a logbook of rotor use for each rotor, recording the speed and length of time for each use.
- To avoid catastrophic rotor failure, many types of rotors must be "de-rated" (limited to a maximum rotation speed that is less than the maximum rotation speed specified for the rotor when it is new) after a specified amount of use, and eventually taken out of service and discarded.
- Use only the types of rotors that are specifically approved for use in a given centrifuge unit.
- Maintain the centrifuge in good condition. Broken door latches and other problems should be repaired before using the centrifuge.
- Whenever centrifuging biohazardous materials, always load and unload the centrifuge rotor in a Biosafety cabinet.

16.9.1 Centrifuge Rotor Care

Basic centrifuge rotor care includes:

- Keep the rotor clean and dry, to prevent corrosion.
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- Remove adapters after use and inspect for corrosion.
-
- Store the rotor upside down, in a warm, dry place to prevent condensation in the tubes.
-
- Read and follow the recommendations in the manual regarding:
 - Regular cleaning
 - Routine inspections
 - Regular polishing
 - Lubricating O-rings
 - Decontaminating the rotor after use with radioactive or biological materials
- Remove any rotor from use that has been dropped or shows any sign of defect, and report it to a manufacturer's representative for inspection.

There is a description of an accident that occurred at New Mexico Tech and how to prevent centrifuge accidents on the Centrifuge Accident webpage.

16.10 Cryogenic Safety

A cryogenic gas is a material that is normally a gas at standard temperature and pressure, but which has been supercooled such that it is a liquid or solid at standard pressure.

Commonly used cryogenic materials include the liquids nitrogen, argon, and helium, and solid carbon dioxide (dry ice).

Hazards associated with direct personal exposure to cryogenic fluids include:

- Frostbite - Potential hazards in handling liquefied gases and solids result because they are extremely cold and can cause severe cold contact burns by the liquid, and frostbite or cold exposure by the vapor.
- Asphyxiation - The ability of the liquid to rapidly convert to large quantities of gas associated with evaporation of cryogenic liquid spills can result in asphyxiation. For instance, nitrogen expands approximately 700 times in volume going from liquid to gas at ambient temperature. Total displacement of oxygen by another gas, such as Carbon dioxide, will result in unconsciousness, followed by death. Exposure to oxygen-deficient atmospheres may produce dizziness, nausea, vomiting, loss of consciousness, and death. Such symptoms may occur in seconds without warning. Death may result from errors in judgment, confusion, or loss of consciousness that prevents self-rescue.
- Working with cryogenic substances in confined spaces, such as walk-in coolers, can be especially hazardous. Where cryogenic materials are used, a hazard assessment is required to determine the potential for an oxygen-deficient condition. Controls such as ventilation and/or gas detection systems may be required to safeguard employees. Asphyxiation and chemical toxicity are hazards encountered when entering an area that has been used to store cryogenic liquids if proper ventilation/purging techniques are not employed.
- Toxicity - Many of the commonly used cryogenic gases are considered to be of low toxicity, but still pose a hazard from asphyxiation. Check the properties of the gases you are using, because some gases are toxic, for example, Carbon monoxide, Fluorine, and Nitrous oxide.
- Flammability and Explosion Hazards - Fire or explosion may result from the evaporation and vapor buildup of flammable gases such as hydrogen, carbon monoxide, or methane. Liquid oxygen, while not itself a flammable gas, can combine with combustible materials and greatly accelerate combustion. Oxygen clings to clothing and cloth items, and presents an acute fire hazard.
- High Pressure Gas Hazards - Potential hazards exist in highly compressed gases because of the stored energy. In cryogenic systems, high pressures are obtained by gas compression during refrigeration, by pumping of liquids to high pressures followed by rapid evaporation, and by confinement of cryogenic fluids with subsequent evaporation. If this confined fluid is suddenly released through a rupture or break in a line, a significant thrust may be experienced. Over-pressurization of cryogenic equipment can occur due to the phase change from liquid to gas if not vented properly. All cryogenic fluids produce large volumes of gas when they vaporize.

- Materials and Construction Hazards - The selection of materials calls for consideration of the effects of low temperatures on the properties of those materials. Some materials become brittle at low temperatures. Brittle materials fracture easily and can result in almost instantaneous material failure. Low temperature equipment can also fail due to thermal stresses caused by differential thermal contraction of the materials. Over-pressurization of cryogenic equipment can occur due to the phase change from liquid to gas if not vented properly. All cryogenic fluids produce large volumes of gas when they vaporize.

16.10.1 Cryogenic Safety Guidelines

- Responsibilities
 - Personnel who are responsible for any cryogenic equipment must conduct a safety review prior to the commencement of operation of the equipment. Supplementary safety reviews must follow any system modification to ensure that no potentially hazardous condition is overlooked or created and that updated operational and safety procedures remain adequate.
 -
 - Personal Protective Equipment
 - Wear the appropriate PPE when working with cryogenic materials. Face shields and splash goggles must be worn during the transfer and normal handling of cryogenic fluids. Loose fitting, heavy leather or other insulating protective gloves must be worn when handling cryogenic fluids. Shirt sleeves should be rolled down and buttoned over glove cuffs, or an equivalent protection such as a lab coat, should be worn in order to prevent liquid from spraying or spilling inside the gloves. Trousers without cuffs should be worn.
 -
 - Safety Practices
- Cryogenic fluids must be handled and stored only in containers and systems specifically designed for these products and in accordance with applicable standards, procedures, and proven safe practices.
- Transfer operations involving open cryogenic containers such as dewars must be conducted slowly to minimize boiling and splashing of the cryogenic fluid. Transfer of cryogenic fluids from open containers must occur below chest level of the person pouring the liquid.
- Only conduct such operations in well-ventilated areas, such as the laboratory, to prevent possible gas or vapor accumulation that may produce an oxygen-deficient atmosphere and lead to asphyxiation. If this is not possible, an oxygen meter must be installed.
- Equipment and systems designed for the storage, transfer, and dispensing of cryogenic fluids need to be constructed of materials compatible with the products being handled and the temperatures encountered.

All cryogenic systems including piping must be equipped with pressure relief devices to prevent excessive pressure build-up. Pressure reliefs must be directed to a safe location. It should be noted that two closed valves in a line form a closed system. The vacuum insulation jacket should also be protected by an over pressure device if the service is below 77 degrees Kelvin. In the event a pressure relief device fails, do not attempt to remove the blockage; instead, call New Mexico Tech at 575-835-5842.

The caps of liquid nitrogen dewars are designed to fit snugly to contain the liquid nitrogen, but also allow the periodic venting that will occur to prevent an overpressurization of the vessel. Do not ever attempt to seal the caps of liquid nitrogen dewars. Doing so can present a significant hazard of overpressurization that could rupture the container and cause splashes of liquid nitrogen and, depending on the quantity of liquid nitrogen that may get spilled, cause an oxygen deficient atmosphere within a laboratory due to a sudden release and vaporization of the liquid nitrogen.

If liquid nitrogen or helium traps are used to remove condensable gas impurities from a vacuum system that may be closed off by valves, the condensed gases will be released when the trap warms up. Adequate means for relieving resultant build-up of pressure must be provided.

First Aid

- Workers will rarely, if ever, come into contact with cryogenic fluids if proper handling procedures are used. In the unlikely event of contact with a cryogenic liquid or gas, a contact “burn” may occur. The skin or eye tissue will freeze. The recommended emergency treatment is as follows:
- If the cryogenic fluid comes in contact with the skin or eyes, flush the affected area with generous quantities of cold water. Never use dry heat. Splashes on bare skin cause a stinging sensation, but, in general, are not harmful
- If clothing becomes soaked with liquid, it should be removed as quickly as possible and the affected area should be flooded with water as above. Where clothing has frozen to the underlying skin, cold water should be poured on the area, but no attempt should be made to remove the clothing until it is completely free.
- Contact NMT campus Police 575-835-5555 for additional treatment if necessary.
- Complete an Injury/Illness Report.

16.10.2 Cryogenic Chemical Specific Information

A) Liquid Helium

Liquid helium must be transferred via helium pressurization in properly designed transfer lines. A major safety hazard may occur if liquid helium comes in contact with air. Air solidifies in contact with liquid helium, and precautions must be taken when transferring

liquid helium from one vessel to another or when venting. Over-pressurization and rupture of the container may result. All liquid helium containers must be equipped with a pressure-relief device. The latent heat of vaporization of liquid helium is extremely low (20.5 J/gm); therefore, small heat leaks can cause rapid pressure rises.

B) Liquid Nitrogen

- Since the boiling point of liquid nitrogen is below that of liquid oxygen, it is possible for oxygen to condense on any surface cooled by liquid nitrogen. If the system is subsequently closed and the liquid nitrogen removed, the evaporation of the condensed oxygen may over-pressurize the equipment or cause a chemical explosion if exposed to combustible materials, e.g., the oil in a rotary vacuum pump. In addition, if the mixture is exposed to radiation, ozone is formed, which freezes out as ice and is very unstable. An explosion can result if this ice is disturbed. For this reason, air should not be admitted to enclosed equipment that is below the boiling point of oxygen unless specifically required by a written procedure.
- Any transfer operations involving open containers such as wide-mouth Dewars must be conducted slowly to minimize boiling and splashing of liquid nitrogen. The transfer of liquid nitrogen from open containers must occur below chest level of the person pouring the liquid.

C) Liquid Hydrogen

- Anyone proposing the use of liquid hydrogen must first obtain prior approval of New Mexico Tech(575-835-5842).
- Because of its wide flammability range and ease of ignition, special safety measures must be invoked when using liquid hydrogen.
- Liquid hydrogen must be transferred by helium pressurization in properly designed transfer lines in order to avoid contact with air. Properly constructed and certified vacuum insulated transfer lines should be used.
- Only trained personnel familiar with liquid hydrogen properties, equipment, and operating procedures are permitted to perform transfer operations. Transfer lines in liquid hydrogen service must be purged with helium or gaseous hydrogen, with proper precautions, before using.
- The safety philosophy in the use of liquid hydrogen can be summarized as the following:
 - Isolation of the experiment
 - Provision of adequate ventilation
 - Exclusion of ignition sources plus system grounding/bonding to prevent static charge build-up.
 - Containment in helium purged vessels.
 - Efficient monitoring for hydrogen leakage.

Limiting the amount of hydrogen cryopumped in the vacuum system.

16.11 Extractions and Distillations

Extractions

- Do not attempt to extract a solution until it is cooler than the boiling point of the extractant due to the risk of overpressurization, which could cause the vessel to burst.
-
- When a volatile solvent is used, the solution should be swirled and vented repeatedly to reduce pressure before separation.
-
- When opening the stopcock, your hand should keep the plug firmly in place.
-
- The stopcock should be lubricated.
-
- Vent funnels away from ignition sources and people, preferably into a hood.
-
- Keep volumes small to reduce the risk of overpressure and if large volumes are needed, break them up into smaller batches.

Distillations

- Avoid bumping (sudden boiling) since the force can break apart the apparatus and result in splashes. Bumping can be avoided by even heating, such as using a heat mantle. Also, stirring can prevent bumping. Boiling stones can be used only if the process is at atmospheric pressure.
- Do not add solid items such as boiling stones to liquid that is near boiling since it may result in the liquid boiling over spontaneously
- Organic compounds should never be allowed to boil to dryness unless they are known to be free of peroxides, which can result in an explosion hazard.

Reduced pressure distillation

- Do not overheat the liquid. Superheating can result in decomposition and uncontrolled reactions.
- Superheating and bumping often occur at reduced pressures so it is especially important to abide by the previous point on bumping and to ensure even, controlled heating. Inserting a nitrogen bleed tube may help alleviate this issue.
- Evacuate the assembly gradually to minimize bumping.
- Allow the system to cool and then slowly bleed in air. Air can cause an explosion in a hot system (pure nitrogen is preferable to air for cooling).
- See “reduced pressure” for vacuum conditions.

16.12 Glass Under Vacuum

Reduced pressure

Some general guidelines for glass under vacuum include:

- Inspect glassware that will be used for reduced pressure to make sure there are no defects such as chips or cracks that may compromise its integrity.
- Only glassware that is approved for low pressure should be used. Never use a flat bottom flask (unless it is a heavy walled filter flask) or other thin walled flask that are not appropriate to handle low pressure.
- Use a shield between the user and any glass under vacuum or wrap the glass with tape

to contain any glass in the event of an implosion.

Vacuum pumps

- Cold traps should be used to prevent pump oil from being contaminated which can create a hazardous waste.
- Pump exhaust should be vented into a hood when possible.
- Ensure all belts and other moving parts are properly guarded.
- Whenever working on or servicing vacuum pumps, be sure to follow appropriate lock-out procedures.

16.13 Glassware Washing

In most cases laboratory glassware can be cleaned effectively by using detergents and water. In some cases it may be necessary to use strong chemicals for cleaning glassware. Strong acids should be avoided unless necessary. In particular, Chromic acid should not be used due to its toxicity and disposal concerns. One product that may be substituted for Chromic acid is “Nochromix Reagent”. The Fisher catalog describes this material as: “Nochromix Reagent. Inorganic oxidizer chemically cleans glassware. Contains no metal ions. Rinses freely—leaving no metal residue, making this product valuable for trace analysis, enzymology, and tissue culture work. (Mix with sulfuric acid).” Unused Nochromix Reagent can be neutralized to a pH between 5.5 and 9.5 and drain disposed. Acid/base baths should have appropriate labeling and secondary containment. Additionally a Standard Operating Procedure (SOP), proper personal protective equipment (PPE), and spill materials should be available. Proper disposal for spent acid/base bath contents is neutralization and drain disposal.

When handling glassware, check for cracks and chips before washing, autoclaving or using it. Dispose of chipped and broken glassware immediately in an approved collection unit. DO NOT put broken glassware in the regular trash. Handle glassware with care – avoid impacts, scratches or intense heating of glassware. Make sure you use the appropriate labware for the procedures and chemicals. Use care when inserting glass tubing into stoppers: use glass tubing that has been fire-polished, lubricate the glass, and protect your hands with heavy gloves.

If your department/building has a glass washing service there are certain protocols that must be followed before sending the glassware to be washed. It is the responsibility of the lab to empty and rinse all glassware before it leaves the lab. Although the contents may not be hazardous, the washroom support staff cannot be certain of the appropriate PPE to wear, disposal regulations or possible incompatibilities with items received from other researchers. Be aware that labeling for lab personnel is not sufficient for areas outside the lab as per the OSHA Hazard Communication Standard. It is the responsibility of the glassware washing staff to reject or return glassware that is not acceptable due to breakage or containing chemicals. For this reason, glassware should be labeled with the name of the person who is responsible for it.

16.14 General Equipment Set Up

The following recommended laboratory techniques for general equipment set up was taken from the American Chemical Society's booklet – Safety in Academic Chemistry Laboratories.

16.14.1 Glassware and Plasticware

- Borosilicate glassware (i.e. pyrex) is recommended for all lab glassware, except for special experiments using UV or other light sources. Soft glass should only be used for things such as reagent bottles, measuring equipment, stirring rods and tubing.
- Any glass equipment being evacuated, such as suction flasks, should be specially designed with heavy walls. Dewar flasks and large vacuum vessels should be taped or guarded in case of flying glass from an implosion. Household thermos bottles have thin walls and are not acceptable substitutes for lab Dewar flasks.
- Glass containers containing hazardous chemicals should be transported in rubber bottle carriers or buckets to protect them from breakage and contain any spills or leaks. It is recommended to transport plastic containers this way as well since they also can break or leak.

16.14.2 Preparation of Glass Tubing and Stoppers

- To cut glass tubing:
 - Hold the tube against a firm support and make one firm quick stroke with a sharp triangular file or glass cutter to score the glass long enough to extend approximately one third around the circumference.
 - Cover the tubing with cloth and hold the tubing in both hands away from the body. Place thumbs on the tubing opposite the nick 2 to 3 cm and extended toward each other.
 - Push out on the tubing with the thumbs as you pull the sections apart, but do not deliberately bend the glass with the hands. If the tubing does not break, re-score the tube in the same place and try again. Be careful to not contact anyone nearby with your motion or with long pieces of tubing.
- All glass tubing, including stir rods, should be fire polished before use. Unpolished tubing can cut skin as well as inhibit insertion into stoppers. After polishing or bending glass, give ample time for it to cool before grasping it.
- When drilling a stopper:
 - Use only a sharp borer one size smaller than that which will just slip over the tube to be inserted. For rubber stoppers, lubricate with water or glycerol. Holes should be bored by slicing through the stopper, twisting with moderate forward pressure, grasping the stopper only with the fingers, and keeping the hand away from the back of the stopper.
 - Keep the index finger of the drilling hand against the barrel of the borer and close to the stopper to stop the borer when it breaks through. Preferably,

drill only part way through and then finish by drilling from the opposite side.

- Discard a stopper if a hole is irregular or does not fit the inserted tube snugly, if it is cracked, or if it leaks.
-
- Corks should have been previously softened by rolling and kneading. Rubber or cork stoppers should fit into a joint so that one-third to one-half of the stopper is inserted.
- When available, glassware with ground joints is preferable. Glass stoppers and joints should be clean, dry and lightly lubricated.

16.14.3 Insertion of Glass Tubes or Rods into Stoppers

The following practices will help prevent accidents:

- Make sure the diameter of the tube or rod is compatible with the diameter of the hose or stopper.
- If not already fire polished, fire polish the end of the glass to be inserted; let it cool.
- Lubricate the glass. Water may be sufficient, but glycerol is a better lubricant.
- Wear heavy gloves or wrap layers of cloth around the glass and protect the other hand by holding the hose or stopper with a layered cloth pad.
- Hold the glass not more than 5 cm from the end to be inserted.
- Insert the glass with a slight twisting motion, avoiding too much pressure and torque.
- When helpful, use a cork borer as a sleeve for insertion of glass tubes.
- If appropriate, substitute a piece of metal tubing for glass tubing.
- Remove stuck tubes by slitting the hose or stopper with a sharp knife.

16.14.4 Assembling Apparatus

Following these recommendations will help make apparatus assembly easier and equipment safer:

- Keep your work space free of clutter.
- Set up clean, dry apparatus, firmly clamped and well back from the edge of the lab bench making adequate space between your apparatus and others work. Choose sizes that can properly accommodate the operation to be performed. As a rule, leave about 20% free space around your work.
- Use only equipment that is free from flaws such as cracks, chips, frayed wire, and obvious defects. Glassware can be examined in polarized light for strains. Even the smallest crack or chip can render glassware unusable. Cracked or chipped glassware should be repaired or discarded.
- A properly placed pan under a reaction vessel or container will act as secondary containment to confine spilled liquids in the event of glass breakage.
- When working with flammable gases or liquids, do not allow burners or other ignition sources in the vicinity. Use appropriate traps, condensers, or scrubbers to minimize release of material to the environment. If a hot plate is used, ensure the temperatures of all exposed surfaces are less than the autoignition temperature of the chemicals likely to be released and that the temperature control device and the

- stirring / ventilation motor (if present) do not spark.
- Whenever possible, use controlled electrical heaters or steam in place of gas burners.
 - Addition and separatory funnels should be properly supported and oriented so that the stopcock will not be loosened by gravity. A retainer ring should be used on the stopcock plug. Glass stopcocks should be freshly lubricated. Teflon stopcocks should not be lubricated.
 - Condensers should be properly supported with securely positioned clamps and the attached water hoses secured with wire or clamps.
 - Stirrer motors and vessels should be secured to maintain proper alignment. Magnetic stirring is preferable. Only non-sparking motors should be used in chemical laboratories. Air motors may be an option.
 - Apparatus attached to a ring stand should be positioned so that the center of gravity of the system is over the base and not to one side. There should be adequate provision for removing burners or baths quickly. Standards bearing heavy loads should be firmly attached to the bench top. Equipment racks should be securely anchored at the top and bottom.
 - Apparatus, equipment, or chemical bottles should not be placed on the floor. If necessary, keep these items under tables and out of aisleways to prevent creating a tripping hazard.
 - Never heat a closed container. Provide a vent as part of the apparatus for chemicals that are to be heated. Prior to heating a liquid, place boiling stones in unstirred vessels (except test tubes). If a burner is used, distribute the heat with a ceramic-centered wire gauze. Use the thermometer with its bulb in the boiling liquid if there is the possibility of a dangerous exothermic decomposition as in some distillations. This will provide a warning and may allow time to remove the heat and apply external cooling. The setup should allow for fast removal of heat
 - Whenever hazardous gases or fumes are likely to be evolved, an appropriate gas trap should be used and the operation confined to a fume hood.
 - Fume hoods are recommended for all operations in which toxic or flammable vapors are evolved as is the case with many distillations. Most vapors have a density greater than air and will settle on a bench top or floor where they may diffuse to a distant burner or ignition source. These vapors will roll out over astonishingly long distances and, if flammable, an ignition can cause a flash back to the source of vapors. Once diluted with significant amounts of air, vapors move in air essentially as air itself.
 - Use a hood when working with a system under reduced pressure (which may implode). Close the sash to provide a shield. If a hood is not available, use a standing shield. Shields that can be knocked over must be stabilized with weights or fasteners. Standing shields are preferably secured near the top. Proper eye and face protection must be worn even when using safety shields or fume hoods.

16.14.5 Mercury Containing Equipment

Elemental Mercury (Hg) or liquid Mercury is commonly seen in thermometers, barometers, diffusion pumps, sphygmomanometers, thermostats, high intensity microscope bulbs, fluorescent bulbs, UV lamps, batteries, Coulter Counter, boilers,

ovens, welding machines, etc.

Most of these items can be substituted with equipment without Mercury, thus greatly decreasing the hazard potential. Larger laboratory equipment may be more difficult to identify as “Mercury containing” due to the fact that mercury can be hidden inside inner components such as switches or gauges.

The concerns surrounding mercury containing equipment are:

- It is difficult to identify exposures or cross-contamination due to Mercury leaks or spills.
- The amount of Mercury used is usually much greater than the Department of Environmental Conservation (DEC) reportable quantities for releases to the environment.
- People may be unaware of the Mercury and thus may not be properly trained for use, maintenance, spills, transport or disposal or may not use the appropriate engineering controls or Personal Protective Equipment (PPE).
- There is legal liability if human health and the environment are not properly protected

To minimize the potential for Mercury spills and possible exposures, laboratory personnel is strongly encouraged to follow these recommendations:

- Identify and label “Mercury Containing Equipment”.
- Write a Standard Operating Procedure (SOP).
- Train personnel on proper use, maintenance, transport and disposal.
- Conduct periodic inspections of equipment to ensure no leaks or spills have occurred.
- Consider replacing Mercury with electronic or other replacement components.
- Have available proper PPE such as nitrile gloves.
- Use secondary containment, such as trays as a precaution for spills.
- Plan for emergency such as a spill or release of mercury.
- Decontaminate and remove Mercury before long-term storage, transport or disposal.
- For new equipment purchases, please attempt to procure instruments with no or little Mercury

16.15 Ergonomics

Many lab tasks such as looking through microscopes, working in exhaust hoods, pipetting, and continuously looking down for bench tasks require both significant repetitive movements and sustained awkward posturing. Often there is no leg room when sitting at counters or hoods, which causes more leaning and reaching. Although the essential job tasks probably cannot change, you can develop important personal strategies that can improve comfort and health. There may also be equipment changes you can make.

The section below outlines some steps you can take to reduce your risk for injury from this demanding work. Links to product ideas and additional related information are provided. Product links do not imply endorsement.

Seating

- Take the time to adjust the seat depth and chair back height and tilt in order to maximize individual back support. Consider a slightly reclined position to promote better support.
- Try using chairs “backward”, supporting the torso when leaning forward to do bench/hood/microscope work, as a means for changing positions throughout the day.
- Make sure the feet reach the floor, foot ring or separate footrest comfortably. The stabilization of both feet makes it easier to sit back in a supported manner. Some lab chairs have adjustable foot rings—consider this feature when buying new chairs. For lower surfaces use office-style footrests. Step.n.Up or NeXtep are adjustable rests that attach to the cylinder of lab stools. Another style of freestanding rest with extended height adjustment is by Safco or similar
- Seat height—be sure lab chairs have adequate height adjustment. Extended cylinder heights (32 inch) may provide additional adjustment that will help employees comfortably reach/perform work at counter height.
- Pull your torso close to the work surface and then sit back. This technique will help avoid ‘perching’ on the edge of the chair.
- Select benches where there is leg room under the surface.

Extended Standing

Standing all day for bench work, particularly on concrete/tile flooring, is difficult. The body requires time to recover from these demands, even within a given shift.

Recommendations to minimize risks from extended standing include:

- Microbreaks--allow time (as little as 30 seconds - 1 minute every 20 minute) and a chair/stool so spinal structures and joints can recover from extended standing.
- Consider anti-fatigue matting in areas where practical.
- Proper footwear is important and using a foam/gel insole can also reduce fatigue. Remember, they need to be replaced before they appear worn out.
- Provide a footrest so you can elevate one foot, then the other. This will reduce static fatigue. If safe/appropriate, try opening cabinets to create a footrest.

Microscope Station

- Be cognizant of neutral postures while working. Adjust the chair or microscope as needed to maintain an upright head position. Elevate, tilt or move the microscope closer to the edge of the counter to avoid bending your neck.
- Avoid leaning on the hard edges on the table - consider padding the front lip of microscope table (AliEdge or similar) or using forearm pads. A simple, versatile solution is a variety of foam pads, like Wedge-Ease. Be sure these supports do not cause awkward wrist postures when focusing/adjusting the stage.
- Keep scopes repaired and clean.
- Spread microscope work throughout the day and between several people, if possible.
- Observe seating adjustment and support techniques.

Additional resources can be found at Nikon Microscopy U.

16.16 Pipetting

Below are some general guidelines to reduce the physical impact of pipetting.

- Sit or stand close to your work at bench. If safe/appropriate, try opening cabinets to create legroom.
- Work at appropriate heights to minimize twisting of the neck and torso. Elevate your chair rather than reaching up to pipette.
- Alternate or use both hands to pipette.
- Select a lightweight pipette sized for your hand. Hold the pipette with a relaxed grip and use minimal pressure while pipetting.
- Avoid standing or sitting for long periods. Alternating between sitting and standing provides relief and recovery time for fatigued body structures.

Hood Work

- Observe seating recommendations to promote supported postures.
- Position work supplies as close as possible in order to avoid awkward leaning/reaching while working. Consider turntables to rotate materials closer to the user. Be sure that only essential materials are in the hood to avoid unnecessary reaching around clutter
- Consider lower-profile sample holders, solution container, waste receptacles to prevent awkward bending of wrist, neck and shoulders. Reduced repetitive movement also means increased efficiency.

Other Tips

- Gloves— Wear slightly snug gloves to reduce forces on hands and improve accuracy during fine manipulation. Wearing loose gloves during pipetting and other tasks makes manipulating small materials more forceful and difficult.
- Rotate tasks throughout the work day and among several people, whenever possible. Take frequent small rest breaks (1-2 minute in duration) every 20 minutes. Every 45-60 minutes, get up to stretch and move.

Take vision breaks during intensive computer and fine visual work. Every 20 minutes, close the eyes or focus on something in the distance.

CHEMICAL HYGEINE PLAN

The Occupational Safety and Health Administration (OSHA) regulation 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" mandates the development of a Chemical Hygiene Plan which is capable of protecting employees from health hazards associated with hazardous chemicals in the laboratory and capable of keeping exposures below OSHA Permissible Exposure Limits.

The New Mexico Tech University Chemical Hygiene Plan is developed and coordinated by New Mexico Tech Safety. This Chemical Hygiene Plan is designed to supplement department and laboratory specific safety manuals and procedures that already address chemical safety in laboratories.

As per the OSHA Laboratory Standard, the following are elements of the Chemical Hygiene Plan:

1) Standard Operating Procedures

There are over three thousand research laboratories at New Mexico Tech University and most of these use hazardous chemicals. Many departments have developed comprehensive safety and health manuals. These manuals address specific safety rules, regulations and standard operating procedures for laboratory workers in the department or college.

New Mexico Tech will assist laboratories in developing general and specific standard operating procedures for chemical use in laboratories. Due to the large variety of research and the number of laboratories involved, it will be the responsibility of each laboratory, department or college to ensure that their practices and procedures are adequate to protect their workers who use hazardous chemicals.

It will be up to the Principal Investigator or department head to ensure that written safety procedures are developed for work in their labs and that controls and protective equipment are adequate to prevent overexposure. In many cases, standard operating procedures for laboratory safety have been developed and implemented for years and few changes will be necessary to comply with the OSHA Lab Standard. Existing standard

operating procedures may need to be reevaluated to ensure that they address the health and safety requirements for the chemicals in use.

2) Control Measures

The exposure to hazardous chemicals in the laboratory shall be controlled through the use of engineering controls, personal protective equipment, good general laboratory practices, and standard operating procedures specific to an individual laboratory or department.

- Engineering controls: There are a variety of engineering controls that can be used in the laboratory to control exposures to hazardous chemicals. Some of the engineering controls that will be used in laboratories at New Mexico Tech may include dilution ventilation, local exhaust ventilation (fume hoods), and proper storage facilities.
- Personal protective equipment: Personal protective equipment (PPE) will be available to laboratory workers for use to reduce exposures to hazardous chemicals in the laboratory. Common PPE such as goggles, gloves, face shields, and aprons are recommended for use with hazardous chemicals. Other PPE such as respirators will be available and recommended for use if necessary. New Mexico Tech will assist in the proper selection, use, and care of PPE. PPE will be readily available and most equipment is provided at no cost to the employee.
- General laboratory practices: New Mexico Tech provides laboratories with information about general laboratory work practices and rules that are recognized as effective control measures to minimize exposure to hazardous chemicals in the laboratory. The information is referenced from Prudent Practices in the Laboratory, Safety in Academic Chemistry Laboratories, and other references. These general procedures include guidelines on use of chemicals, accidents and spills, personal protection, use of fume hoods and other good laboratory practice information.
- Specific laboratory practices: Individual departments or laboratories must develop additional written safety procedures whenever necessary to protect laboratory workers from specific chemical hazards that are unique to their particular area of research. Particular attention should be given to control measures for operations that involve the use of particularly hazardous substances such as select carcinogens, reproductive toxins, or acutely toxic chemicals. New Mexico Tech can assist researchers in developing safety procedures for specific hazards.
- Other: Other control methods that will be used to determine and reduce employee exposures to hazardous chemicals in the laboratory may include exposure monitoring, testing eyewash and emergency shower facilities, developing emergency procedures, proper container selection, and substitution of less toxic chemicals whenever possible.

3) Fume Hoods and Other Protective Equipment

Fume hoods and emergency eyewash and showers are inspected annually by New Mexico Tech and Facilities. New Mexico Tech will coordinate the inspection and repairs with the Facilities and Campus Services shops to ensure a timely and accurate repair process.

The proper functioning and maintenance of other protective equipment used in the lab is the responsibility of a variety of service groups. Maintenance Management, Facilities Engineering, New Mexico Tech Safety, and other groups provide and service equipment such as fire extinguishers, eyewash/shower facilities, spill response equipment and mechanical ventilation. Periodic inspections and maintenance by these groups ensure proper functioning and adequate performance of the equipment.

4) Information and Training

Federal and state laws and New Mexico Tech University policy require all laboratory workers to receive Laboratory Safety and Chemical Waste Disposal training and be informed of the potential health and safety risks that may be present in their workplace. Documentation must be maintained to demonstrate that such training was provided and received. In order to assist laboratory personnel comply with this requirement, laboratory safety training must be obtained either through New Mexico Tech(classroom or web-based sessions) or documented as having been received from an alternative source. Laboratory personnel who attend New Mexico Tech training classes will have documentation entered and maintained for them in a training database. Laboratory personnel who have not attended the New Mexico Tech Laboratory Safety Training program must submit documentation of training received from alternative sources for verification by New Mexico Tech Safety

It is the responsibility of Principal Investigators and laboratory supervisors to ensure personnel working in laboratories under their supervision have been provided with proper training, have received information about the hazards in the laboratory they may encounter, and have been informed about ways the employees can protect themselves.

New Mexico Tech University will provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area. New Mexico Tech regularly provides a variety of training programs for laboratory workers such as Laboratory Safety, EPA – Chemical Waste Disposal, Radiation Safety, Biological Safety, Spill Response, and other training programs, including providing laboratory workers with information on how to obtain additional safety information.

Individual laboratories maintain notebooks or electronic access to Material Safety Data Sheets (SDSs) for chemicals used in the lab. Employees are encouraged to consult the SDSs before working with new chemicals, or to call or write to New Mexico Tech for additional information. New Mexico Tech also maintains a webpage with links to a variety of internal and external websites for SDS and other chemical safety related information.

New Mexico Tech will provide information to laboratories, including the Chemical Hygiene Plan, the Laboratory Safety Manual, SDSs, OSHA Permissible Exposure Limits, and specific topical information from employee requests. New Mexico Tech personnel are available on a daily basis to answer questions and provide information to employees about chemical safety in laboratories.

Other sources of information and training may come from informal group or individual discussions with a supervisor, posted notices, fliers, web documents, and other written materials. Properly labeled containers, such as those using Right-To-Know labels, will give immediate warning information to workers about specific chemical hazards. Many departments have safety committees and safety manuals that provide information on laboratory safety. Employees are encouraged to contact their Department Safety Representative and New Mexico Tech for more information about safety in laboratories.

5) Prior Approval for High Hazard Work

New Mexico Tech can assist in identifying circumstances when there should be prior approval before implementation of a particular laboratory operation. Due to the large variety of research being conducted in laboratories at the University, it is impossible to apply one prior approval process that can apply to all laboratories. Instead, high hazard types of activities should be identified by the Principal Investigator or person responsible for the work, and any type of approval process should be addressed in the laboratory's or department's standard operating procedures.

New Mexico Tech will assist in providing information to researchers about work with select carcinogens, reproductive toxins, and acute toxins. General guidelines and recommendations for the safe handling, use and control of high hazard materials can be provided through SDSs, and reference sources such as Prudent Practices in the Laboratory, Safety in Academic Chemistry Laboratories, and other resources.

6) Medical Consultations and Medical Examinations

Medical consultations and medical examinations will be made available to laboratory workers who work with hazardous chemicals as required. All work related medical examinations and consultations will be performed by or under the direct supervision of a licensed physician and will be provided at no cost to the employee through the Gannett Health Center.

The opportunity to receive medical attention, including any follow up examinations, will be provided to employees who work with hazardous chemicals under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
- Where airborne exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements. Action level means the airborne concentration of a specific chemical, identified by OSHA, and calculated as an 8-hour time weighted average (TWA).
- Whenever an event such as a spill, leak, explosion or other occurrence takes place and results in the likelihood of a hazardous exposure. Upon such an event, the affected employee shall be provided an opportunity for a medical consultation. The consultation shall be for the purpose of determining the need for a medical examination.

All records of medical consultations, examinations, tests, or written opinions shall be maintained at Gannett Health Center in accordance with 29 CFR 1910.1020 - Access to employee exposure and medical records. The NMT health Center is located at 801 Leroy Place, Fidel Center. For more information, contact New Mexico Tech at 575-835-5842.

7) Personnel Responsible for the Chemical Hygiene Plan

New Mexico Tech will provide technical information and program support to assist laboratories comply with the OSHA Laboratory Standard. New Mexico Tech will maintain the campus Chemical Hygiene Plan (CHP) and the institutional Chemical Hygiene Officer responsibilities will reside within New Mexico Tech Safety. However, it will be the responsibility of the Principal Investigator or individual supervisor, department or college to be in compliance with the components of the CHP.

Each college, center, department, or laboratory may adopt or modify this CHP or write their own chemical hygiene plan as long as the requirements of the OSHA Laboratory Standard are met. It is assumed if a college, center, department, or laboratory has not developed their own chemical hygiene plan, then that unit or laboratory has adopted the New Mexico Tech University Chemical Hygiene Plan.

8) Provisions for Additional Employee Protection for Work with Particularly Hazardous Substances

The Chemical Hygiene Plan includes provisions for additional employee protection for work with particularly hazardous substances. Research involving the use of particularly hazardous substances, such as select carcinogens, reproductive toxins or acute toxins may require prior review to ensure adequate controls are in place which will protect the worker. New Mexico Tech will assist with the review and make recommendations for additional employee protection.

Additional employee protection may require the use of additional provisions such as:

- Establishment of a designated area.
- Use of containment devices such as fume hoods or glove boxes.
- Procedures for safe removal of contaminated waste.
- Decontamination procedures.

The provision for additional controls may require the expertise and recommendations of various groups including New Mexico Tech Safety, Facilities Engineering, technical committees and outside consulting companies. These groups have all been previously involved with review and implementation of controls for high hazard research. All additional provisions for work with particularly hazardous substances must be incorporated into the lab's standard operation procedures for those materials.

- It is the responsibility of Principal Investigators and laboratory supervisors to ensure that personnel working in laboratories under their control are familiar with the contents and location of the Chemical Hygiene Plan, including any lab specific standard operating procedures and any department or college level laboratory safety manuals, policies, and procedures. (Section 1.1)
- It is the responsibility of the Principal Investigator and individual supervisors (and

individuals working under their supervision) to be in compliance with the components of the University Chemical Hygiene Plan, the University Health and Safety Policy, and any other department or University specific policies. (Section 1.2)

- It is the responsibility of laboratory personnel to immediately report malfunctioning protective equipment, such as fume hoods, or mechanical problems to their Building Coordinator as soon as any malfunctions are discovered. (Section 2.1)
- Principal Investigators, laboratory supervisors, departments and colleges are free to set policies that establish minimum PPE requirements for personnel working in and entering their laboratories. Be sure to check with your DSR to see if there are any department or college specific requirements for PPE. (Section 3.1)
- It is the responsibility of the Principal Investigator or laboratory supervisor to ensure laboratory staff have received the appropriate training on the selection and use of proper PPE, that proper PPE is available and in good condition, and laboratory personnel use proper PPE when working in laboratories under their supervision. (Section 3.2)
- New Mexico Tech strongly encourages Principal Investigators and laboratory supervisors to make use of eye protection a mandatory requirement for all laboratory personnel, including visitors, working in or entering laboratories under their control. (Section 3.3)
- New Mexico Tech strongly recommends that Principal Investigators and laboratory supervisors discourage the wearing of shorts and skirts in laboratories using hazardous materials (chemical, biological, and radiological) by laboratory personnel, including visitors, working in or entering laboratories under their supervision. (Section 3.5)
- New Mexico Tech strongly encourages Principal Investigators and laboratory supervisors to require the use of closed toed shoes for all laboratory personnel, including visitors, working in or entering laboratories and laboratory support areas under their supervision. (Section 3.8)
- It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that personnel working in laboratories under their supervision are informed and follow laboratory specific, departmental, and campus wide policies and procedures related to laboratory safety – such as the guidelines and requirements covered in this Laboratory Safety Manual. (Section 4.0)
- It is the responsibility of the Principal Investigator and laboratory supervisor to ensure written SOPs incorporating health and safety considerations are developed for work involving the use of hazardous chemicals in laboratories under their supervision and that PPE and engineering controls are adequate to prevent overexposure. In addition, Principal Investigators and laboratory supervisors must ensure that personnel working in laboratories under their supervision have been trained on those SOPs. (Section 4.1)
- It is the responsibility of Principal Investigators and laboratory supervisors to ensure laboratories under their supervision are maintained in a clean and orderly manner and personnel working in the lab practice good housekeeping. (Section 4.4)

- It is the responsibility of Principal Investigators and laboratory supervisors to ensure procedures for working alone are developed and followed by personnel working in laboratories under their supervision. (Section 4.7)
- It is the responsibility of Principal Investigators and laboratory supervisors to ensure procedures for unattended operations are developed and followed by personnel working in laboratories under their supervision. (Section 4.9)
- It is the responsibility of the Department Chairperson, Principal Investigators, and laboratory supervisors to restrict access of visitors and children to areas under their supervision when potential health and physical hazards exist. (Section 4.10.1)
- It is the responsibility of the Principal Investigator and individual supervisors to ensure research areas under their supervision have been registered using the online HASP program. (Section 4.19)
- It is the responsibility of laboratory personnel to activate (flush) emergency showers and eyewash units on a regular basis. (Section 5.5.1)
- It is the responsibility of the Principal Investigator and laboratory supervisor to ensure all injuries are reported to University officials through the use of the New Mexico Tech University injury/illness reporting system. (Section 5.6)
- It is the responsibility of Principal Investigators and laboratory supervisors to ensure personnel working in laboratories under their supervision have been provided with the proper training, have received information about the hazards in the laboratory they may encounter, and have been informed about ways they can protect themselves. (Section 6.0)
- It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students under their supervision are provided with adequate training and information specific to the hazards found within their laboratories. (Section 7.2.1)
- It is the responsibility of Principal Investigators and laboratory supervisors to ensure that staff and students working in laboratories under their supervision have obtained required health and safety training and have access to SDSs (and other sources of information) for all hazardous chemicals used in laboratories under their supervision. (Section 7.3)
- While New Mexico Tech can provide assistance in identifying circumstances when there should be prior approval before implementation of a particular laboratory operation, the ultimate responsibility of establishing prior approval procedures lies with the Principal Investigator or laboratory supervisor. (Section 9.5)
- It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that personnel working in laboratories under their supervision are familiar with and follow hazardous chemical waste container requirements and have attended New Mexico Tech Chemical Waste Disposal training. (Section 10.1)
- It is the responsibility of the Principal Investigator or laboratory supervisor to ensure any employee working under their supervision who ships or prepares shipments of hazardous materials have received the proper training. (Section 11.0)

- The responsibility for ensuring that all work with pesticides at New Mexico Tech is conducted properly and legally rests on the individual user. (Section 12.0)
- When using pesticides in a non-dispersive manner in a laboratory setting, an individual must follow the safety rules outlined in the New Mexico Tech University Laboratory Safety Manual. (Section 12.1.1)
- It is the responsibility of the Principal Investigator or laboratory supervisor to ensure biological safety cabinets within laboratories under their supervision are certified annually. (Section 13.5.1)
- It is the responsibility of the Principal Investigator or laboratory supervisor with class 3b or 4 LASERs in laboratories under their supervision to ensure the class 3b or 4 LASERs have been registered with New Mexico Tech and employees using these LASERs have received the appropriate training. (Section 15.0)
- It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students in laboratories under their supervision are provided with adequate training and information specific to the physical hazards found within their laboratories. (Section 16.0)