Environmental Health & Safety

Oklahoma State University

Laboratory Safety Manual

January 2016

Contents

1. Approvals and Revisions

<table>
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<tr><td>DATE:</td><td colspan="3">______________________
Original Approval Date</td></tr>
<tr><td rowspan="2">The OSU Laboratory Safety Manual is the capstone document for laboratory implementation and use by departments. It is compliant with OSHA regulations and ANSI recommendations.</td><td>REV.NO:</td><td>1</td><td>DATE:</td><td></td></tr>
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APPROVAL:

Director of EHS, Oklahoma State University

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Dr. Tolga Durak — Date

Chief Public Safety Officer, Oklahoma State University

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Mr. Michael W. Robinson — Date

Contact/Author	Correction Date	Comments

2. Preface

Oklahoma State University (OSU) is committed to maintaining the safest possible teaching and research laboratories. We encourage faculty and researchers to take all reasonable precautions to protect the health and safety of everyone—staff, students, visitors and the general public. In other words, we want to keep you and those around you safe.

Laboratory operations can be dangerous whether you are working with hazardous materials, handling laboratory equipment, or just performing common laboratory procedures. Every day there are safety incidents in university teaching and research laboratories across the U.S. Although many accidents are minor, there are also serious cases, including fatalities. Our goal is to reduce the number of incidents and injuries at OSU.

This Laboratory Safety Manual (LSM) has been prepared specifically for the OSU Stillwater Campus by Environmental Health and Safety (EHS), and meets Occupational Safety and Health Administration (OSHA) requirements (Occupational Safety and Health Administration, 2011c). This manual promotes safe and practical laboratory procedures, as well as establishes common operational procedures for EHS support roles. We have included information concerning the use of personal protective equipment (PPE), the use and storage of chemicals, hazard communication and the proper methods of waste disposal. This manual also covers emergency procedures and incident response should something go wrong.

It is important to recognize that this manual does not cover all the risks and hazards in every laboratory. There are a wide variety of hazardous materials handled in laboratories across OSU facilities and campuses. Faculty and researchers know the most about the unique hazards in their laboratory. It is expected that the other OSU campuses and departments will append any supplementary safety information to this manual to reflect their specialized requirements.

This OSU Laboratory Safety Manual was derived from Laboratory Safety Manuals and Chemical Hygiene Plans of the University of Texas (Austin), University of Alabama, Massachusetts Institute of Technology, and the previous version of Oklahoma State University Laboratory Safety Manual.

3. General Program Requirements

3.1 Roles and Responsibilities

3.1.1 Deans and Associate Deans

The Deans and Associate Deans are responsible for ensuring that departments are aware of their responsibilities under the Laboratory Safety Manual.

3.1.2 Department Head, Supervisor, or other Administrative Officer in the Department

The department head, supervisor, or other administrative officer of the department is responsible for developing the Department Laboratory Safety Manual (DLSM) that addresses department-specific chemical hygiene and common operations. Each department is responsible for implementing a laboratory safety program, which includes documentation and training. Departments are also responsible for monitoring procurement, use, and storage of laboratory chemicals.

3.1.3 Principal Investigator and/or Laboratory Supervisor

The Principal Investigator (PI) or Laboratory Supervisor has the overall responsibility for laboratory safety that includes the responsibility to:

- Develop and implement Standard Operating Procedures (SOPs) for specific laboratory procedures.
- Ensure that workers and/or students know and follow the laboratory safety guidelines.
- Ensure that protective apparel and equipment are available and appropriate for the potential exposure.
- Ensure that appropriate training has been provided and documented.
- Conduct regular internal laboratory safety inspections.
- Ensure that facilities and training are adequate for the use of any material that is present in the laboratory.
- Report incidents and near misses in accordance with procedures outlined in this manual.
- Implement and enforce the use of safety procedures.
- Ensure the availability of the chemical inventory list and Safety Data Sheets (SDS).
- Consult with Environmental Health and Safety (EHS) for safety matters as they pertain to specific laboratory and research. In particular, EHS should be aware of operations with extremely hazardous chemicals.
- Submit all necessary and appropriate documents to EHS.

3.1.4 Laboratory Employees and Personnel

Laboratory employees and personnel have the responsibility to:

- Plan and conduct each operation in accordance with the LSM, DLSM, and any other applicable safety guidelines.
- Comply with all aspects of the laboratory safety program.
- Participate in training programs concerning the requirements of the laboratory safety program and other applicable environmental, safety and health regulations.
- Request information or training when unsure how to work with a hazardous chemical.
- Follow all health and safety procedures.

- Wear or use prescribed personal protective equipment.
- Report all hazardous conditions to the supervisor.
- Report any job-related incidents, injuries, or illnesses to the supervisor immediately.
- Provide the initial response for any laboratory incidents.

3.1.5 The Office of Environmental Health and Safety

EHS has the responsibility to:

- Work with administrators, faculty and laboratory personnel to develop and implement appropriate chemical hygiene and laboratory safety policies and practices.
- Provide disposal routing and monitoring of laboratory chemical waste.
- Ensure that individual departments complete and maintain adequate documentation.
- Perform annual inspection to ensure compliance with the LSM.
- Assist with training programs as needed or requested.
- Assist departments, administrators, laboratory personnel, students and the campus community regarding laboratory and chemical safety.
- Provide industrial hygiene monitoring and services as needed.
- Serve as the university subject-matter-experts concerning laboratory safety.
- Respond to chemical-related laboratory incidents.

3.1.6 Laboratory Safety Committee (LabSC)

The Laboratory Safety Committee (LabSC) is charged with providing consultation to EHS regarding the impact of safety and environmental regulations on academic and/or research activities. Deans of colleges that have laboratories will select one- to- three committee members. These committee members will provide information to their colleagues and serve as representatives of their respective departments/colleges in discussions regarding new and changing regulations. They will assist EHS by sharing information that can be used to formulate university responses to specific issues. The LabSC consists of subject-matter-experts who provide guidance and assistance in assessing extremely hazardous materials or operations. The experts will review lab incidents and may make recommendations for changes to policies or procedures.

3.2 Training

3.2.1 General Training Requirements

Departments are responsible for ensuring that all employees working in laboratories have the following minimal training:

- Laboratory Safety
- Hazardous Waste
- Hazard Communications
- Personal Protective Equipment in Laboratory
- Specific training such as Radiation, Laser, Bloodborne Pathogens, or Nanomaterials

Departments may institute or request EHS to provide additional training programs deemed necessary.

3.2.2 PIs/Laboratory Managers

PIs/laboratory managers are responsible for ensuring that their employees have the following laboratory specific training:

- Operation of relevant SOPs
- Laboratory specific hazards
- Locations of laboratory safety equipment
- Location of the chemical inventory list and SDS
- Emergency and evacuation procedures
- Laboratory specific waste disposal

3.2.3 EHS

EHS will provide the following training that is available to all OSU employees:

- General training requirement courses (Section 3.2.1)
- training (as necessary) for campus-wide safety systems/procedures
- training as requested by departments

3.2.4 Documentation

Proof of employee training is required to ensure regulatory compliance. Unless other arrangements are made, departments are responsible for recording and retaining results/certifications of individuals' laboratory training. EHS will provide training completion documentation to the departments for training given by EHS personnel.

3.3 Visitors/Minors in Lab

Access to university laboratories, workshops, and other areas housing hazardous chemicals, physical agents, and/or machinery is limited to trained and authorized OSU employees. Prior to entry, it is the responsibility of the host to contact department or facility-responsible individuals. The host must ensure that those entering any of these areas are adequately protected from hazards and are informed about the relevant safety and emergency procedures.

Minors (children under the age of 18) are not permitted in hazardous work areas with the exception of university or department-sanctioned tours and visits as defined by university policies. In these instances, the tour leader or other knowledgeable personnel must exercise careful supervision. Minors are never authorized to use radioactive materials and/or x-rays. Radiation Safety Officer (RSO) should be consulted before tours of such laboratories by minors. This policy does not apply to minors who are enrolled OSU students.

Exceptions to the foregoing must be approved by appropriate college and university officials, and must be documented by written agreements such as a Memorandum of Agreement or a Sponsored Research Agreement that is signed by an authorized university official. Exceptions include cooperative use of university facilities and equipment by university and corporate researchers, or use of university facilities and equipment by visiting scholars.

If visitors will be performing laboratory work or working within a laboratory space, they must receive required laboratory safety and departmental training prior to starting.

3.4 Working Alone Policy

Work with chemicals/physical hazards that might prove immediately dangerous to an individual's life and health <u>should not</u> be conducted alone. We recommend that all laboratory work be conducted with a partner or co-worker in close proximity. We request that all employees utilize the buddy system and schedule overlapping work hours.

EHS suggests that two properly trained employees are present for any of the below hazardous operations:

- Chemicals with Permissible Exposure Limit (PEL) below 10 mg/m^3 and/or Short Term Exposure Limit (STEL) of 5 mg/m^3, or dermal exposure of 10 mg. Check with EHS before handling these chemicals as safety air monitoring may also be required.
- Chemicals with autoignition point below 50 °C
- Explosives or shock sensitive compounds

3.5 Basic Rules

3.5.1 General Laboratory Safety Rules

Basic safety rules for laboratory conduct should be observed whenever working in a laboratory. Many of common safety rules are listed below.

- Know locations of laboratory safety showers, eyewash stations, and portable fire extinguishers. The safety equipment may be located in the hallway near the laboratory entrance.
- Know emergency exit routes.
- Avoid skin and eye contact with all chemicals.
- Minimize all chemical exposures.
- No horseplay will be tolerated.
- Assume that all chemicals of unknown toxicity are highly toxic.
- Post warning signs when unusual hazards, hazardous materials, hazardous equipment, or other special conditions are present.
- Avoid distracting or startling persons working in the laboratory.
- Use equipment only for its designated purpose.
- Combine reagents in their appropriate order, such as adding acid to water.
- Avoid adding solids to hot liquids.
- All laboratory personnel should place emphasis on safety and chemical hygiene at all times.
- Never leave containers of chemicals open.
- All containers must have appropriate labels. Unlabeled chemicals should never be used.
- Do not taste or intentionally sniff chemicals.
- Never consume and/or store food or beverages or apply cosmetics in areas where hazardous chemicals are used or stored.
- Do not use mouth suction for pipetting or starting a siphon.
- Wash exposed areas of the skin prior to leaving the laboratory.
- Long hair and loose clothing must be pulled back and secured from entanglement or potential capture.
- No contact lenses should be worn around hazardous chemicals—even when wearing safety glasses.

- Laboratory safety glasses or goggles should be worn in any area where chemicals are used or stored. They should also be worn any time there is a chance of splashes or particulates to enter the eye.
- Closed toe shoes will be worn at all times in the laboratory. Perforated shoes or sandals are not appropriate.
- Determine the potential hazards and appropriate safety precautions before beginning any work.
- Develop procedures that minimize the formation and dispersion of aerosols.
- If an unknown chemical is produced in the laboratory, consider the material hazardous.
- Do not pour chemicals down drains. Do NOT utilize the sewer for chemical waste disposal.
- Keep all sink traps (including cup sink traps and floor drains) filled with water by running water down the drain at least once a month.
- Do not utilize fume hoods for evaporations and disposal of volatile solvents.
- Perform work with hazardous chemicals in a properly working fume hood to reduce potential exposures.
- Avoid working alone in a building. Do not work alone in a laboratory if the procedures being conducted are hazardous.
- Observe the PEL and the Threshold Limit Values (TLV) in all areas. If exposure above a PEL/TLV is suspected for an ongoing process, please contact EHS immediately.
- Laboratory employees should have access to a chemical inventory list, applicable SDSs, Department Laboratory Safety Manual, and relevant SOPs.
- Access to laboratories and support areas such as stockrooms, specialized laboratories, etc. should be limited to approved personnel only.
- All equipment should be regularly inspected for wear or deterioration.
- Equipment should be maintained according to the manufacturer's requirements and records of certification, maintenance, or repairs should be maintained for the life of the equipment.
- Designated and well-marked waste storage locations are necessary.
- No cell phone or ear phone usage in the active portion of the laboratories, or during experimental operations.
- Clothing made of synthetic fibers should not be worn while working with flammable liquids or when a fire hazard is present as these materials tend to melt and stick to exposed skin.
- Laboratory coats should not be stored in offices or break rooms as this spreads contaminates to other areas.
- Computers and instrumentation should be labeled to indicate whether gloves should be worn or not. Inconsistent glove use around keyboards/keypads is a source of potential contamination.
- Avoid wearing jewelry in the lab as this can pose multiple safety hazards.

3.5.2 Laboratory Specific Safety Rules

Safety rules for laboratory specific operations will be provided in appropriate laboratory SOPs.

3.6 Emergency Response

General first aid training can be provided by Oklahoma State University EHS. Laboratory specific response training will be provided by departments and PI/laboratory manager.

Emergency Phone Numbers

- Campus Police—911 using landline phones to reach OSU police.
- Poison Control – 800-222-1222

Students (not an employee) General Procedures

- An evacuation diagram showing evacuation routes must be posted.
- All students must be trained on the evacuation procedure, and this training must be documented.
- Immediate evacuation is necessary upon activation of the fire alarm, notification by authorized personnel, or an immediate threat to life and health.
- If evacuation is necessary, stop all work.
- Extinguish all experiment-related flames and heat sources.
- Proceed to the nearest exit.
- Do not use elevators.
- If conditions permit, supervisors should check to determine if the area is vacated.
- Do not re-enter until instructed by authorized personnel.

Laboratory Employee General Procedures

- Know your department's Emergency Action Plan.
- Be aware of the locations of all laboratory safety equipment and evacuation routes.
- Understand the procedures as outlined in the laboratory's SOP.
- Understand the hazards and emergency response associated with laboratory procedures and/or chemicals used.
- Ensure your personal safety first.
- Ensure safety of others.
- Mitigate immediate danger if it can be done safely.
- Notify proper authorities.
- Provide initial response according to the type of incident and personal threat.
- Evacuate area until response personnel arrive, and provide response personnel with incident-related information.

Documentation

All chemical spills or potential exposures will be reported on the Employee Exposure Form (Appendix 3, Form 1) to the department and EHS regardless of size. If injury occurs, the incident is also documented on the Employee Injury Form (Appendix 3, Form 2). Both forms can be found at http://ehs.okstate.edu/forms/index.htm.

3.7 Contact Information

For emergency or general laboratory safety questions/concerns, please contact the below persons. Please notify Campus Dispatch for all emergencies, anytime day or night.

Police	**OSU/Campus Dispatch**	**Land line 911**
Police	**Stillwater**	**Cell Phone 911**
Air Quality	Kim Southworth	405-744-3017
Biological Safety	Mindy James	405-744-3203
Chemical Safety	Brad Rowland	405-744-7309
EHS	Operator	405-744-7241
Hazardous Waste	David Piper	405-744-3031
Laser Safety	Brandi Simmons	405-744-3474
Occupational Health and Safety	Kim Southworth	405-744-3017
Radiation Safety	Jim Tucker	405-744-7890

4. Laboratory Design and Safety Features

4.1 Ventilation

4.1.1 General Laboratory Ventilation

Proper laboratory ventilation will meet both air quality and laboratory safety standards. Laboratories with imbalanced flows may compromise workers' protection from hazardous substances. Therefore, any significant changes to air flow in a laboratory must be evaluated and approved (by an appropriate professional) before implementation. General considerations for laboratory ventilation and air quality are listed below.

- General ventilation of each laboratory room should have at least six room air changes per hour.
- General ventilation provides a source of air for breathing and makeup air for local ventilation devices; it must not be relied upon for protection from toxic substances released into the laboratory.
- General airflow should not be turbulent and should be relatively uniform throughout the laboratory.
- Quality and quantity of general ventilation should be evaluated when equipment is installed, whenever a change in the local or general ventilation is made, whenever significant structural modifications are made in the laboratory, and annually.
- Ventilation system alterations will only be made if testing and analysis indicate that employee protection from toxic contaminants will continue to be adequate.
- Each hood should have a device that continuously monitors hood performance. Do not disable alarms. Know what each means, act on what it indicates, and report the discrepancy for corrective maintenance.
- Exhaust air from glove boxes and isolation chambers will be passed through scrubbers, filtration or adsorption media prior to release.
- The general ventilation system will be designed to avoid the intake of contaminated air.
- Do not start a laboratory procedure if you suspect the ventilation system cannot handle the chemical emissions.
- Apparatuses such as vacuum pumps, distillation columns, chromatographs, etc., which may discharge toxic amounts of hazardous chemicals, will be vented into a local exhaust, snorkel exhaust or hood system.
- Glove boxes and gloves will be inspected prior to each use.
- Negative pressure glove boxes must have a ventilation rate of at least two volume changes per hour.
- EHS should be contacted immediately anytime the ventilation systems are not operating properly.

4.1.2 Fume Hood

The primary purpose of a laboratory hood is to keep toxic or irritating vapors and fumes out of the general laboratory working area. A secondary purpose is to serve as a shield between the employee and equipment being used when there is the possibility of an explosive reaction. Fume hood performance requirements are listed below (American Industrial Hygiene Association, 2012).

- Hood ventilation systems are designed to have average airflows of no less than 80 ft/min (linear) and no more than 120 ft/min (linear) across the face of the hood. Flow rates of higher than 125 ft/min can cause turbulence problems and are not recommended. A mark will be placed on the hood so the sash can be drawn to a point to indicate 100 linear ft/min.
- Avoid creation of cross drafts (100 ft/min) caused by open doors and windows, air conditioning and/or heating vents, or personnel movement. Drafts will pull contaminants from the hood and into the laboratory.
- 100 ft/min is generally not perceptible (100 ft/min is approximately 3 mph, a normal walking pace). Air conditioning, heating vents, and personnel traffic all create airflows in excess of 200 ft/min, often much higher. Therefore, laboratory activity in the hood area should be minimized while the hood is in use.
- Laboratory personnel should neither adjust nor remove baffles. If ventilation problems develop, contact Facility Management (4-7154) immediately.
- When not in use, the sash of the hood should be kept closed. While performing work in the hood, the sliding sash should be kept at the height designated to provide the minimum face velocity required (usually 100 ft/min). This will ensure proper velocity of airflow into the hood and out of the laboratory.
- Work should be performed as deeply within the fume hood as possible. Equipment, reagents, and glassware should be placed as far back in the hood as is practical without blocking the rear baffle. Solid objects placed at the face of the hood cause turbulence in the airflow. Therefore, each hood should have a clearly marked "safety zone" (6” inside hood sash) in which no work should be conducted or equipment placed.
- ONLY ITEMS NECESSARY TO PERFORM THE PRESENT EXPERIMENT SHOULD BE IN THE HOOD. The more equipment placed in the hood, the greater the air turbulence produced, and the chance for gaseous escape increases.
- When instrumentation is utilized for a process inside a hood, all instruments should be elevated a minimum of two inches from the hood base to facilitate proper air movement.
- The purpose and function of a hood is NOT to store chemicals or unused items. Fume hoods are not a storage cabinet.
- Hoods will not be used as a means of disposing toxic or irritating chemicals. If vaporization of large quantities of such materials is a necessary part of the operation, a means of collecting the vapor by distillation or scrubbing should be considered. The collected liquid can then be disposed of as a liquid waste.
- Some hoods are constructed of stainless steel. These are usually "perchloric acid hoods" or "radioisotope hoods." Never use perchloric acid in a hood that is not designed for that use. Perchloric acid hoods have a wash-down feature that should be used after each use of the hood and at least every two weeks when the hood is not in use. Date of wash-down should be recorded by the laboratory.
- Always ensure the fan motor power switch is in the "on" position before initiating experiment. Note: Most hoods do not have individual "on/off" switches and remain "on" continuously.
- Do not use infectious material in a chemical fume hood.
- Exhaust fans should be spark-proof if exhausting flammable vapors and corrosive resistant if handling corrosive vapors.
- Controls for all services (i.e., vacuum, gas, electric, water) should be located at the front of the hood and should be operable when the hood door is closed.

- Radioactive materials may not be used in the hoods without prior approval of the RSO.
- An emergency plan should be prepared in the event of ventilation failure or other unexpected occurrence such as fire or explosion in the hood.
- ALWAYS ENSURE THE HOOD IS OPERATIONAL BEFORE INITIATING AN EXPERIMENT

4.1.3 Biological Safety Cabinets

Biological safety cabinets are among the most effective, as well as the most commonly used, primary containment devices in laboratories working with infectious agents. Biological safety cabinets (Class I and II) provide an effective engineering control for safe manipulation of microorganisms. Please contact the Biological Safety Officer (BSO) for additional information concerning biological safety.

- Class I and II biological safety cabinets must be tested and certified as installed any time the cabinet is moved, and at least annually thereafter. Contact the BSO regarding testing and certification of biological cabinets.
- Personnel must be trained in the proper use of the biological safety cabinets.
- Eliminate, reduce, or contain any generated aerosol particles.
- Avoid any repeated insertion and withdrawal of workers' arms in-and-out of the work chamber.
- Avoid opening and closing doors to the laboratory or isolation cubicle.
- Avoid improper placement or operation of materials or equipment within the work chamber.
- Avoid brisk walking past the cabinet while it is in use.
- Always decontaminate the hood using procedures adopted by the laboratory after each use or at the end of the workday.
- BIOLOGICAL SAFETY CABINETS ARE NOT CHEMICAL FUME HOODS AND WILL NOT BE USED AS SUCH.

4.1.4 Radioactive Materials in Hoods

Fume hoods, laminar flow hoods, and biosafety cabinets used for procedures involving radioisotopes must be approved and properly labeled by the Radiation Safety Office. Annual certifications must be maintained and not allowed to expire. For radioisotopes that are volatile, special filter requirements may apply. Contact the Radiation Safety Office at radsafe@okstate.edu for additional information.

4.1.5 LASER Ventilation Requirements

Special ventilation requirements may apply to certain laser systems, depending on the type(s) of air contaminants that may be produced during operation. While most commercial laser systems will provide the ventilation requirements in the accompanying users' manual, laser systems constructed by OSU faculty, staff, and students may require an assessment for special ventilation considerations. Contact the Laser Safety Office at lasersafety@okstate.edu for guidance or additional information.

4.2 Fire & Life Safety

Flammable and combustible materials are ubiquitous in laboratories. Many laboratories store and use highly flammable organic solvents. Simple precautions and preparation can significantly reduce the risk of a laboratory fire.

- Portable fire extinguisher should be located within a 10-second-travel distance; this is generally accepted to be no more than 75 feet.
- If an extinguisher has been discharged, notify EHS.
- Dry sand and/or other applicable materials should be present for pyrophoric metals in case of fire.
- Before using an open flame, make sure there are no flammable vapors in the area.
- Gas burner tubing should be examined periodically for wear.
- All laboratory employees must know the location of and use fire safety equipment.
- When transferring flammable liquids from one metal container to another, containers will be bonded and grounded. Many solvents are also toxic, and should be transferred in the hood.

4.3 Emergency Safety Equipment

All laboratory employees will have access to emergency eyewash and safety shower equipment (Occupational Safety and Health Administration, 2011a), a fire alarm, portable fire extinguishers, and a telephone for use in an emergency. Employees should be familiar with the facility and emergency procedures in the laboratory. All employees are expected to know where the fire alarm pull stations, safety showers, eyewashes, spill clean-up kits, portable fire extinguishers, and emergency exits are located.

- Approved eyewash stations will be available in-or-near each laboratory that utilizes hazardous chemicals or materials.
- Safety shower and eyewash stations should be located within a 10 second-travel distance—this is generally accepted to be no more than 75 feet with only one obstruction, such as a door.
- The only exception is in the event that the overall hazard to the laboratory would be increased by the presence of a shower unit coupled with existing instrumentation (e.g. electrical shock hazard due to the presence of instrumentation). In this case, a shower in an adjacent area will be designated for use by the occupants of the affected laboratory.
- Portable fire extinguishers must be available, charged, and hung in locations that are immediately accessible (generally in a hallway). If discharged, contact EHS to get the extinguisher serviced and returned.
    - EHS inspects university-issued fire extinguishers monthly and provides upkeep. The PIs are responsible for inspection and upkeep for any additional portable fire extinguishers purchased.
- EHS will annually inspect laboratory safety equipment, such as hoods, showers, eyewashes, and drench hoses. Departments are encouraged to test eyewash stations, drench hoses and safety showers weekly.

4.4 Signage

Proper signage at a laboratory entrance provides important information about the hazards located inside, as well as required PPE. Properly posted signage provides valuable information for responders and visitors, and reminds employees of the hazards they encounter upon entering a laboratory. Standardized guidance (below) provides easy identification of hazards and locations of safety equipment.

- All signs will be conspicuously posted in each area where hazardous chemicals are used or stored. These signs must be written in English.
- Current laboratory emergency POC information must be posted, which includes POC(s) name and a 24-hour contact number.
- Signage at laboratory entrances should represent the current laboratory hazards. Signage (Figure 4.4.1) should include Global Harmonized System (GHS) hazard pictograms (≥2 inch), emergency contact information, required PPE (≥2 inch), and National Fire Protection Association (NFPA) 704 diamond (≥ 4 inch). Signage should be placed on the wall near the door and not on the laboratory door.

Figure 4.4.1 GHS (a), PPE (b), and NFPA Diamond (c) Signage

- Laboratory safety equipment must be easy to locate. Locations of the portable fire extinguisher, eyewash station, and safety shower should have signs that are ≥ 6 inches for both height and width (Figure 4.4.2).

Figure 4.4.2 Example of Eyewash Stations and Safety Shower Signage

- Laboratories or work areas with non-chemical hazards such as a magnetic field, radioactivity, biological hazards, heat, cryogenic, molten metals, high electrical energy, etc. will have the appropriate warning signs posted at each entrance.
- Chemical and hazardous waste storage locations inside the laboratory will be clearly marked with lettering at least 1 inch in height.

5. General Lab Practices

5.1 Housekeeping

The following list of good housekeeping practices provides common sense activities that prevent incidents:

- Work areas will be kept clean and free of obstructions. Avoid clutter, excessive storage, and excessive combustible materials (e.g. empty boxes).
- Laboratory employees will be responsible for maintaining the cleanliness of their work areas.
- Reagents and equipment should be returned to their proper place after use. Contaminated or dirty glassware should be placed in specific cleaning areas and not allowed to accumulate.
- Counter tops should be kept neat and clean. Bench tops and fume hoods will not be used for chemical storage. All work done in fume hoods will be performed in the "Safety Zone" (6" minimum from the sash).
- Stored items, equipment, and glass tubing will not extend beyond the front of a shelf or counter limits.
- Access to exits, emergency equipment, utility controls and other safety equipment must never be blocked, such that a 3 foot clearance for access must be maintained.
- Materials stored near aisles will be restrained to prevent their falling.
- Mats and carpeting will be kept in good condition.
- All working surfaces and floors should be cleaned regularly.
- All containers must be labeled with the identity of the contents and with associated hazards.
- Waste will be stored in appropriate receptacles. All employees must be instructed about the different kinds of waste generated and appropriate methods for disposal.
- Sharps such as needles, scalpels, broken glass will be placed in approved sharps containers prior to disposal.
- Hallways and stairways must not be used as storage areas.
- Chemicals, especially liquids, should never be stored on the floor – unless secondary containment is provided. Large bottles (2.5L or larger) or heavy items (greater than 25 lbs) should never be stored above the bench top.
- Reagents, solutions, glassware or other materials will not be permanently stored in hoods.

5.2 Personal Protective Equipment (PPE)

Personal protective equipment including laboratory coats, eye protection, gloves, respirators, etc. (appropriate for the hazards present) will be worn during laboratory operations. The PI/Laboratory Supervisor may need to perform a Job Hazard Analysis (JHA) (Appendix 3, Form 3 and Appendix 4) for the proper PPE selection. The PI/Laboratory Supervisor is also responsible for subsequent proper PPE usage and maintenance:

- All personnel will be informed of PPE requirements and trained in the proper use.
- All PPE will be regularly checked for integrity and maintained in clean and functional order.
- PPE will be readily available for use at all times in a location known to laboratory employees.

- OSU EHS suggests using flame resistant lab coats and clothing when using flammable, pyrophoric or other reactive hazardous chemicals.
- If possible, respirator use should be avoided. Engineering controls (fume hoods, etc.) should be utilized to minimize exposure. If OSHA PELs are being exceeded, then respirators will be required. Respirator use will be consistent with the Oklahoma State University's Respiratory Protection Program. Before using respirators, contact EHS about the respiratory protection program.
- Eye protection will be worn at all times by employees and students in laboratories:
    - Where hazardous chemicals are used or stored.
    - Where a significant potential for eye injury exists.

5.3 Safety Data Sheet

The SDS is a key document for laboratory safety. SDS provides the necessary information for evaluating risk and hazards, which includes health risk, exposure limits, and required PPE.(Occupational Safety and Health Administration, 2011b)

- MSDS may be used until June 1, 2016.
- SDSs must be available for each chemical stored or used.
- SDSs will be made available (paper or electronic) to any employee or student who must work with or in the immediate vicinity of chemicals. If using an electronic version the following criteria must be met:
    - A back-up system must be in place in case of an emergency.
    - The process is integrated into the overall hazard communication plan.
    - Employees have hard-copy access, if requested.
- Prior to use, employees and students will receive an explanation covering the information on the SDS for each chemical or process.
- Manufacturers' specific SDS is the preferred version. For generic SDS information, multiple internet sites are excellent resources for SDSs.
- If you have questions or concerns regarding SDSs or PPE, please contact EHS.

5.4 Glassware

Glassware is commonly used in a wide variety of laboratories, and pose both a contamination and a sharps hazards. The risk of potential injury can be reduced by following the listed guidance below.

- Broken uncontaminated glass should be disposed of in a puncture resistant container labeled "sharps" or "broken glass."
- Each laboratory will have a specified container for broken glass.
- To dispose of broken glass containers, please label the container, seal and carry to the dumpster. Glassware exposed to acutely hazardous chemicals (Environmental Protection Agency, 2012) must either be properly cleaned before disposal or disposed as hazardous waste.
- Tubing should be fire-polished (or rounded) and lubricated prior to insertion into rubber stoppers.
- Only glassware designed for vacuum work will be used for that purpose.
- Glass vacuum Dewars will be wrapped with the appropriate materials.

- Appropriate hand protection should be used when picking up broken glass.
- Glassware with small chips should be discarded in the broken glass container.
- Conventional laboratory glassware must never be pressurized.
- Glassware should be inspected prior to use for chips or "stars." Damaged glassware should be discarded or repaired prior to use.
- Use only Borosilicate glassware (e.g. Pyrex, Chemglass) when experiments call for elevated or cryogenic temperatures.

5.5 Unattended Experiments

If a laboratory employee starts a potentially dangerous process and must leave it unattended for a long period, then the following safety procedures should be used:

- Any necessary arrangements must be finalized prior to experimentation. Someone should check the experiment periodically. If the procedure involves continuous utilities such as water, power, etc., the employee must confirm that no outages are scheduled during the time of the experiment.
- No open flames should be left unattended. Over-temperature cutoff devices should be used on heated oil baths that run unattended.
- Post a notice on or near the experiment. The notice should clearly communicate the emergency shutoff procedures, nature of the hazards, and contact information.
- Place an appropriate warning sign on the door that lists the nature of the experiment in progress, and includes the name and phone number of the person responsible for the experiment.
- Provide items appropriate for the containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation.
- Whenever possible, use automatic shutoff devices for long-term or unattended operations. Please be mindful of potential situations such as the loss of cooling water and overheating.

5.6 Spill Policy

General guidance for laboratory spills is listed below.

- The employee should attempt to clean up or contain a spill, <u>assuming it can be done safely</u>. Otherwise, spills of a potentially hazardous nature should be immediately reported to Campus Dispatch (911 on the landline) or EHS.
- Chemical spills of 4 L or more may require additional cleanup materials, protective equipment and/or special handling that could make it unsafe for cleanup by laboratory employees. Employees should contact EHS personnel to evaluate how to proceed with spill cleanup.
- EHS personnel will determine the need for any further action, such as ventilation of the area, summoning the fire department, or evacuation.
- Please call EHS regarding all mercury spills.
- If the spill is potentially life threatening, evacuate the laboratory immediately.
- Each laboratory will maintain a spill containment kit.
- The chemical spill kit should be available and contain supplies relevant for the specific hazards and quantities in the laboratory.

- For labs with biological agents, a basic biological spill kit should include disinfectant, absorbent material, waste containers, PPE, and mechanical tools. Please contact BSO for additional information.
- If a lab has the potential for a radioactive material spill, then a radiation decontaminant should be available. Please contact RSO for additional information.
- Spill area should be closed immediately and signs posted at each entrance to the area.
- Employees involved in cleaning a hazardous materials spill must utilize appropriate protective equipment and supplies.
- Waste generated from a spill cleanup will be handled as hazardous waste that follows procedures outlined in Section 6.6.
- The PI/Laboratory Supervisor is required to complete the Employee Exposure Form.

5.7 Laboratory Decommissioning

Decommissioning will return a laboratory to a move-in ready state for the next occupant, and should occur for laboratories that are being closed or moved. General guidance for laboratory decommissioning is listed below. However, departments are encouraged to have their own specific policies. In addition, failure to identify all waste streams for disposal may incur direct cost to the department.

- The PI will coordinate the removal of laboratory equipment and supplies. Facility Management should be notified of any needed repairs.
- Chemicals will be separated into surplus and disposal. Surplus chemicals are any in-date chemical that could be reused within a department or university. Disposal chemicals will be routed through EHS Material Management using procedures outlined in Section 6.6.
- PIs are responsible to identify unknown chemicals before disposal. Disposal of unknown chemicals may result in direct cost to the department.
- Online chemical inventory lists will be updated for transferred and disposed chemicals. If a PI is leaving OSU, please contact EHS to remove the PI from the online inventory list.
- Disposal of all hazardous waste will be routed through EHS Material Management following procedures outlined in Section 6.6. Avoid disposing of unknown chemicals, which may incur direct cost to the department. Please contact EHS regarding any waste-related questions.
- The decommissioned laboratory will be decontaminated (if required) and cleaned.
- Removal of engineering controls that affect laboratory ventilation (e.g. fume hoods) must be coordinated with Facility Management to ensure proper room ventilation.
- For laboratories that use biological agents or radioactive substances, please coordinate decommissioning with the BSO and RSO.

6. Chemical Managements

6.1 Chemical Procurement and Storage

6.1.1 Procurement of Chemicals

Safe handling, use, and disposal of hazardous substances begin with the person requesting the chemical. The requestor should first determine if surplus supplies exist before ordering. Otherwise, the requestor must know the flowing information concerning the requested chemicals:

- Potential hazards
- Adequacy of facilities and trained employee
- Safe disposal

Before a new substance is received, information concerning its proper handling methods (including proper disposal procedures) will be given to all those who will be working with it. It is the responsibility of the PI/Laboratory Supervisor to ensure that the facilities are adequate and that employees have received proper training and education to work safely.

No container or cylinder should be accepted that does not have an identifying label. Every effort should be made to ensure that this label remains on the container and is legible. For chemicals, it is desirable that this label has the following minimum components in accordance with the GHS by June 1, 2016 (United Nations, 2009):.

- Identification of container contents
- Signal word and summary description of any hazard(s)
- Precautionary information—what to do to minimize hazard or prevent an accident from happening
- First aid in case of exposure
- Spill and cleanup procedures
- If appropriate, special instructions to physicians

Every effort should be made to ensure that this label remains on the container and that it is legible.

6.1.2 General Chemical Storage

Storage of chemicals poses a significant challenge because of the inherent chemical properties (flammability, toxicity, corrosion, etc.) and incompatibilities (Section 6.5) between chemicals that can result in fire, explosion, and release of flammable or toxic gases. The guidance below will reduce the risks for incident and injury. However, segregation of chemicals for storage can be complex, due to numerous chemical incompatibilities. Please consult the SDS or contact EHS regarding any chemical storage concerns or questions.

- Every chemical in the laboratory should have a specific storage location, and to which it is returned to after each use.
- Storage must conform to compatibility restrictions. Typically, solvents, acids, bases, reactives, oxidizers, and toxins will be stored separately. Ideally, separate cabinets or isolated areas within a central storage area should be utilized to store incompatibles.
- Chemical storage areas should be labeled using signage at least 1-inch in height (Figure 6.1.2). Visitors or responders should be able to easily find chemical storage locations.

Figure 6.1.2. Examples for Marking Chemical Storage Areas

- Adequate containment for spills and releases will be available.
- Hazardous chemicals should never be stored on the floor. Containers should be kept on low shelves or in cabinets. The shelves should have a lip on the forward edge to prevent bottles from slipping off. Shelving units should be securely fastened to the wall or floors, and not be overloaded.
- Utilize compatible/suitable containers for experiments, storage, and collected wastes. See the SDS for specific compatibility information.
- Containers storing chemical waste must be inspected weekly for any sign of chemical leakage. Containers of all types should be free of rust and deformation.
- Caps and covers for containers will be secured whenever the container is not in immediate use.
- NFPA signage will be posted on laboratory doors/entrance. (National Fire Protection Association, 2012)
- All containers used for storage (even short term) will be labeled in accordance with applicable codes, standards, and good business practices (American National Standards Institute, 2010), NFPA (National Fire Protection Association, 2012) and/or Hazardous Material Identification System (HMIS) labels (Safety Emporium, 2012). At a minimum, all containers must be labeled with regard to content and general hazard. (Section 6.4)
- Unless in manufacturer container, flammable liquids in quantities greater than 1 L should be kept in metal safety cans designed for such storage. The cans should be used only as recommended by the manufacturer, including the following safety practices:
    - Never disable the spring-loaded closure.
    - Always keep flame-arrestor screen in place; replace if punctured or damaged.
- Flammable liquids will not be stored in amounts greater than the limits for flammable liquid storage given in Table 6.1.2.

Table 6.1.2 Maximum Quantity within 100 ft²

Class	Without Flammable Cabinet	With Flammable Cabinet
I	7.5 L (2 gal)	15 L (4 gal)
I,II, and III	15 L (4 gal)	30 L (8 gal)

I = Flash point < 38 C
II = Flash point between 39 - 60 C
III = Flash point > 68 C

NOTE. Values above are general and subject to change depending on laboratory construction and location. For additional information, call EHS.

- Metal drums used for storage and dispensing of flammable chemicals will be properly grounded or bonded. Ground cables will be available and utilized in any laboratory using metal storage containers for flammable liquid storage.
- Chemicals should be stored as close as feasible to the point of use in order to maximize efficiency and minimize transport distance. Chemical storage should be limited only to areas in which particular chemicals are used.

- Small quantities of chemicals can be held at individual workstations. Workbench quantities must be promptly used and not exceed lower explosion limits (LEL) vapor concentration. Containers must be properly labeled.
- Only limited quantities of chemicals and solvents should be stored in the laboratory. When possible, large drums or multiple bottles of chemicals should be stored in a centralized chemical storage area.
- Out-of-date chemicals will be disposed of on a periodic basis to reduce overall hazard potential and minimize inventory tracking and updating.
- It is always suggested to utilize secondary containment (spill tray) during chemical storage or transfer to minimize damage due to an uncontrolled release of liquid.
- When storing compressed gases:
    - Always clearly mark empty cylinders and store them separately.
    - Only compatible gases should be stored together in a gas cylinder cabinet.
    - Do not store compressed gas cylinders in areas where the temperature can exceed 125° F.

6.2 General Handling and Transporting Chemicals

Many laboratory incidents occur through the simple operation of carrying chemicals from one place to another or transferring from one container to another. The chemicals used in laboratories are often corrosive, toxic, or flammable. Any incident has the potential for personal injury.

- Incompatible chemicals should not be transported on the same cart.
- Individuals transporting chemicals must ensure that containers are properly labeled, and know what to do in the event of a release or spill.
- Wear appropriate PPE. Minimum PPE includes safety glasses, closed toed shoes, and other appropriate laboratory attire. Hazardous chemicals must be attended at all times while being transported.
- If possible, freight-only elevators should be used to avoid exposure to other passengers on the elevators. If freight elevators are not available, use unoccupied passenger elevators.
- Special padded or rubber bottle carriers, pails, or carts should be used to prevent breakage by accidental striking against walls or floor, and to contain the material if breakage does occur.
- Materials that are unstable, shock sensitive, or explosive should not be moved. Please contact EHS for assistance.
- Large quantities of concentrated mineral acids (e.g., sulfuric, nitric and hydrochloric acids) will be kept in storage rooms or cabinets for corrosive substances. Bottles of concentrated acids must be carried from the aforementioned areas in an approved acid bottle carrier.
- Organic solvents will be carried from storage areas in special bottle carriers.
- When large bottles of acids, solvents, or other liquids are transported within the laboratory, only one bottle should be carried at a time. Never carry or attempt to pick up a bottle by the cap. Using a bottle carrier is the safest method for transporting chemicals within a laboratory.
- When transporting bottles within the laboratory facility, a wheeled cart may be used. Carts should be stable under load and have wheels large enough to negotiate uneven surfaces (such as expansion joints and floor drain depressions) without tipping or stopping suddenly. Bottles should not be placed near the edge of the cart, nor should they be

touching each other or other glassware during transport. Be cautious rolling the cart over doorsills or other possible obstructions.
- When transporting chemicals using a cart outside on sidewalks and other paved surfaces, two people are required to prevent cart tipping over uneven terrain and changes in elevation.
- When transporting compressed gases:
    - To transport a cylinder, put on the safety cap and strap the cylinder to a hand truck in an upright position. Never roll a cylinder.
    - Be careful while handling compressed gas cylinders and never drop or strike a cylinder against anything.

6.3 Chemical Inventory

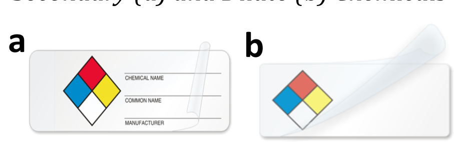
Chemical inventory will be tracked using the OSU Chemical Safety Assistant online program (http://ehs.okstate.edu/hazcom/OnSite.htm). Departments will reconcile the inventory information annually. During the year, it is the responsibility of PIs and/or departments to keep the inventory data current, such as significant/permanent changes in inventory volumes or additions of new hazardous materials.

6.4 Chemical Labeling

Labeling of chemical containers is fundamental to effective hazard communication. The manufacturer provides compliant labeling for each chemical they sell. However, OSU labeling standards are needed for labeling secondary containers and expiration sensitive chemicals such as peroxide formers. OSU labeling standards are listed below.

- Manufacturers' chemical labeling will remain intact and not defaced.
- All chemicals must be prominently and accurately labeled as to content. The full chemical name must be in legible English. Formulas and abbreviations are not acceptable.
- Unlabeled chemicals must not be stored or used.
- Make sure all labels are legible and intact. Periodically check inventory for labels that may have degraded or fallen off. Labels must be on containers that are designated for chemical pick up.
- Date all peroxidizable and other chemicals that may become unstable over time. They should display the arrival date, date opened, and latest date tested. Expiration dates may be extended based on testing.
- All secondary containers must be labeled with common name, chemical name, and NFPA diamond (Figure 6.4). Dilutions should be labeled with common name, chemical name, concentration, and NFPA diamond (if hazardous).

Figure 6.4. Example Labels for Secondary (a) and Dilute (b) Chemicals



6.5 *Incompatibles*

Many chemicals, when mixed with other materials, can produce violent reactions resulting in heat, pressure, fire, explosion, violent reactions, toxic dusts, mists, fumes, gases, or flammable fumes or vapors. Precautions should be taken not to store incompatible chemicals together.

To avoid unwanted reactions, keep chemicals separated by hazard class whenever possible. EHS recommends the following hazard classes for general separation of chemicals, but other approaches can be used. The SDS can provide further guidance on chemical compatibility. Suggested general hazard classes for storage are listed below.

- Acids
- Bases
- Flammables
- Oxidizers
- Reactives

Laboratories with large numbers of hazard classifications may choose to further segregate mineral/organic acids, unstable compounds, heat sensitive compounds, gases, etc.

If you need assistance with your chemical storage/segregation, please contact EHS.

6.6 *Chemical Disposal*

EHS Material Management is responsible for coordinating the pickup of surplus and waste chemical substances from generating departments. To ensure compliance with regulations, safe handling, and efficiency of operations, Material Management has established the following standards applicable to the collection, storing, labeling, and packaging of these waste substances.

6.6.1 Unaccepted Waste

- Department personnel will not accept any chemical, hazardous substance or item containing hazardous substances as gifts or donations on the behalf of the university without notifying Material Management prior to the transfer.
- Department personnel will not give or sell university property, including hazardous substances, to any person or organization outside the university except through the legally established procedures.
- Under no circumstances is any person to dispose of a hazardous substance down the drain or in the refuse disposal system.
- Material Management cannot accept any unidentified substance(s) for disposal. The generating department will make every effort to identify unknown chemicals and prevent generating unknowns. In instances when unknown chemicals have been generated, the generating department will provide a separate storage area to hold these materials until characterization can be conducted.
- Contact the University Recycling Department before placing anything in the Green Recycle dumpsters that is not listed on the dumpster label.

6.6.2 Basic Procedures

- Collect substances in their original or other suitable primary container. Food containers are unacceptable.
- Ensure that all containers are properly labeled as to contents and hazards. (Section 6.6.4)
- Containers must be properly stored until ready for disposal.
- When accumulation exceeds the available storage limits within the laboratory area, arrange for the transfer of the substances with the PI or lab manager, who will coordinate the pickup with EHS Material Management.
- The generator or Department EHS POC will prepare individual containers by attaching a Hazardous Chemical Surplus tag to any unlabeled container or any container that is not the original container of its contents, and complete the Chemical Removal Request Form (Appendix 3, Form 4).
- The waste containers will be placed together in a specific, marked location. Individual containers, except in prearranged situations, will NOT be boxed together.
- OSU Material Management will pick up surplus substances from the laboratory or collection area upon written request only.

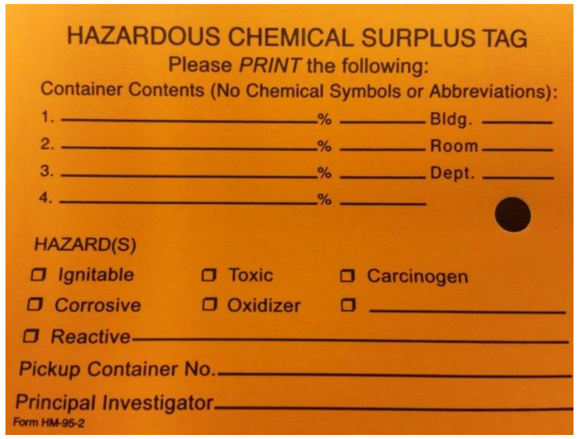
6.6.3 Containers

- Where possible, materials should be kept in their original containers. Food containers are unacceptable.
- Containers will be in good condition; leaking or damaged containers are not acceptable. If leaking or damaged, either repackage or call Material Management to determine the proper packaging for disposal.
- Containers will be equipped with a properly fitting cap or other closure means. Paraffin sealed containers are not allowed.
- Containers will be compatible with substances contained therein.
- Plastic bags (where acceptable) will be without punctures or tears and will be tightly sealed. Double bagging is preferred. Ordinary garbage (2 mil or less) bags will not be used as a primary or secondary container for hazardous chemical waste.
- Containers should be inspected weekly for signs of leaks or deterioration.
- Compressed gas cylinders will not be handled or transported until the regulating device is removed and the safety cap installed.
- Glass containers will not exceed 4 L, and will not be filled into the neck of the fill/pour spout.
- Where containers have flat tops, the liquid level will be at least 1 inch from the fill/pour opening. Glass carboys are unacceptable.
- Due to increased disposal costs, risks of handling larger containers, and restrictions by the University Waste Disposal Contractor, metal or plastic containers greater than 20 L in size require special approval by Material Management.

6.6.4 Labeling

- Waste containers must have accurate labeling. A Hazardous Chemical Surplus Tag (Figure 6.6) must be attached to any unlabeled container or any container whose contents do not match the original manufacturer's label. The label must clearly and neatly list the chemical or common name of each substance that is at least 1% by volume of the total contents or mixture.

Figure 6.6. Hazardous Chemical Surplus Tag for Hazardous Waste


HAZARDOUS CHEMICAL SURPLUS TAG
Please *PRINT* the following:
Container Contents (No Chemical Symbols or Abbreviations):
1. ______ % ______ Bldg. ______
2. ______ % ______ Room ______
3. ______ % ______ Dept. ______
4. ______ % ______

HAZARD(S)
☐ Ignitable ☐ Toxic ☐ Carcinogen
☐ Corrosive ☐ Oxidizer ☐ ______
☐ Reactive ______
Pickup Container No. ______
Principal Investigator ______
Form HM-95-2

- Carcinogens or highly toxic substances (0.1% or more by volume) must also be listed. Any amount of a heavy metal (e.g. As, Ba, Cd, Cr, Hg, Ni, Se, Ag, Th) greater than 1 part per million (1 ppm) in the container must be listed.
- Indicate the strength or concentration of the substance where applicable. Example: hydrochloric acid may have strength of 10%, 28%, or 38%.
- Do not use chemical formulas, chemical symbols, chemical equations, or abbreviations. All labels must be written in English.
- Indicate the physical and/or health hazards of the substance, if known.
- Indicate the name of the building, room, and PI or person responsible for generating the waste (or someone with direct knowledge of the process).
- In the instances of time-sensitive substances such as ethers, the date of container opening or initial accumulation will be included on the form.
- Remove or obliterate any other labels or wordings not related to the current substance.
- Do not allow the creation of "UNKNOWNS" through the lack of secure labeling.

6.6.5 Container Disposal

- Most empty chemical containers can be triple-rinsed and disposed in normal refuse.
- If a container does contain chemicals listed in 40 CFR 261.33(e)(Environmental Protection Agency, 2012), or Tri- Tetra- or Penta-phenol, the container will be considered empty only if the container has been triple-rinsed using a solvent capable of removing the chemical or cleaned by another method to achieve equivalent removal. The rinsate then becomes a hazardous waste. If the container has not been cleaned as stated above, the container will become hazardous waste.
- Once a container has been triple-rinsed, it can be placed in the normal refuse.
- Compressed gas cylinders will be considered empty when the pressure in the container approaches 25 PSI. An existing agreement should be in place for the supplier to accept containers once they are no longer needed.

6.6.6 Storage of Waste

- Waste chemicals will be stored in the same manner and using the same procedures as other chemicals. It may be advantageous to further segregate chemical waste. A typical segregation of waste chemicals would be:

- Acids
- Caustics
- Chlorinated Solvents
- Non -chlorinated Solvents
- Mercury Wastes
- Oxidizing Agents
- PCB Wastes
- Reactive Chemicals
- Used Oil
- Wastes with Heavy Metal Contamination
- Mineral (inorganic) acids, straight-chain fatty acids, and bases (hydroxides) should be neutralized by the laboratory generating these wastes, as long as there are no other hazardous components.

Consult EHS regarding proper storage and disposal requirements not covered in the section.

6.6.7 Bulking and Boxing

Bulking or mixing of waste chemicals will not be done without prior approval from Material Management. In addition, laboratory personnel will not be involved in "boxing up" chemical containers inside overpack or boxes for transport, except when permission has been granted by Material Management.

6.6.8 Other Waste Needs

For all other waste needs such as Satellite Accumulation Areas (SAA), laboratory cleanout or hazard waste surplus, please contact EHS Material Management.

6.7 Inspections

Departments are encouraged to perform weekly inspections of eyewash stations, drench hoses, and safety showers. EHS will perform annual chemical fume hood, eyewash, and safety shower inspections. EHS also performs annual general laboratory safety inspections to encourage laboratory compliance with regulatory requirements, industrial standards, and laboratory best practices.

The EHS annual inspection checklist is presented in Form 5 (Appendix 3), and addresses the following items:

- Signage and Labels
- Personal Protective Equipment
- Laboratory Safety Equipment
- Compressed Gasses
- Chemical and Hazardous Waste Storage
- Electrical Hazards
- Bloodborne Pathogens
- Laboratory Documentation and Training
- Laboratory Conditions
- Pressure and Vacuum Systems

7. Procedures for Common Categories of Hazardous Chemicals

This section offers specific guidelines for working with common hazardous materials that may pose a significant risk to human life and health. Seven fundamental classes of laboratory chemicals will be discussed: flammables, corrosives, reactives, oxidizers, compressed gases, nanomaterials, and cryogenics.

Hazard characteristics of these classes are generalized. Check the SDS to determine the specific hazard characteristics for the chemical before using it. In addition, information contained in this section may be repeated elsewhere in the LSM; it is included here to provide a robust description of listed chemical hazard classes.

7.1 Flammable Liquids

Flammable liquids are among the most common chemicals found in a laboratory. The primary hazard associated with flammable liquids is their ability to readily ignite and burn. The vapor of a flammable liquid, not the liquid itself, can ignite and start a fire.

Use and Storage of Flammables

- Flammable liquids that are not in active use should be stored inside fire resistant flammable storage cabinets.
- Minimize the amount of flammable liquids stored in the laboratory. General storage guidance is outlined in Table 6.1.2.
- Keep flammables away from vacuum pumps and other ignition sources.
- The transfer of material to/from a metal container can result in an accumulation of static charge on the container. When transferring flammable liquids, this static charge could generate a spark, thereby igniting the vapors. To make these transfers safer, flammable liquid dispensing and receiving containers should be bonded together before pouring.
- Large containers, such as drums, must also be grounded when used as dispensing or receiving vessels. All grounding and bonding connections must be metal-to-metal.
- Do not heat flammables with an open flame. Instead, use steam baths, water baths, oil baths, hot air baths, sand baths or heating mantles.
- Prior to lighting a flame, remove all flammable substances from the immediate area.
- Use only non-sparking explosion-proof electrical equipment such as explosion-proof refrigerators for volatile chemicals.
- Do not store flammable chemicals in a standard household refrigerator. There are several ignition sources located inside a standard refrigerator that can cause a fire or explosion. Flammables that need to be refrigerated should be stored in an explosion-proof refrigerator.
- Laboratory desks and furniture should be constructed of fire-retardant materials.

Health Hazards Associated with Flammables

The vapors of many flammables are irritating to mucous membranes of the respiratory system and eyes. Routes of entry with corresponding symptoms are listed below. For specifics, consult the SDS.

- Acute Health Effects
    - Inhalation effects include headache, fatigue, dizziness, drowsiness, narcosis (stupor and unresponsiveness).
    - Ingestion may cause slight gastrointestinal irritation, dizziness, fatigue.
    - Skin Contact causes dry, cracked, and chapped skin.
    - Eye Contact will cause stinging, watering eyes, and inflammation of the eyelids.
- Chronic Health Effects
  The chronic health effects will vary depending on the specific chemical, the duration of the exposure, and the extent of the exposure. However, damage to the lungs, liver, kidneys, heart, and/or central nervous system may occur. Cancer and reproductive effects are also possible.
- Flammable Groups Exhibiting Similar Health Effects
    - Aliphatic hydrocarbons are narcotic, but their systemic toxicity is relatively low.
    - Aromatic hydrocarbons are potent narcotic agents, and overexposure to the vapors can lead to loss of muscular coordination, collapse and unconsciousness. Benzene is toxic to bone marrow and can cause leukemia.
    - Alcohols vapors can be moderately narcotic.
    - Ethers exhibit strong narcotic properties and can be moderately toxic.
    - Esters vapors may result in irritation to the eyes, nose and upper respiratory tract.
    - Ketones systemic toxicity is generally low.

First Aid Procedures for Exposures to Flammable Materials

If a person has inhaled, ingested or come into direct contact with these materials, the person should be removed from the immediate area as quickly as possible. Seek medical attention immediately. If there is direct skin exposure, rinse with a safety shower for at least 15 minutes. If there is direct eye exposure, flush with eyewash for at least 15 minutes.

Personal Protective Equipment (PPE)

Fume hoods should be used when working with flammable liquids. Nitrile and neoprene gloves provide protection against most flammables. However, consult SDS or glove compatibility charts for chemical-specific compatibility. Wear a fire-resistant lab coat to provide a barrier to your skin. Always wear safety goggles/glasses while handling flammable chemicals in a laboratory.

7.2 Oxidizers

Oxidizing chemicals are fire and explosion hazards on contact with flammable and combustible materials. Depending on the class, an oxidizing material may increase the burning rate of combustibles. Such contact can cause the spontaneous ignition of combustibles, or produce an explosive reaction when exposed to heat, shock or friction. Oxidizers are generally corrosive.

Examples of Oxidizers

Peroxides	Chlorates
Nitrates	Chlorites
Nitrites	Hypochlorites
Perchlorates	Dichromates

Use and Storage

- Oxidizers should be stored away from flammables, organic compounds, and combustible materials.
- Strong oxidizing agents like chromic acid should be stored in glass or some other inert container. Corks and rubber stoppers should not be used.
- Reaction vessels containing oxidizing material should be heated in a mantle or sand bath. Oil baths should not be used.

Use and Storage of Perchloric Acid

- Perchloric acid is an oxidizing agent of particular concern. The oxidizing power of perchloric acid increases as the concentration and temperature increase. Cold, 70% perchloric acid is a strong non-oxidizing corrosive. A 72% perchloric acid solution at elevated temperatures is a strong oxidizing agent. An 85% perchloric acid solution is a strong oxidizer at room temperature.
- If you do not have access to a properly functioning perchloric acid fume hood, **do not** attempt to heat perchloric acid. Perchloric acid can only be heated in a hood specially equipped with a wash-down system to remove perchloric acid residue. The hood should be washed down after each use, and (preferably) restricted to perchloric acid use only.
- Whenever possible, substitute a less hazardous chemical for perchloric acid or use a dilute solution.
- Perchloric acid can be stored in a perchloric acid fume hood. Keep only the minimum amount necessary for your work. Another acceptable storage site for perchloric acid is in an acid cabinet that has secondary containment.
- Do not allow perchloric acid to contact any strong dehydrating agents, such as sulfuric acid. The dehydration of perchloric acid is a severe fire and explosion hazard.
- Do not order or use anhydrous perchloric acid. It is unstable at room temperature and can decompose spontaneously with a severe explosion. Anhydrous perchloric acid will explode upon contact with wood.
- Consult with EHS before working with perchloric acid.

Health Hazards Associated with Oxidizers

- Acute Health Effects
  Some oxidizers act as irritant gases. All irritant gases can cause inflammation in the surface layer of tissues when in direct contact. They can also cause irritation of the upper airways, conjunctiva, and throat.
  - Fluorine can severely burn skin and mucus membranes.
  - Chlorine trifluoride is extremely toxic and can cause severe burns to tissue.
  - Nitrogen trioxide is very damaging to tissue, especially the respiratory tract. The symptoms from an exposure to nitrogen trioxide may be delayed for hours, but, fatal pulmonary edema can result.
  - Osmium tetroxide is dangerous due to its high degree of acute toxicity. It is a severe eye and respiratory tract irritant. Inhalation can cause headache, coughing, dizziness, lung damage, difficulty breathing and death. Osmium tetroxide has "poor warning properties" because it is difficult to detect by smell or other means. It is recommended that laboratories using osmium tetroxide have necessary safeguards in place before the container is opened.

- Chronic Health Effects
  Nitrobenzene and chromium compounds can cause hematological and neurological changes. Compounds of chromium and manganese can cause liver and kidney disease. Chromium (VI) compounds have been associated with lung cancer.

First Aid
If a person has inhaled, ingested or come into direct contact with these materials, the person should be removed from the immediate area as quickly as possible. Seek medical attention immediately. If there is direct skin exposure, rinse with a safety shower for at least 15 minutes. If there is direct eye exposure, flush with eyewash for at least 15 minutes.

Personal Protective Equipment
Oxidizers should be used in a chemical fume hood because of the inhalation hazard risk. Neoprene, polyvinyl chloride (PVC), or nitrile gloves are acceptable. Consult a glove compatibility chart or the SDS to ensure that the glove material is appropriate for the particular chemical you are using. Safety glasses must be worn.

7.3 Corrosives (Acid and Bases)

General Characteristics

- Corrosives are most commonly acids and bases.
- Corrosives can damage tissue. Inhalation of the vapor or mist can cause severe bronchial irritation. Corrosives are particularly damaging to the skin and eyes.
- Certain substances considered non-corrosive in their natural dry state are corrosive when they contact moist skin or mucus membranes. Examples include lithium chloride, halogen fluorides, and allyl iodide.
- Sulfuric acid is a very strong dehydrating agent while nitric acid is a strong oxidizing agent. Dehydrating agents can cause severe burns to the eyes due to their affinity for water.
- Examples of Corrosives

Sulfuric Acid	Chromic Acid
Ammonium Hydroxide	Bromine

Use and Storage of Corrosives

- Acids and bases should always be stored separately. Store acids in acid storage cabinets or plastic secondary containment away from flammables, as many acids are also strong oxidizers.
- Do not work with corrosives unless an emergency shower and eyewash are available within 10 seconds travel time.
- Add acid to water, but never add water to acid.
- Do not store liquid acids above eye level. Store on a low shelf or inside a cabinet.
- Store acids in a plastic tray, tub or rubber bucket to contain any leakage
- Purchase corrosives in containers that are plastic or plastic coated.
- Acids should be stored in an acid cabinet or cabinet with corrosion-resistant lining. Acids stored in an ordinary metal cabinet will quickly corrode the interior. If an acid cabinet is not available, store the corrosive in a plastic tub or wooden cabinet. Never store corrosives in a flammable liquid cabinet.
- Nitric acid should always be stored away from other acids and organic materials due to its high reactivity.

Use and Storage of Hydrofluoric Acid

- Laboratories using hydrofluoric acid should have SOPs giving specific procedures for usage and safety.
- Hydrofluoric acid can cause severe burns. Inhalation of anhydrous hydrogen fluoride can be fatal. Initial skin contact with hydrofluoric acid may not produce any symptoms. However, hydrofluoric acid can scavenge calcium from skin and bones, causing severe injuries.
- Always use hydrofluoric acid in a properly functioning fume hood, and wear personal protective clothing.
- If you suspect that you have come in direct contact with hydrofluoric acid, wash the area with water for at least 5 minutes, and then the apply specifically formulated cream. Remove contaminated clothing and seek medical attention. If hydrogen fluoride vapors are inhaled, move the person immediately to an uncontaminated atmosphere (if safe to do so) and seek prompt medical attention.
- Never store hydrofluoric acid in a glass container as it is incompatible with glass. Hydrofluoric acid usually comes in a plastic bottle.
- Store hydrofluoric acid separately in an acid storage cabinet and keep only the amount necessary in the laboratory.
- Creams, such as calcium gluconate, are commercially available and specifically formulated to treat hydrofluoric acid exposure.

Health Hazards Associated with Corrosives

- Acute Health Effects
    - Inhalation causes irritation of mucus membranes; difficulty in breathing; fits of coughing; pulmonary edema ingestion; irritation and burning sensation of lips, mouth, and throat; pain in swallowing; swelling of the throat; painful abdominal cramps; vomiting; shock; and risk of perforation of the stomach.
    - Skin contact results in burning, redness and swelling, painful blisters, profound damage to tissues and (with alkalis) a slippery soapy feeling.
    - Eye contact will cause stinging, watering of eyes, swelling of eyelids, intense pain, ulceration of eyes, loss of eyes or eyesight.
- Chronic Health Effects
  Chronic exposure symptoms vary greatly depending on the chemical. For example, the chronic effect of hydrochloric acid is damage to the teeth. However, the chronic effects of hydrofluoric acid are decreased bone density, fluorosis, and anemia.
- All corrosives possess the property of being severely damaging to living tissues. Acids also react with other materials such as metals.
- Skin contact with alkali metal hydroxides (e.g., sodium hydroxide and potassium hydroxide) is more dangerous than with strong acids. Contact with base metal hydroxides normally causes deeper tissue damage because there is less pain than with an acid exposure. The exposed person may not wash it off thoroughly enough or seek prompt medical attention.
- All hydrogen halides are acids that are serious respiratory irritants and cause severe burns.

First Aid

- For inhalation, remove person from source of contamination if safe to do so, and then seek medical attention.

- For ingestion, remove person from source of contamination. Seek medical attention and inform emergency responders of the chemical swallowed.
- For skin contact, remove person from source of contamination and take immediately to an emergency shower or source of water. Remove clothing, shoes, socks, and jewelry from affected areas as quickly as possible, cutting them off if necessary. Be careful not to get any chemical on your skin or to inhale the vapors. Flush the affected area with water for a minimum of 15 minutes, and then seek medical attention.
- For eye contact, remove person from source of contamination and take immediately to eyewash or other source of water. Rinse the eyes for a minimum of 15 minutes. Have the person look up and down and from side to side. Get medical attention. Do not let the person rub their eyes or keep them tightly shut.

Personal Protective Equipment

Always wear the proper gloves when working with corrosives. Neoprene and nitrile gloves are effective against most acids and bases. Polyvinyl chloride (PVC) is also effective for most acids. A rubber-coated apron and goggles should be worn. If splashing is likely to occur, wear a face shield over the goggles. Always use corrosives in a chemical fume hood.

7.4 Reactives

General Characteristics

- Polymerization Reactions
    - Polymerization is a chemical reaction in which two or more molecules of a substance combine to form repeating structural units of the original molecule. This can result in an extremely high or uncontrolled release of heat. An example of a chemical that can undergo a polymerization reaction is styrene.
- Water Reactive Materials
    - When water reactive materials encounter water, one or more of the following can occur: liberation of heat which may cause ignition of the chemical itself (if flammable) or nearby flammables; release of a flammable, toxic, or strong oxidizing gas; release of metal oxide fumes; and/or formation of corrosive acids.
    - Water reactive chemicals can be particularly hazardous to firefighting personnel responding to a laboratory fire because water is the most commonly used fire-extinguishing medium.
    - Examples of water reactive materials are listed below.

Alkali Metals (Lithium, Sodium, Potassium)	Aluminum
Silanes	Magnesium
Alkylaluminums	Zinc

- Pyrophorics
    - Pyrophoric materials can ignite spontaneously in the presence of air.
    - Examples of pyrophoric materials are listed below.

Tert-butyllithium	Triethylaluminum
Phosphorus	Several organometallic compounds

- Peroxide-Forming Materials
    - Peroxides are very unstable, and peroxide forming chemicals are commonly used in laboratories. This makes peroxide-forming materials some of the most hazardous

substances found in a laboratory. Peroxide-forming materials are chemicals that react with air, moisture, or impurities to form peroxides. The tendency to form peroxides by most of these materials is greatly increased by evaporation or distillation.

  - Organic peroxides are extremely sensitive to shock, sparks, heat, friction, impact, and light. Many peroxides formed from materials used in laboratories are more shock sensitive than TNT. Just the friction from unscrewing a bottle cap can provide enough energy to cause a severe explosion.
  - Examples of peroxide-forming materials are listed below.

Diisopropyl Ether	Divinylacetylene
Sodium Amide	Potassium Amide
Dioxane	Diethyl Ether
Tetrahydrofuran	Vinyl Ethers
Butadiene	Vinylpyridine
Acrylonitrile	Styrene

- Peroxide Testing
  For certain classes of compounds (such as ethers), the date the container was opened should be written on the label. Peroxide formers should have the test history and date of discard written on the label as well.
  - The following tests can detect most (but not all) peroxy compounds, including all hydroperoxides:
    - Add 1 to 3 milliliters (mL) of the test liquid to an equal volume of acetic acid, add a few drops of 5% aqueous potassium iodide solution, and shake. The appearance of a yellow-to-brown color indicates the presence of peroxides. Alternatively, addition of 1 mL of a freshly prepared 10% solution of potassium iodide to 10 mL of an organic liquid in a 25-mL glass cylinder should produce a yellow color if peroxides are present.
    - Add 0.5 mL of the test liquid to 1 mL of 10% aqueous potassium iodide solution and 0.5 mL of dilute hydrochloric acid to which has been added a few drops of starch solution just prior to the test. The appearance of a blue or blue-black color within a minute indicates the presence of peroxides.
    - Peroxide test strips, which turn to an indicative color in the presence of peroxides, are available commercially.
  - None of these tests should be applied to materials (such as metallic potassium) that may be contaminated with inorganic peroxides.
- Other Shock-Sensitive Materials
  These materials are also explosive and sensitive to heat and shock:
  - Chemicals containing nitro-functional groups fulminates
  - Hydrogen Peroxide with concentration greater than 30%
  - Ammonium Perchlorate and Benzoyl Peroxide (when dry)
  - Compounds containing the functional groups: acetylide, azide, diazo, halamine, nitroso, and ozonide

Use and Storage of Reactives

Potential risks are best minimized by reducing the amount of material used in the project. Use only the amount of material necessary to achieve the desired results.

Always substitute a less hazardous chemical for a highly reactive chemical whenever possible. If it is necessary to use a highly reactive chemical, order only the amount that is necessary for the work.

- Water-Reactive Materials
  - Water-reactive chemicals must be stored in an isolated part of the laboratory. An appropriate cabinet location is removed from water sources such as sinks, emergency showers, and chillers. Clearly label the cabinet "Water-Reactive Chemicals – No Water".
- Pyrophorics Material
  - Pyrophorics materials must be stored in an isolated part of the laboratory in a clearly marked cabinet. Be sure to routinely check the integrity of the container and have the material disposed of through EHS if the container is corroded or otherwise damaged.
- Peroxide-Forming Materials
  - Do not open the chemical container if peroxide formation is suspected. The act of opening the container can be sufficient to cause a severe explosion. Visually inspect liquid peroxide-forming materials for crystals or unusual viscosity before opening. Pay special attention to the area around the cap. Peroxides usually form upon evaporation, so they will most likely form on the threads under the cap.
  - Date all peroxide forming materials with the date received. Chemicals such as diisopropyl ether, divinyl acetylene, sodium amide, and vinylidene chloride should be discarded after three months. Chemicals such as dioxane, diethyl ether, and tetrahydrofuran should be submitted to EHS for disposal after one year if opened or expired.
  - Store all peroxide-forming materials away from heat, light, and sources of ignition. Light accelerates the formation of peroxides.
  - Secure the lids and caps on these containers to discourage the evaporation and concentration of these chemicals.
  - Never store peroxide-forming materials in glass containers with screw cap lids or glass stoppers. Friction and grinding must be avoided.
  - If you suspect that peroxides may be present, contact EHS. If you notice crystal formation in the container or around the cap, do not attempt to open or move the container. Call EHS for proper disposal.
  - Never distill ether unless it is known to be free of peroxides.
  - Do not use metal spatulas.
  - Do not use glass containers with glass stoppers.
- Other Shock-Sensitive Materials
  - Store these materials separately from other chemicals and in a clearly labeled cabinet.
  - Never allow picric acid to dry out, as it is extremely explosive. Always store picric acid in a moist environment.

Health Hazards Associated with Reactives

Reactive chemicals are grouped as a category primarily because of the safety hazards associated with their use and storage, and not because of similar acute or chronic health effects. For health hazard information on specific reactive materials, consult the SDS, manufacturer, or EHS. However, there are some hazards common to the use of reactive materials. Injuries can occur due to heat, flames, inhalation of fumes, vapors, reaction products, and flying debris.

First Aid

General first aid principles may be applied when treating injuries cause by reactives. For specific first aid instruction, please consult the specific SDS.

- If someone is seriously injured, the most important step is to contact emergency responders as quickly as possible. Explain the situation and describe the location clearly and accurately.
- If someone is severely bleeding, put on protective gloves and then apply a sterile dressing, clean cloth, or handkerchief to the wound. Next, place the palm of your hand directly over the wound and apply pressure. Keep the person calm, and continue to apply pressure until help arrives.
- If a person's clothes are on fire, he or she should drop immediately to the floor and roll. If a fire blanket is available, put it over the individual. An emergency shower can also be used to douse flames.
- If a person goes into shock, have the individual lie on his or her back (if safe to do so) and raise the feet about one foot above the floor.

Personal Protective Equipment

Wear appropriate personal protective clothing while working with highly reactive materials. This might include impact resistant safety glasses or goggles, face shield, gloves, flame-resistant lab coat, and a blast shield. Conduct work within a chemical fume hood as much as possible, and pull down the sash as far as is practical. When the project does not require you to reach into the fume hood, keep the sash closed.

Barriers protect employee against explosions and should be used. Many safety catalogs offer commercial shields, which are commonly polycarbonate and weighted at the bottom for stability. It may be necessary to secure the shields firmly to the work surface.

7.5 Compressed Gas

General Characteristic

Cylinders of compressed gases can pose a chemical as well as a physical hazard. If the valve were to break off a cylinder, the amount of force present could propel the cylinder through a brick wall. For example, a cylinder of compressed breathing air used by SCUBA divers has the explosive force of 1 ½ pounds of TNT.

Use and Storage of Compressed Gases

- Whenever possible, use flammable and reactive gases in a fume hood or other ventilated enclosure. As noted previously, certain categories of toxic gases must always be stored and used in ventilated enclosures. Note any specific gases that require ventilated storage. Maximum allowable storage limits are given in Table 7.5.
- Storage areas must be located away from sources of ignition or excess heat.
- Cylinder temperature must never exceed 51 degrees C (124°F).
- Cylinders must always be stored in an upright position.
- Cylinders will be chained or strapped in place to prevent falling, even if they are assumed empty.
- Close the main cylinder valve whenever the cylinder is not in use.

- Cylinder caps will be in place at all times when not in use.
- Oxygen should be stored in an area that is at least 20 feet away from any flammable or combustible materials (including gasses) or separated from combustibles by a non-combustible barrier at least 5 feet high and having a fire-resistance rating of at least 1½ hours.
- Always use the appropriate regulator on a cylinder. Do not attempt to adapt or modify a regulator to fit a cylinder for which it was not designed. Regulators are designed to fit only specific cylinder valves to avoid improper use.
- Inspect regulators, pressure relief devices, valves, cylinder connections, and hose lines frequently for damage.
- Do not use a cylinder that cannot be positively identified. Color-coding is not a reliable way of identifying a cylinder because the colors can vary from supplier to supplier.
- Do not use oil or grease on any cylinder component, because a fire or explosion can result.
- Do not transfer gases from one cylinder to another. The gas may be incompatible with the residual gas remaining in the cylinder or may be incompatible with the cylinder material.
- Never completely empty cylinders during lab operations.
- When opening the cylinder valve, crack the valve first to ensure the regulator and plumbing can handle pressure, and then slowly open the valve.
- Leave approximately 25 PSI of pressure. This will prevent any residual gas in the cylinder from becoming contaminated. If the cylinder is non- returnable, call EHS. If inert gas, vent the remainder of the gas. If not inert gas, react off the remainder of gas. In either case, EHS will be able to discard the cylinder after valve removal. If venting or reacting is unsafe, EHS can still dispose of most cylinders.
- Orient cylinders so that the main valve is always accessible and the name of the gas is visible.
- Always secure cylinders (empty or full) to prevent them from falling over and damaging the valve (or falling on your foot). Secure cylinders by firmly chaining or strapping them to a wall, lab bench, or other fixed support.
- Old, empty, or unusable cylinders will be returned to the supplier or disposed of in a manner in accordance with all federal, state, local and incorporated guidelines. An existing agreement should to be in place for the supplier to accept containers once they are no longer needed before receiving them.
- To transport a cylinder, put on the safety cap and strap the cylinder to a hand truck in an upright position.
- Always clearly mark empty cylinders and store them separately.
- Be careful while handling compressed gas cylinders and never drop or strike a cylinder against anything.
- Only compatible gases should be stored together in a gas cylinder cabinet.

First aid

The health effects of compressed gasses vary depending on the composition of the gas. First aid procedures outlined in the SDS should be followed in the event of exposure.

Table 7.5 Allowable Quantity of Gases per Laboratory

	Unsprinklered Areas		Sprinklered Areas	
Materials	**No gas cabinet, gas room, or exhausted enclosure**	**Gas cabinet, gas room, or exhausted enclosure**	**No gas cabinet, gas room, or exhausted enclosure**	**Gas cabinet, gas room, or exhausted enclosure**
Corrosive Gas Liquefied Nonliquefied	68 kg (150 lb) 23 m^3 (810 ft^3)	136 kg (300 lb) 46 m^3 (1620 ft^3)	136 kg (300 lb) 46 m^3 (1620 ft^3)	272 kg (600 lb) 92 m^3 (3240 ft^3)
Cryogenic Fluid Liquefied Nonliquefied	0 L (0 gal) 170 L (45 gal)	170 L (45 gal) 340 L (90 gal)	170 L (45 gal) 340 L (90 gal)	170 L (45 gal)*** 681 L (180 gal)
Flammable Gas Liquefied Nonliquefied	114 L (30 gal) 28 m^3 (1000 ft^3)	227 L (150 gal) 28 m^3 (2000 ft^3)	227 L (60 gal) 28 m^3 (2000 ft^3)	454 L (120 gal) 56 m^3 (4000 ft^3)
Highly Toxic Gas Liquefied Nonliquefied	0 kg (0 lb) 0 m^3 (0 ft^3)	2.3 kg (5 lb) 0.6 m^3 (20 ft^3)	0 kg (0 lb) 0 m^3 (0 ft^3)	4.5 kg (10 lb) 1.1 m^3 (40 ft^3)
Nonflammable Gas Liquefied Nonliquefied	No Limit No Limit	No Limit No Limit	No Limit No Limit	No Limit No Limit
Oxidizing Gas Liquefied Nonliquefied	57 kg (15 gal) 43 m^3 (1500 ft^3)	114 kg (30 gal) 85 m^3 (3000 ft^3)	114 kg (30 gal) 85 m^3 (3000 ft^3)	227 L (60 gal) 170 m^3 (6000 ft^3)
Pyrophoric Gas Liquefied Nonliquefied	0 kg (0 lb) 0 m^3 (0 ft^3)	0 kg (0 lb) 0 m^3 (0 ft^3)	1.8 kg (4 lb) 1.4 m^3 (50 ft^3)	3.6 kg (8 lb) 2.8 m^3 (100 ft^3)
Toxic Gas Liquefied Nonliquefied	68 kg (150 lb) 23 m^3 (810 ft^3)	136 kg (300 lb) 46 m^3 (1620 ft^3)	136 kg (300 lb) 46 m^3 (1620 ft^3)	272 kg (600 lb) 92 m^3 (3240 ft^3)

NOTE: Amounts above are subject to change depending on laboratory construction and location. For additional information, call EHS.

7.6 Nanomaterials (Initial Guidance)

General (Lawson, 2013)

A nanoparticle is any material that has at least one dimension that is less than 100 nanometers. They exhibit unique properties because of their small size and large comparative surface area. National Institute for Occupational Safety and Health (NIOSH) has studied in detail the toxicity of incidental exposures to nanoparticles generated from processes involving combustion, welding, and diesel engines. However, less is known about nanoparticles that are intentionally produced with diameters smaller than 100 nanometers, and uncertainties exist as to whether they pose occupational health risks. These uncertainties arise because of gaps in knowledge about potential routes of exposure, movement of nanomaterials once they enter the body, and the interaction of the materials with the body's biological systems.

Results from existing studies in animals and humans on exposure to incidental nanoscale and other repairable particles provide preliminary information on the possible adverse health effects from exposures to similarly engineered nanomaterials.

Important: Use established industrial safety protocols for established manufacturing tasks, such as welding.

Control Measures

- Engineering Controls
  For personnel and environmental protection, all manipulations with nanomaterials must be performed in a fume hood or local exhaust ventilation system with High Efficiency Particulate Air (HEPA) filtration.
- Work Place Controls
  For personnel and environmental protection, the following work practice controls will be performed:
  - SOPs must be developed, implemented and readily accessible to all personnel, detailing safe practice while preparing and using nanomaterials.
  - All protocols involving the *in vivo* use of nanomaterials must be discussed and have Institutional Animal Care and Use Committee (IACUC) approval before the anticipated start date.
  - Hand washing is required before and after working with nanomaterials, when removing PPE, and before leaving the lab area.
  - An eyewash station will be provided in the laboratory and a safety shower will be located in close proximity.
  - Clean all laboratory work areas using a HEPA-filtered vacuum cleaner or using a wet-method (wetting a cloth or sponge and wiping down all surfaces with this wet cloth or sponge) after the completion of work.
  - No eating, drinking, applying cosmetics or lip balm, smoking, or handling contact lenses is permitted in the nanomaterials work area.

Personal Protective Equipment

For personnel and environmental protection, the following types of PPE will be used:

- Gowns or laboratory coats must be worn at all times in the nanomaterial use area.
- Protective gloves that are compatible with the chemical(s) in use must be worn at all times in the nanomaterial work area. Gloves should cover the hands and wrists completely and should overlap with the sleeves of the lab coat or gown.
- Closed-toed shoes must always be worn in the nanomaterial use area.
- Minimize wearing personal protective equipment such as lab coats and gowns outside of the nanomaterial use areas to avoid potential secondary exposure.
- P-100 filtering face pieces (including "dust masks") or a more protective respirator must be worn when *engineering controls are not adequate or not available*. Please consult your department EHS POC or EHS for any questions.
  Note: All persons who wear any type of respirator must be enrolled in OSU's Respiratory Protection Program.
- Safety glasses should be considered minimal eye protection and are worn to prevent injury. Goggles and/or face shields should be used when performing tasks with hazardous liquids or gases.

7.7 Cryogenic Materials

General

The use of cryogenic liquids in the laboratory presents a number of hazards. Employees should be properly trained in these hazards prior to use. The transfer of liquefied gases from one container to another should not be attempted for the first time without the direct supervision and instruction of someone experienced in the operation.

Storage and Use of Cryogenic Materials

- Cylinders and other pressure vessels used for the storage and handling of liquefied gases should not be filled to more than 80% of capacity, which will prevent the possibility of bursting the vessel by increased hydrostatic pressure.
- Use care when filling portable Dewars and do not overfill them.
- Transfer or pour cryogens slowly to minimize boiling and splashing. Use a phase separator or special filling funnel (the top of the funnel should be partly covered to reduce splashing). If the liquid cannot be poured, use a cryogenic liquid withdrawal device for the transfer (be sure to follow all instructions provided with the device).
- Remove metal jewelry/watches on your hands and wrists before working with cryogenic materials. If exposed to cryogenic liquids or boil-off gases, the jewelry can freeze to the skin.
- Wear an apron when working with cryogenic liquids.
- When hand-carrying cryogen-containing Dewar, ensure the Dewar is your only load (no books, coffee or other items). Watch carefully for people who may run into you, and ensure that the Dewar is carried with both hands and as far away from your face as comfortably possible.
- Ensure Dewars are properly labeled with the identity of the cryogen. Do not mix different cryogen Dewars.
- To avoid asphyxiation, an oxygen monitor in good working order is recommended if you are working with a cryogen in a confined space.
- Do not permit smoking or open flame in any area where oxygen or hydrogen is stored, handled or used.
- Do not lubricate oxygen equipment with oil, grease or unapproved lubricants.

Hazards

- Fire/Explosions
  - Neither liquid nitrogen nor liquid air should be used to cool a flammable mixture in the presence of air. Oxygen can condense from the air and lead to a potentially explosive condition.
  - Adequate ventilation must always be used to prevent the build-up of vapors of flammable gases such as hydrogen, methane, and acetylene.
  - Adequate ventilation is also required when using gases such as nitrogen, helium, or hydrogen. In these cases, oxygen can be condensed out of the atmosphere creating a potential for explosive conditions.
- Pressure Buildup and Explosions
  - Without adequate venting or pressure-relief devices on the containers, high pressures can build up by cryogen evaporation. Cryogens boil as they sit in their storage vessels by absorbing heat energy from the (much warmer) surroundings. The gas boiling out of the liquid must expand or the pressure will increase. Thus, users must make certain that cryogenic liquids are never contained in a closed

system. Use a pressure relief vessel or a venting lid to protect against pressure build-up.
    - Liquid Dewar flasks are non-pressurized vacuum-jacketed vessels that are somewhat like a "Thermos bottle." Dewars are designed with loose-fitting caps or pressure-relief valves that prevent air and moisture from entering, yet allows excess pressure to vent. Do not use any stopper or other device that would interfere with venting of gas.
- Appropriate impact-resistant containers must be used that have been designed to withstand the extremely low temperatures.
- Asphyxiation
    - As the liquid gas warms and evaporates, oxygen may be displaced to the point that employees may experience oxygen deficiency or asphyxiation. Any area where such materials are used should be well ventilated. If there are any concerns about entering a room with suspected oxygen deficiency, do not enter and either increase ventilation, or (in the case of a confined space) call EHS.
    - Asphyxiation is a concern, because the threat may not be obvious. <u>Rescue of an asphyxiated employee will endanger the life of the rescuer if oxygen is not provided</u>. Laboratory entrance signage should alert the responder concerning the use of cryogenic liquids or solids.
- Contact with and Destruction of Living Tissue
    - Even very brief contact with a cryogenic liquid is capable of causing tissue damage similar to that of thermal burns.
    - Prolonged contact may result in blood clots that have potentially serious consequences. In addition, surfaces cooled by cryogenic liquids can cause severe damage to the skin.
    - "Chunks" or cubes should be added slowly to any liquid portion of a cooling bath to avoid foaming over.

First Aid

- Take the victim away from the cryogen hazard.
- Any clothing that may interfere with the circulation of blood to the frozen tissues should be removed in a slow, careful manner to prevent salvageable skin from being pulled off.
- Do not rub or massage the affected parts of the body. Rubbing may further damage the tissue.
- Immerse the affected area in a warm water bath not to exceed 105 °F or expose to warm air.
- The rewarming (thawing) of affected area(s) should be done gradually. It may take up to 60 minutes to thaw the affected area(s) and bring back the natural color of the skin.
- If the eyes are affected, flush them with warm water for at least 15 minutes and then seek medical attention.

Personal Protective Equipment

- Gloves, eye protection, and face shield should be worn at all times when handling cryogenic liquids.
- Gloves should be chosen that are impervious to the fluid being handled and loose enough to be tossed off easily. Appropriate dry gloves should be used when handling dry ice.
- Proper attire includes long sleeve shirts, long pants (skirts), a long sleeve lab coat, well-fitted leather shoes (no sneakers), and gloves.

8. Particularly Hazardous Chemicals and Other Less Common Hazards

Procedures outlined in this section cover those hazards not addressed in the Procedures for Common Classes of Hazardous Chemicals (Section 7).

8.1 Particularly Hazardous Chemical Precautions

In addition to the general safety guidelines, special precautions are needed when handling carcinogens, organ specific toxins, pyrophorics, reproductive toxins and chemicals with a high degree of acute toxicity. A minimum set of guidelines that should be followed are listed below. The Laboratory Supervisor/PI should author an SOP to ensure appropriate engineering controls are available and that all administrative processes are designed to minimize risk of exposure to these substances.

- Quantities of these chemicals used and stored in the laboratory should be minimized, as should their concentrations in solution or mixtures.
- Work should be performed within a functioning fume hood, ventilated glove box, sealed system, or other system designed to minimize exposure.
- Compressed gas cylinders that contain acutely toxic chemicals must be kept in ventilated gas cabinets.
- Each laboratory utilizing acutely hazardous substances must be designated by appropriate laboratory signage. Depending on the hazard, the designated area may be an entire laboratory, an area of the laboratory or a device such as a fume hood or glove box.
- Depending on the chemical, known human carcinogens, mutagens and teratogens should be used only in designated work areas. These areas must be posted and their boundaries clearly marked.
- Only those persons trained in the use of these chemicals can work in the designated area. Pregnant women are urged to consult with EHS before working with mutagens or teratogens.
- All such persons wishing to work with these chemicals will:
    - Use the smallest amount of chemical that is consistent with the requirements of the work to be done.
    - Use the high-efficiency particulate air (HEPA) and/or charcoal filters or high efficiency scrubber systems to protect vacuum lines and pumps. Depending on toxicity, filtration may be required for fume hoods as well.
    - Decontaminate a designated area when work is completed.
    - Prepare wastes in accordance with specific disposal procedures.
- Employees must be trained in the hazards associated with these chemicals and the precautions to take, including proper selection and use of PPE.
- Employees must be informed of the signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
- Storage of all adverse chemicals in locked and enclosed spaces with a slightly negative pressure compared to the rest of the building is preferred.
- Do not wear jewelry when working in designated areas, because chemical decontamination of jewelry may be difficult or impossible.
- Wear long-sleeved permeation resistant clothing when working in designated areas.

- Detection equipment (safety air monitoring) may be required in laboratories where chemicals (especially poisonous gases) with a high degree of acute toxicity are utilized.
- Designated work areas will be appropriately decontaminated and cleaned at regular intervals.
- Emergency response planning for releases or spills will be prepared by the PI/Laborartory Supervisor and included in the training of the employee and others who may be affected in the building.

8.2 Chemical of High Chronic and Acute Toxicity

The actual hazards that a chemical may present depend not only on the properties of the chemical, but also on the manner in which it is used and the resulting exposure to the worker. With the proper handling, even highly toxic or dangerous chemicals can be used safely. On the other hand, chemicals that are not highly toxic can be extremely hazardous if handled improperly. The following steps will reduce the risk of employee exposure:

- Work with high chronic or acutely toxic chemicals will be done in a controlled or restricted access laboratory.
- All glassware, equipment, fixtures, etc., must be thoroughly decontaminated prior to removal from the controlled laboratory.
- Vacuum pumps should be protected from contamination by scrubbers or HEPA filters.
- Contaminated equipment, supplies, glassware, etc. will be decontaminated or managed as hazardous waste. Contaminated equipment must be labeled indicating which portion of the equipment remains contaminated if any.
- The controlled laboratory must be decontaminated prior to the resumption of normal activity.
- When exiting a controlled laboratory, remove any protective clothing, place it in a designated waste container, and thoroughly wash hands, arms, face and neck.
- Only wet cleaning methods and/or a HEPA filter equipped vacuum must be used for housekeeping.
- If cancer-causing substances are used, a medical surveillance program may be initiated. Controlled laboratories will be marked on the exterior of all entrances with signs stating "WARNING: RESTRICTED ACCESS".

8.3 Carcinogens

Containers of waste from experiments involving appreciable amounts of weak, moderate or controlled carcinogens should be labeled as to content and the warning: "CANCER SUSPECT AGENT."

Carcinogens are chemicals that can cause cancer. In research, there are many potential exposures to carcinogens. Generally, workplace exposures are considered to be at higher levels than for public exposures. SDSs should always contain an indication of carcinogenic potential.

A list of carcinogens is located at: http://www.cdc.gov/niosh/topics/cancer/npotocca.html
https://www.osha.gov/SLTC/carcinogens/

8.4 Teratogens, Mutagens, and Embryotoxins

Mutagens and teratogens may affect the embryo or fetus or may affect the genetic makeup of the exposed person in such a way as to produce cancer or disease in later generations.

- Strict safety precautions should not allow chemicals to touch the skin or to be inhaled.
- Some common chemicals that are known or highly suspected to affect the embryo or fetus are listed below.

Benzene	Vinyl Chloride	Hydrogen sulfide
Toluene	Formaldehyde	Carbon disulfide
Xylene	Dimethylformamide	Carbon monoxide
Anjline	Dimethyl sulfoxide	Nitrates
Nitrobenzene	N,N-Dimethylacetamide	Nitrites
Phenol	PCB	Lead
Mercury	Nitrous Oxide	Formamide

- If the storage container is breakable, it must be kept in an impermeable, unbreakable, secondary container having sufficient capacity to retain the material should the primary container be broken.
- Each container should be labeled as to the specific toxin contained.
- Embryotoxins will only be used in a functional fume hood.

8.5 Allergen and Sensitivities

Wide varieties of substances can elicit skin and lung hypersensitivity. Examples include common substances such as diazomethane, chromium, nickel, dichromates, formaldehyde, isocyanates, and certain phenols. Because of this variety and the varying response of individuals, suitable gloves should be used whenever there is potential for contact with chemicals that may cause skin irritation.

- Be aware of PPE sensitivities such as Latex.
- Wear appropriate protective apparel to prevent skin contact.
- Wash hands and arms thoroughly after chemical usage.

8.6 Epoxy Resin Components

Epoxy chemicals are commonly used for building composites and bonding plastic materials, and pose inhalation and/or skin exposure hazards.

- All potentially exposed persons will be instructed as to the potential health hazards.
- All skin contact with the components must be eliminated.
- If any skin contact occurs, immediately wash the area with soap and water. The soap should be acidic or neutral.
- If any component contacts clothing, remove the garment immediately and wash the affected skin under the area.
- All volatile epoxy resin work should be done in exhaust-ventilated enclosures or hoods.
- Ovens used for curing must have their vents exhausted to the outside of the building.
- Disposable containers and stirring rods will be used to mix and work the resin.
- Disposable items will be discarded in containers specifically for epoxy resin waste.

- Containers used for waste must be labeled as containing unwanted chemicals-epoxy resin.
- All epoxy resin materials must be disposed of as hazardous waste.
- All non-disposable items used with the resin components will be cleaned immediately after use.

8.7 New Compounds (Compounds without SDS)

On occasion, some laboratories may synthesize or develop new chemical substances. If the composition of the substance is known and used exclusively in the laboratory, the laboratory employee must label the substance and determine the hazardous properties (e.g., corrosive, flammable, reactive, toxic, etc.) of the substance. This can often be done by comparing the structure of the new substance with the structure of similar materials with known hazardous properties. If the chemical is of unknown composition, it must be assumed hazardous and appropriate precautions will be taken.

If a chemical substance is produced for another user outside this facility, the PI producing the substance is required to provide as much information as possible regarding the identity and known hazardous properties of the substance to the receiver of the material. All chemicals must be adequately labeled upon arrival in the laboratory.

If a new compound is shipped, the laboratory responsible for creating the new compound must provide SDS information as well as additional required documentation and/or notification. Please contact EHS before shipping new compounds.

8.8 Biological, LASER and Radiation Safety

Biological, LASER and radioactive materials are common in OSU laboratories and pose unique laboratory hazards. Please contact OSU's Biological, LASER, and Radiation Safety Officers in the Office of University Research Compliance, 405-744-1676.

9. Medical

OSHA requires medical consultation, follow-up examinations, and treatment to employees that have (or may have) been exposed to hazardous materials. (Occupational Safety and Health Administration, 2011c) Monitoring is also required for work environments where exposure may exceed the action limits (TLV/PEL). The following sections provide OSU guidance to employee exposure and monitoring.

9.1 Employee Exposure

Upon employee exposure, the department, supervisor/PI, physician, and employee have specific responsibilities regarding reporting and treatment. Specific reporting requirements, criteria, and forms are listed below.

- All lab personnel will be provided medical consultation and examination whenever:
  - An employee or student develops signs or symptoms associated with a hazardous chemical to which they may have been exposed in the laboratory.
  - Exposure monitoring reveals a level routinely above the action level of PEL, STEL, or TLV.
  - A potential exposure event occurs such as a spill, leaking container, explosion, etc.
- All medical exams and consultations will be performed by a licensed physician and provided without cost to laboratory personnel and without a loss of pay.
- Department/PI will provide the following information to the physician:
  - Provide the identity of the hazardous chemicals which the employee and/or student may have been exposed.
  - Provide a description of the conditions under which the exposure occurred, including quantitative exposure data, if available.
  - Provide a description of any exposure signs and symptoms that the employee and/or student are experiencing.
- University Health Services (UHS) will provide the following information:
  - Complete the Employee Injury Report Form (Appendix 3, Form 2)
    - Ability to return to work
    - Ability to return to the same job
    - Physical limitations
    - Estimation of disability
    - Recommendations concerning further medical follow-up
    - Diagnosis and comments
  - Provide the results of the medical exam and any associated tests.
  - Identify any medical condition that may place the employee and/or student at an increased risk because of hazardous chemical exposure in the laboratory
  - Provide a statement that the employee or student has been informed (by the physician) regarding the medical exam results and the need for any further exams or treatment. The physician's written opinion will not reveal findings or diagnoses unrelated to the exposure.
- Department will further execute the following steps:
  - Complete the Incident Employee Exposure Form (Appendix 3, Form 1)
    - NOTE: The Incident Exposure form should be filled out regardless of whether the worker suffered injury or not.
  - Complete the Employee Injury Report Form (Appendix 3, Form 2)

   - Employee contribution regarding the incident
   - Supervisor section provides further analysis of the incident. EHS will be available to assist if requested.
- The completed Employee Exposure Form and Employee Injury Report Form will be sent to OSU Human Resources (HR).

9.2 Monitoring

Exposure monitoring will be provided to all employees and/or lab personnel if there is reason to believe that exposure levels exceed action levels.

Monitoring and analysis will be conducted in a manner consistent with NIOSH methodology or recognized competent practices. Within 15 working days after the receipt of any monitoring results, EHS will notify the affected employees, lab personnel, or students in writing. This notification may be communicated either individually or by posting the results in an area accessible to all individuals involved.

10. Department Documentation

10.1 Department Laboratory Safety Manual

The DLSM may refer, expand or add to sections given in this document. (Section 11) Standard procedures and processes that exist within departments may either be incorporated into DLSM or documented in department level SOPs.

Off-campus OSU departments may require procedures that differ from on-campus procedures. These modifications may be captured in this LSM.

10.2 Standard Operating Procedures

The LSM and DLSM address generic procedures for campus and department-wide hazards. However, SOPs address specific operations in a laboratory:

- The PI/Laboratory Supervisor is responsible for developing written standard operating procedures for routinely performed tasks or any work with hazardous chemicals that is not addressed by the LSM or DLSM. Examples include working with explosives, peroxide formers, and/or pyrophoric materials.
- SOP training must be provided to affected employees and lab personnel.
- SOPs should be reviewed and approved by knowledgeable persons in the department.
- Please update SOPs to capture and review incremental changes in procedures to avoid procedure creep.
- SOPs should include the following sections:.
    - Introductory Information: The author should list the title, department, building, room, and supervisor.
    - Procedure Overview: Provide a brief description of the project and/or procedure.
    - Health and Safety Information for the Hazardous Chemicals:
Briefly describe the hazards associated with the materials or equipment used during the procedure.
    - Hazard Control Measures: Include engineering controls, administrative controls, and PPE that will be used to mitigate hazards.
    - Method Procedures: Give a systematic instruction for the procedure.
    - Waste Disposal Procedures
    - First Aid Procedures
    - Spill/Release Containment, Decontamination, and Clean-up Procedures
    - Author and Approver Signatures
    - Job Hazard Analysis (Appendix 4)
    - Training Record: Employees must be trained on specific laboratory SOPs that they use. The training record should be attached and have the employee's printed name, signature, trainer, and date.
- Other established departmental SOP formats may be acceptable. Please contact EHS.

10.3 Incident and Near Miss Reports

Incident and near miss reports provide key metrics to improve safety. These reports provide quantitative data that identify recurring safety incidents and used to perform root-cause analysis that are necessary to change-related safety processes. Without such forms, continual safety improvements either cannot be made or will be made arbitrarily. Further explanation of each form can be found in Table 10.3.

Table 10.3. Incident Forms

Employee Exposure Report (Form 1)	
Explanation	The Employee Exposure Report provides a written record of any type of exposure, and provides initial information for UHS to assist in patient treatment. This report is filled out whenever an exposure occurs (such as a spill) whether an employee needs medical attention or not.
Author	Employee or PI
Recipients	UHS, Department, and EHS
Employee Injury Report (Form 2)	
Explanation	The Employee Injury Report provides documentation of the incident (filled out by employee or PI), incident analysis/investigation (filled out by PI or Department EHS POC), and medical treatment (filled out by UHS attending physician). UHS will send the completed form to OSU-HR. This form is important for addressing future workers compensation or insurance claims.
Author	Employee, PI, and UHS physician
Recipients	UHS and then OSU-HR and EHS
Near Miss Form (Form 6)	
Explanation	The purpose of the Near Miss Form is to document events that could have caused an accident. A near miss may be subjective, but provides the only metric to improve safety without incident or injury. Misses may include not wearing eye protection while handling chemicals, hood not working before starting a hazardous operation, or dropping a bottle that fortunately did not break. Every laboratory employee has experienced at least one near miss.
Author	Anybody
Recipients	Department and/or EHS

10.4 Documentation Control

Each department is responsible for document version control and annual reviews of DLSM and SOPs.

EHS is responsible for the version control and annual review of the LSM and support SOPs, such as inspection-related SOPs.

11. Department Specific Procedures

This section is for amending the Laboratory Safety Manual to include procedures common throughout a department. Variances from the procedures given in above sections may also be listed here. Procedures unique to specific laboratories should be documented in SOPs.

12. Index

Appendix 1: Terms and Definitions

Term	Definition
Acute	Single short-term exposure that may produce immediate reversible symptoms
BSO	Biological Safety Officer
Chronic	Repeated exposure with delayed effects that is usually irreversible.
Department EHS POC	Department point of contact for OSU-EHS
EHS	Environmental Health & Safety
ft/min	Feet per minute
Fire Hazard	
Class I*	Flash point < 38 C
Class II	Flash point between 39 - 60 C
Class III	Flash point > 68 C
Hazardous Chemical	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. Chemicals covered by this definition include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic system, and agents that damage the lungs, skin, eyes, or mucous membranes. Operationally: Any neat chemical with an NFPA label number greater than 2.
HEPA	High Efficiency Particulate Air
HR	Human Resources
Laboratory Supervisor	Person officially designated as being in charge of a laboratory in place of the Principle Investigator.
DLSM	Department Laboratory Safety Manual
LSM	Laboratory Safety Manual
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Agency
NIOSH	National Institute of Occupational Health & Safety
OSHA	Occupational Health & Safety Administration
OSU	Oklahoma State University
PEL	Permissible Exposure Limit
PI	Principal Investigator
PPE	Personal Protective Equipment
RSO	Radiation Safety Officer
SDS	Safety Data Sheet – previously Material Safety Data Sheet
STEL	Short Term Exposure Limits
SOP	Standard Operating Procedure
TLV	Threshold Limit Values
UHS	University Health Services

Appendix 2: References

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Appendix 3: Forms

Form 1: Employee Exposure Report

Oklahoma State University
Hazardous Substance Employee Exposure Report

Last Name: ______________________ First Name: _____________ Middle Initial: _________

Department: ______________________ Title: __________________ CWID: ______________

Date/Time of Exposure:___________________________Duration of Exposure: ________________

Location of Exposure (Bldg. & Room #): ____

Chemical Name(s):_________________________ Chemical Abstract # (CAS): ________________

Trade and/or Common Name(s) of Chemical(s): ____

Type of Exposure (e.g. inhalation, ingestion, contact) (If contact, what body part was involved?)

____

How did exposure occur? (Use additional sheet if necessary):

____

Was personal protection equipment (PPE) available? Yes ☐ No ☐

Was personal protection equipment (PPE) used? Yes ☐ No ☐

If PPE was used, what type(s)? ____

What training/instructions was provided prior to exposure? ___________________________________

Were any symptoms present at time of exposure? Yes ☐ No ☐

If so, describe: ____

Severity of Exposure: First Aid ☐ Medical Treatment ☐ Unknown ☐

Describe: ____

(Attach Physician's Report, Employee Injury Report, Sharps Injury Log if applicable)

Lost time from work? Yes ☐ No ☐ Estimate of lost time: ______________________________

Were other employees exposed? Yes ☐ No ☐

If so, list names & CWID (use additional sheet if needed): ___________________________________

List suggestions to prevent reoccurrence: ____

_________________________________ (exposed employee's signature)

_________________________________ (today's date)

_________________________________ (supervisor's signature)

_________________________________ (print/type name of supervisor)

Complete form and return to EHS, FILE REPORT WITHIN 24 HOURS OF NOTIFICATION
Report can be faxed (744-7148) or emailed ohsp@okstate.edu

The statements and facts in this form shall not constitute nor be construed to constitute any admission or evidence of liability.

Reviewed by EHS December 2014

Form 2: Employee Injury Report

EMPLOYEE INJURY REPORT

INSTRUCTIONS: When a work-related injury occurs, an OSU employee is required to report the injury to his/her supervisor, and must complete the first section of the Employee Injury Report at the time of the injury. The supervisor is required to investigate any work-related injury and complete the second section of the Employee Injury Report at that time of the injury. The supervisor must accompany the employee for medical treatment at the designated medical facility (On the Stillwater campus: University Health Services during office hours or AMC Urgent Care after hours). Environmental Health Services or the branch campus safety office is to be notified of the accident by telephone.

TO BE COMPLETED BY EMPLOYEE
(Please Print Legibly)

As Shown on Social Security Card: Last Name First Mid Init. ______________________________	Campus Wide ID (CWID): ____________	Sex: ___M ___F	Birthdate (mm/dd/yy) ___/___/___	Work Phone#____________ Home Phone#____________

Number of Dependents:	Marital Status:	Home Mailing Address (include City, Zip Code):

Dept/Unit Name:	Job Title:

Where did injury occur? Location: Rm # Building:

Date of Injury (mm/dd/yy) ___/___/___ Time ___:___ AM/PM (Circle One)	Body Part Injured. Finger___ Hand___ (Right/Left) Arm___ (Right/Left) Head ___ Torso ___ Leg___(Right/Left) Other ______________________________	Witness Name(s):

Was injury reported on date it occurred? ___YES ___ NO If NO, please explain.

To whom was the injury reported?

What was the date/time reported?

Did you seek medical attention for this injury prior to reporting it? ___YES ___No If YES, please provide name of provider and explanation.

Did the injury require time off from work? __YES __NO. If YES, please indicate amount of time (hours) taken.

Supervisor's Name	Supervisor's Phone#	Was supervisor notified of incident? ___YES ___NO If NO, please explain.

Describe how and what happened to cause this injury:

Has body part been injured before? ___YES ___NO If YES, please explain.

Employee Signature:________________________________ Date Completed: ___/___/_____

EMPLOYEE INJURY REPORT

TO BE COMPLETED BY SUPERVISOR
(Please Print Legibly)

Department Name: ________________________ Supervisor Name: ________________________	Employee Name: ________________________________ Employee CWID: ________________	Injured on employer's premises? ____YES ____NO Were others injured in this incident? ___YES ____NO

Is this a questionable case? __YES ___NO. If YES, please explain.

How could this injury have been prevented? (Note: "Be more careful" is not an adequate response.)

RE: Sharps--If non-safety sharps device used, what other mechanism (administrative or work practice) may have prevented this injury?

Type of Event	Contributing Condition	Contributing Behavior
__Struck by (what) ________________	__Equipment defect or failure	__Inattention to task
__Caught in/under/between	__PPE (personal protective equipment) unavailable	__Rushing or hurried
__Overexertion	__Work area set-up/arrangement	__Failure to get assistance
__Patient handling	__Floor/work surfaces	__Not using assistive device (lift equipment)
__Material handling	__Ventilation	__Procedure not followed
__Fall/slip/trip	__Lighting	__Unbalanced/poor position or motion
__Chemical or other exposure	__Disassembling equipment	__Bypassing safety device
__Body fluid splash	__Safety device not activated (needle/sharp)	__Failure to wear PPE
__Needlestick or Sharps injury	__Lack of training	__Lack of experience by other person(s)
__Other __________________________	__Other ____________________________	__Other ___________________________

Action Taken to Prevent Reoccurrence (Check)

__Scheduled safety training
__Developed/revised safety procedure
__Ordered PPE
__Took equipment out of service for repair/replacement
__Reviewed policy/procedure
__Ordered or posted hazard/warning signs
__Reported equipment/condition to ______________________
__Counseled Employee ______________________________
__ Corrective Action__________________________________
__Other ____

For Needlestick/Sharps Injury:(Check) ___Patient Room ___ER ___OR ___ICU ___Lab ___Other:

1. Exposed Substance: ___Human blood ___Non-human blood___ Blood fluid
   Did employee bleed? ____Was visible blood on device? ___
2. When did incident occur? __during use ___between steps ___after use but before disposal
   ___during disposal ___Sharp left in wrong place
3. Procedure was: ___blood draw ___injection ___Start IV ___IV flush ___Cutting ___Suturing ___Other
4. Sharp product type/brand/mode ________________________ Was this a safety type device? _________
5. Was safety protection mechanism activated? ___Fully ___Partially ____Not At All

Did exposure occur ___Before ___During ___After safety activation?

Supervisor's Signature:	Phone #:	Date Completed: (mm/dd/yy) ___/___/____

EMPLOYEE INJURY REPORT

CERTIFICATE FOR RETURN TO WORK STATUS

TO BE COMPLETED BY UHS STAFF
(Please Print Legibly)

Employee Name ____ has been under my care from ___________ to ____________.

Campus Wide ID (CWID)_________________________________

DATE OF INJURY____

___First Aid ___Medical	Estimated Disability: __None __Minimal/Mildly Restrictive __Disabling __Permanently Disabling __Death	Was employee removed by ambulance? __YES __NO Was employee hospitalized? __YES __NO If YES, where?
Can the employee now return to work/school? __YES __NO If NO, approximate date of return to work (mm/dd/yy): __ /__ /___		Will employee be able to return to the same job? __YES __NO
Restrictions, if any:		Is the employee to return for checkup/treatment? __YES __NO If YES, when?

Was the employee referred to another physician/healthcare provider? If so, to whom?

Diagnosis:

Comments:

Treating Physician:____ Date __ /__ /____

TO BE COMPLETED BY ADMINISTRATIVE UNIT/SUPERVISOR

BROADSPIRE INFORMATION
Claim Submission: 800.753.6737
Claim Submission Fax: 800.245.9927
E-mail: nol@choosebroadspire.com

Parent Company:	Address: 106 Whitehurst	County:	Phone: 405.744.5449	Nature of Business:
Oklahoma State University	Stillwater, OK 74078	Payne	Fax: 405.744.8345	University

Employee Information

Loc Code-Div & Dept (ex: AA-D0401):__________________	Class Code: ______	Date of Hire (mm/dd/yy): ___/___/____
Campus Wide ID (CWID)____________________________	Name As Shown On HRS/SCHIP Information (LAST, FIRST MIDDLE INITIAL): ____	

Employment Status: __Full-time __Part-time	Pay Type: __Monthly __Bi-weekly	Gross Wages (Hourly/Monthly): $_____________	
Shift/work begins at: ______ am/pm	Hours per day: ____	Days per week: ____	Hours per week: __________

CLAIM NUMBER:_________________

Broadspire to Send Claim Number to*: ___________________________________ E-mail:_______________________________

**Broadspire will send an email notice of the initial claim (including claim number) to Juanita Phelan, EHS and the individual listed within 24 hours of receipt.*

Form 3: Job Hazard Analysis

Job Hazard Analysis (JHA)

Identified Task:	**Priority Ranking:** **Severity:** I – Catastrophic; II – Critical; III – Marginal; IV – Negligible **Probability:** A – Very Likely; B – Probably; C – Occasional; D – Remote; E – Improbable	**Severity (S) + Probability (P) = Priority Ranking** Example: Working at a height of 4 meters without fall protection. S (1) + P (A) = PR (1A)
Tools/Equipment Required:	**Material Required:**	Date: Page ____ of ____

Steps	Sequence of Steps	Potential Hazards	PR	Controls in Place Engineering, Administrative & PPE	Safe Procedures
1					
2					
3					
4					
5					
6					
7					
8					

Developed by:	**Reviewed by:**
Revised by:	**Approved by:**

For more information about this JHA, contact Environment, Health and Safety, 002 University Health Services, Stillwater, OK 74978 / (405) 744-7241

EHS use only
date picked up: ________________
picked up by: ________________

REQUEST FOR CHEMICAL REMOVAL

[Please print or type]

Environmental Health & Safety
University Health Services, Suite 002
(Ofc: 744-7241) (FAX: 744-7148)
(EMAIL: ehs@okstate.edu)

Date: ______________________________

Dept.: ______________________________

Responsible Faculty/Staff Person:
____

Contact Person: ______________________

Phone: ______________________

Bldg. & Room #: ______________________
____

Location of Chemicals:

Bldg. & Room #: ______________________
____

Does EHS need to call to schedule pickup?
❍Yes ❍No

EHS USE ONLY	IDENTIFICATION/DESCRIPTION of CHEMICALS (Do not submit unknowns)	PHYS. STATE	NUMBER, SIZE & TYPE OF CONTAINER	VOLUME or WEIGHT in CONTAINER	pH	HAZARDS

Special Notes or Handling Instructions:

Certification: "I hereby declare that the identification/description of chemicals is accurate and complete to the best of my knowledge and that I have made a reasonable effort to neutralize, detoxify and/or recycle this material."

(Authorizing Signature): Date: (Only one certification is needed per request.)

[This form may be photocopied as needed.]

Form 5: Inspection Checklist

Department				**PI**	
Building		**Building #**		**Phone #**	
Type		**Room #**			

1.0 Signage and Labels					
#	**Inspection Item**	**Explanation/Criteria**	**Yes**	**No**	**NA**
1.1	Is laboratory entrance signage available and up-to-date?	Signage at the laboratory entrances should represent the current laboratory hazards. Signage should include GHS hazard pictograms (2 inch), emergency contact information, required PPE (≥2 inch), and NFPA 704 diamond (≥ 4 inch). If signage does not exist for laser, radiological, or biological laboratories, refer the lack of signage to URC.			
1.2	Do chemical storage areas have appropriate signage?	Chemical storage areas should be labeled with signage font that is at least one inch in height.			
1.3	Are laboratory refrigerators labeled properly?	Laboratory refrigerators should have "Lab Use Only" label. Food refrigerators should be labeled "Food only – no chemicals".			
1.4	Are laboratory ice makers labeled "Not for human consumption"?	Self-explanatory.			
1.5	Do the locations of the Laboratory Safety Equipment have appropriate signage?	Locations of the fire extinguisher, eyewash station, and safety shower must have signs that are ≥ 6 inches for both height and width.			
2.0 Personal Protective Equipment					
2.1	Are employees wearing appropriate PPE in the laboratory?	Proper PPE includes safety glasses/goggles, closed toe shoes, and other appropriate clothing. For laboratories with offices co-located, the employees should know which portion is designated as office and which portion is designated laboratory.			
2.2	Is appropriate PPE available - safety glasses, gloves, etc.?	PPE must be available and compatible for laboratory tasks. This includes glove compatibility, use of fire retardant lab coat (in special cases), face shields, etc.			
2.3	Is the use of respirators or masks compliant?	If a respirator is used, the user MUST be currently enrolled in the OSU Respiratory Program. Refer respirator findings to EHS Occupational Safety Program Manager.			

2.0 Personal Protective Equipment continued					
#	Inspection Item	Explanation/Criteria	Yes	No	NA
2.4	Is the noise level within acceptable limits?	If the laboratory (or location within a workspace) is too loud to easily hear normal conversation at 3 feet, hearing protection may be required. Other examples might include operating pumps or running combustion engines in laboratories. Refer any hearing protection findings to EHS Occupational Safety Program Manager.			
3.0 Laboratory Safety Equipment (Eyewash, Safety Shower, Fire Extinguisher, and Fume Hood)					
3.1	Is the eyewash station unobstructed, tested, and available?	No tripping hazards or blockage should impede an employee's access to the eyewash. The eyewash must also be operational and tested by EHS within the last year. In addition, weekly test log should be available.			
3.2	Is the safety shower unobstructed, tested, and available?	No tripping hazards or blockage should impede an employee's access to the safety shower. The safety shower must also be operational and tested by EHS within the last year.			
3.3	Is the portable fire extinguisher unobstructed and available?	Access to the fire extinguisher should not be blocked and employees should know the location.			
3.4	Are fume hood inspections current?	Ensure the fume hood has been tested by EHS within the last year (sticker), and hood sash height appropriately marked.			
3.5	Are fume hoods clean with minimal chemical storage?	Ideally, only store chemicals and equipment that is being used for the current experiment in the fume hood. Excessive storage inside a fume hood will decrease the effectiveness by blocking baffles and obstructing flow.			
3.6	Are chemicals and equipment at least 6" inside fume hood?	Hoods are designed to have at least 6" of clearance inside the hood. Equipment or chemicals within the 6" mark will affect the hoods ability to capture vapors.			
3.7	Are sinks, soap and towels available for hand washing?	Self-explanatory.			
3.8	Are spill kits available?	Spill kits should be able to clean applicable laboratory spills, particularly organic and corrosive liquids.			
3.9	Are all moving parts on machinery guarded?	Vacuum pumps are the most common laboratory equipment that requires guards. Other equipment such as forklift, CNC, lathe, exposed pulley, belt, shaft, chain, etc. may also be present. Refer machinery concerns to EHS Occupational Safety Program Manager.			
4.0 Compressed Gases					
4.1	Are cylinders properly secured?	Cylinders must be properly strapped/chained to a proper mount or rack. The mount itself must be securely anchored on a permanent structure.			
4.2	Are cylinders properly labeled?	Contents of cylinder must be known and labeled. Also, cylinders should be labeled as EMPTY when emptied.			

4.0 Compressed Gases continued					
#	Inspection Item	Explanation/Criteria	Yes	No	NA
4.3	Are cylinders properly segregated and stored?	Cylinders should be separated according to class with oxygen cylinder 20 ft. away from flammable gases or behind fire wall. Empty cylinders should be stored separately. Ensure the amounts of stored compressed gas are within the screening quantity limits (See *Inspection SOP*). If stored gas amounts exceed the screening limits, refer the finding to the OSU Fire Marshal (or designee).			
4.4	Are regulators compatible with cylinders?	Ensure the correct regulators correspond to the correct gases. For more information, consult the *Inspection SOP*.			
4.5	Are valve caps in place when cylinders are not in use?	Self-explanatory.			
4.6	Are toxic or corrosive gases used under the proper engineering controls and/or monitoring?	Similar to using hazardous liquids and/or solids, experiments that use toxic or corrosive gases should be conducted under engineering controls. For gases that are acutely hazardous, safety monitoring may be required. Refer any concerns or questions to the EHS Occupational Safety Program Manager.			
4.7	Are gases and cryogenic liquids used in a well ventilated area?	Evaporated cryogenic liquids and other gases will displace oxygen in enclosed spaces and/or spaces where ventilation is limited. Gases and cryogenic liquids should be used in fully ventilated laboratories, gas cabinets, under engineering controls, or large open areas.			
4.8	Do cryogenic dewars have pressure release valves or vented?	Cryogenic liquids can produce high pressures, which will rupture vessels that are not built to contain those pressures. Pressure release valves or vented cryogenic containers mitigate this hazard.			
5.0 Chemical and Hazardous Waste Storage					
5.1	Are chemicals properly stored by hazard class/compatibility?	Chemicals must be stored as a function of compatibility, such as organic solvents, acids, bases, reactives, compressed gases, and oxidizers.			
5.2	Are all chemicals labeled? Are lids closed?	All secondary containers must be labeled with common name, chemical name, and NFPA diamond. Dilutions should be labeled with common name, chemical name, concentration, and NFPA diamond (if hazardous).			
5.3	Are peroxide formers properly labeled and not expired?	Peroxide formers pose an explosion hazard. The date opened, expiration, and date tested (if applicable) should be listed.			
5.4	Are flammable chemicals outside flame cabinet compliant?	Amount is dependent on location and fire hazard class. However, try keeping the total volume below 2 gallons per 100 ft^2 of laboratory. For more information, consult the *Inspection SOP* or the OSU Fire Marshal (or designee).			

5.0 Chemical and Hazardous Waste Storage continued					
#	Inspection Item	Explanation/Criteria	Yes	No	NA
5.5	Are flammable chemicals inside flame cabinet compliant?	Amount is dependent on location and fire hazard class. However, try keeping the total volume below 4 gallons per 100 ft^2 of laboratory. For more information, consult the *Inspection SOP* or the OSU Fire Marshal (or designee).			
5.6	Are chemicals properly stored on floor?	Chemical storage must not cause a tripping hazard, and must have secondary containment.			
5.7	Is secondary containment used for transport and storage?	Bottle containers should be available for carrying chemicals. Secondary containment should be used when storing ≥5 gallons volumes of chemicals or waste to avoid spillage on floors or into drains.			
5.8	Are sharps containers available (where required)?	Needles, scalpels, broken glass, etc. will NOT be disposed in the trash or left out to pose a cut/puncture hazard to employees. The only acceptable method of disposal is a sharps container that is not cracked or broken. Broken glass can be put in a taped and labeled box for disposal in common trash.			
5.9	Are explosion proof refrigerators used for storing flammable chemicals?	Standard refrigerators are not acceptable for storing flammable chemicals. Explosion proof refrigerators are designed to not have ignition sources.			
5.10	Are combustibles stored at heights within acceptable limits?	Combustibles must be 18" below the ceiling in sprinkler room and 24" in non-sprinklered rooms.			
5.11	Is the shelving adequate for loads imposed?	Look for shelving that is bowed or starting to break. Also, ensure enough shelving (or other storage) is available for laboratory chemicals and samples.			
5.12	Is liquid hazardous material stored below eye level?	The eyes and skin are vulnerable to damage when exposed to hazardous chemicals. Storing at heights lower than eye level greatly reduces splash or spill incidents that could affect the eyes and typically exposed skin.			
5.13	Are heavy items stored on lower shelves?	Single-person-lift items above 25 lbs should be stored at locations below the waist.			
5.14	Are satellite accumulation areas inspected on a regular basis?	Full containers must be removed within 3 days. Only safety cans should be used for storage of liquid waste.			
5.15	Is the waste storage within acceptable limits?	Alert EHS Material Management if > 1 quart of acutely hazardous waste (see *Inspection SOP*) and/or > 55 gallons of hazardous waste are being stored in a laboratory.			
5.16	Is hazardous waste appropriately segregated?	Ensure that reactive chemical classes are not stored together. Also, the OSU waste segregation method should be used in laboratories that generate significant amounts of organic waste (see *Inspection SOP*). Refer concerns and/or non-compliance to OSU Material Management.			

5.0 Chemical and Hazardous Waste Storage continued					
#	Inspection Item	Explanation/Criteria	Yes	No	NA
5.17	Do hazardous waste containers have proper labels? Are lids closed?	The label must clearly and neatly indicate the chemical or common name of each substance that is at least 1% by volume of the total contents or mixture.			
6.0 Electrical Hazards					
6.1	Are electrical cords in good condition?	Cords should not have signs of wear or bare wires exposed.			
6.2	Are extension cords being used appropriately?	Extension cords should only be used temporarily with adequate gauge to handle current. Extension cords should not replace permanent wiring or be plugged into a power strip.			
6.3	Are GFCIs by water sources?	GFCI receptacles should be located within 6 feet from water source.			
6.4	Are electrical receptacles, switches, and controls safe from liquid spills?	Water pooled in/by electrical outlets can pose a shock hazard. Similarly, organic liquids that pool near outlets could pose a fire hazard.			
6.5	Are approved power strips being used appropriately?	Power strips must be UL certified and have overcurrent protection. In addition, a power strip should not be plugged into another power strip (daisy chaining).			
6.6	Are flexible cords and cables appropriately routed through laboratory?	Use overhead trays or other similar means of running cables throughout the laboratory. Cable routing should not pose a tripping, shock, or clothes-line hazard.			
6.7	Is access to the circuit breaker box unobstructed?	The breaker box must always be accessible for emergency power shut off. The breaker boxes should have a clear work area of 36" front, 24" width, and 48" high.			
6.8	Is the circuit breaker box compliant?	Circuit breakers should have knockouts in place with no combustible materials in the box. In addition, feed locations for the breakers must be labeled.			
6.9	Are employees properly trained to perform maintenance on equipment > 50 V?	Proper training is required to work on any electrical equipment over 50 V. Refer training needs to the EHS Occupational Safety Program Manager.			
6.10	Are approved light bulbs used in laboratories?	No halogen light bulbs should be used.			
7.0 Bloodborne Pathogen					
7.1	Is the Exposure Control Plan (ECP) present and current?	An ECP with attachments should be present in the laboratory and reviewed annually. Refer any concerns or questions to EHS Occupational Safety Program Manager.			
7.2	Is the employee's Hepatitis B vaccine status documented?	The department or PI should have documentation concerning the employee Hepatitis B status, which is a statement of either having or declining vaccination.			
7.3	Is the employee's bloodborne pathogens (BBP) training current and documented?	Bloodborne pathogen training/refresher is required annually.			

#	Inspection Item	Explanation/Criteria	Yes	No	NA
7.0 Bloodborne Pathogen continued					
7.4	Are needle stick injuries properly reported?	Laboratories should have a needle stick log that is kept for five years. In addition, needle sticks should follow the OSU injury process using the Employee Injury Form.			
7.5	Are sharps and needles handled properly?	Sharps and needles must not be bent, sheared, broken, recapped, removed from disposable syringe, or otherwise manipulated by hand before disposal.			
8.0 Laboratory Documentation and Training					
8.1	Do employees have access to Chemical Inventory List?	Chemical inventory list should be readily accessible to all employees working in a laboratory – either through electronic or hardcopy.			
8.2	Do employees have access to (M)SDSs?	(M)SDSs should be readily accessible to all employees working in a laboratory – either through electronic or hardcopy.			
8.3	Are the HazCom Program and Laboratory Safety Manual available?	Employees must have access to common procedures used for handling hazardous chemicals and communicating hazard information.			
8.4	Are task specific SOPs available?	Procedures are required for operations that are not given in the Laboratory Safety Manual. Laboratories that use acutely hazardous chemicals (see *Inspection SOP*) should have special (and specific) handling and safety procedures.			
8.5	Are laboratory specific procedure training documented?	Laboratory specific training is required for using hazardous materials and/or procedures that are not addressed in the Laboratory Safety Manual. This includes laboratory specific hazard awareness training that is required by the Hazard Communication standard.			
8.6	Are general training requirements documented?	Laboratory employees should have general training for Hazard Communication, Laboratory Safety, and Hazardous Waste. General training is provided by EHS.			
8.7	Is lab specific PPE training provided by the employee's supervisor and documented?	Employees should know when PPE is necessary, what PPE to use, how to use the PPE, limitation of PPE, and effective life of PPE. EHS has a PPE course that addresses usage of standard laboratory PPE.			
9.0 Laboratory Conditions					
9.1	Are corridors, aisles, & exits unobstructed?	No tripping hazards or obstructions blocking the laboratory exits.			
9.2	Does the laboratory have good general housekeeping?	Self-explanatory.			
9.3	Is the laboratory area devoid of food or signs of food?	Eating is not allowed in laboratories. In laboratories where offices are co-located, there must be a clear demarcation between office space and laboratories.			

9.0 Laboratory Conditions continued					
#	Inspection Item	Explanation/Criteria	Yes	No	NA
9.4	Are the work areas adequately illuminated?	Ensure that all facility lighting is working. Any lights that do not work should be reported to Facility Management by PI. Also, report any locations in the laboratory that do not receive enough light to the EHS Occupational Safety Program Manager.			
9.5	Do laboratory doors operate, close, and latch properly?	Laboratories should have fire rated doors that are in good condition and will close and latch automatically. In addition, laboratory doors should not be propped open. Refer concerns to the OSU Fire Marshal (or designee).			
9.6	Are all ceiling tiles present, in place, and in good condition?	Self-explanatory.			
10.0 Pressure and Vacuum Systems					
10.1	Is vacuum glassware in good condition?	Glassware should not be cracked or chipped.			
10.2	Are pressure release devices (for vacuum and pressure vessels) present and inspected?	Pressure and vacuum vessels should be rated to operate at maximal or minimal pressures. To avoid ruptures or implosions, pressure safety valves (or rupture disk) should be present and inspected/tested to ensure proper protection.			
10.3	Are glass vessels enclosed or shielded?	Due to the threat of flying debris, pressurized/evacuated glass vessels should be in secondary containment. Containment can be an outer container or fume hood.			

Near-Miss Report Form

A near-miss is a potential hazard or incident that has not resulted in any personal injury or property damage. Some examples of near-misses are unsafe conditions, improper use of equipment, use of faulty equipment, not following proper procedures…. It is everyone's responsibility to report and correct any of these potential hazards immediately. Please use this form to report near-misses and assist us in preventing future incidents and making OSU and the "State Department" a safer workplace.

Department:	**Building:**	**Room #:**
Date of Incident:	**Time of Incident:**	
Mark all appropriate conditions: ○ **Near-miss** ○ **Safety concern** ○ **Safety suggestion** ○ **Other (describe):**	**Type of concern:** ○ **Unsafe act** ○ **Unsafe condition of area** ○ **Unsafe condition of equipment** ○ **Unsafe use of equipment** ○ **Other (describe):**	
Describe the potential incident/hazard/concern and possible outcome (in as much detail as possible):		
Safety Suggestions:		
Name (Optional):		**Date Reported:**
Phone Number (Optional):	**Email Address (Optional):**	

Submit this form to Organization POC, email, phone number, box drop off…..

For questions or cases deemed immediately dangerous to life or death, call Environmental Health and Safety at (405) 744-7241.

In the case of an emergency call 911.

Appendix 4: Job Hazard Analysis (JHA)

EHS uses a standardized JHA template (Appendix 3, Form 3) that was designed to be user-friendly and addresses a wide range of tasks, not just laboratory related tasks. The OSU JHA is compliant with OSHA recommendations, and provides the ability to quantify job-related hazards.

To use a JHA, the author will start by listing the steps used during a procedure on Form 3. These steps will be either the same or similar to SOP procedures (Section 10.2). Next, the author will identify potential hazards associated with each step. These hazards will be "scored" by assigning a Priority Ranking, which will be discussed in more detail below. The author will then describe engineering, administrative, and/or PPE that will be used to mitigate the hazard. Finally, safety mitigations will be included in the last column.

The priority ranking scores the potential hazards as a function of severity and probability of occurring. The scoring criteria for severity and probability are given in Table A.3.1. The severity score is numeric, and the probability score is alphabetic. The priority ranking is effectively the sum of the severity and probability score (e.g. 3B). Once the priority ranking is determined, Table A.3.2 provides the risk for the corresponding step. EHS suggests that PI approval is required for low risk; Department Head approval for medium risk; and Dean approval for high risk. Unacceptable risk should never be taken.

Table A.3.1. Severity and Probability Hazard Score

Severity Table		
Score	**Classification**	**Description**
1	Catastrophic	May cause death
2	Critical	May cause severe injury or illness
3	Marginal	May cause minor injury or illness
4	Negligible	Will not cause injury or illness
Probability Table		
Score	**Classification**	**Description**
A	Very Likely	Very likely to occur frequently
B	Probably	Probably will occur at some time
C	Occasionally	May occur infrequently
D	Remote	Unlikely, but possible
E	Improbable	Very unlikely, it is assumed to never occur

Table A.3.2. Hazard Priority Ranking Matrix

Hazard Priority Ranking Matrix				
Probability	**Severity**			
	1 Catastrophic	**2 Critical**	**3 Marginal**	**4 Negligible**
A – Very Likely	1A	2A	3A	4A
B - Probably	1B	2B	3B	4B
C - Occasionally	1C	2C	3C	4C
D - Remote	1D	2D	3D	4D
E - Improbable	1E	2E	3E	4E
	Unacceptable	High	Medium	Low