KENT STATE UNIVERSITY

Laboratory Safety and Chemical Hygiene Plan

May 2024

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College of Podiatric Medicine

East Liverpool

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Salem

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1. Introduction

1.1. Purpose

The Kent State University "KSU" Chemical Hygiene and Laboratory Safety Plan outlines the minimum requirement for compliance with OSHA standard 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemical in Laboratories" to minimize exposure of laboratory personnel to health and physical hazards associated with the use of chemicals, equipment and other processes that are carried out in the laboratories at Kent State University.

1.2. Scope

This plan applies to all faculty, staff, and laboratory personnel working in an academic and / or research laboratory at Kent State University.

2. Definitions

2.1. Laboratory Personnel

2.1.1 Laboratory personnel is any person working as a Principal Investigator, faculty, staff, research assistant, graduate assistant, teacher's assistant, student, volunteer or visiting scholar.

2.2. Laboratory

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

2.3. Hazardous Chemical

2.3.1 Hazardous chemical means any chemical which is classified as health hazard or simple asphyxiant in accordance with the Hazard Communication Standard (CFR 29 1910.1200).

2.4. Health Hazard

2.4.1 Health hazard refers to a chemical that is classified as posing one of the following hazardous effects: Acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration hazard.

2.5. Physical Hazard

2.5.1 Physical hazard means a chemical that is classified as posing one of the following hazardous effects: Explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self-reactive; pyrophoric (gas, liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or combustible dust.

2.6. Biological Hazard

2.6.1. Biological hazards are agents that could be hazardous to humans or the environment. Examples of materials that fall into the biohazard classification are viruses, bacteria, pathogens, fungi, blood, human tissue, bodily fluids, prions, blood products, Recombinant DNA and chemical toxins.

2.6.2. Universal Precautions must be followed anytime there is work involving animal blood or tissue, human blood, blood products, and body fluids. If working with these materials, then review the Kent State University Bloodborne Pathogens Manual and Biosafety Manual.

2.6.3. Any research involving recombinant DNA, synthetic nucleic acid, cell lines, gene therapy, blood, human tissues or organs, viral vectors, blood products, bodily fluids and microbial pathogens must obtain approval from the Institutional Biosafety Committee (IBC). For more information contact the IBC Office at 2-1977.

2.7. Radiation Hazard

2.7.1 Exposure to radiation has the capability to cause adverse health effects and damage living tissue and DNA. All work with radioactive materials and radiation generating equipment is governed by license or a registration issued by the Ohio Department of Health/Bureau of Radiation Protection (ODH/BRP) as set forth in Rule 3701-39-50-021 of the Ohio Administrative Code (OAC) and OAC 3701:1-38, 3701:1-40, 3701:1-50 and 3701-39-02.1.

2.7.2 All projects involving radioactive materials or radiation-generating equipment must be approved by the KSU Radiation Safety Committee (RSC) and Radiation Safety Officer (RSO). If a lab wants to work with these materials contact the Radiation Safety Office at 2-1977 for more information.

2.8 Laser Hazard

2.8.1 Lasers are capable of causing biological effects, thermal effects and eye and skin injuries if used improperly. Therefore, all projects involving the use of Class 3B and Class 4 lasers must be approved by the KSU Laser Safety Officer (LSO) and Laser Safety Committee (LSC).

2.8.2 Consultation with the Laser Safety Officer (LSO) must be performed prior to installing this type of laser equipment in the space to ensure proper safety controls, techniques and practices are being used. A consultation can be scheduled by contacting the LSO at -4705.

2.9 Mechanical Hazard

2.9.1 Mechanical hazards are created from manual or powered use of tools, equipment, machines or instruments. These hazards are created from a point of operation, power transmission apparatus or other moving parts.

2.9.2 Equipment, machines or instruments that create mechanical motions and actions such as reciprocation, transverse moving parts, cutting, punching, shearing, bending or any other movements should consult EHS at 2-4347 to ensure proper guarding is in place to reduce and minimize injury from these hazards.

3. Roles and Responsibilities

3.1 Environmental Health and Safety Office

3.1.1 The Environmental Health and Safety Office is responsible for providing technical support and educational programs to keep the university in compliance with federal, state and local regulations. EHS will serve as consultants to the KSU community. Their duties will include developing policies, guidelines, recommendations and providing personnel training to ensure that the university remains in compliance.

3.2 University Chemical Hygiene Officer

3.2.1 Serves as the technical expert in identifying chemical hazards, performing risk assessments, and supporting safe work practices within laboratories.

3.2.2 Develops and maintains a comprehensive chemical hygiene plan, aids the development of laboratory safety plans, and provides collaborative technical guidance to researchers, staff, students, and administrators.

3.2.3 Regularly leads projects that involve development & implementation of policies & program development.

3.2.4 Develops and implements training content, guidelines, policies, and technical documents for the safe use, storage, and disposal of hazardous chemicals in laboratories.

3.2.5 Within the context of hazardous chemical use in research, supports campus committees such as the Laboratory Safety Committee (LSC), Institutional Animal Care and Use Committee (IACUC), Institutional Biosafety Committee (IBC), Institutional Review Board (IRB) and others as needed.

3.2.6 Assists with complex problem solving, using innovative and novel solutions using information attained from professional chemical safety knowledge, skills, and abilities, often in collaboration with researchers, and/or other subject matter experts throughout the Kent State University system.

3.2.7 Serves as technical leader and a chemical safety subject matter expert in the development/implementation of chemical and laboratory safety programs throughout Kent State University.

3.2.8 The CHO will interface, on behalf of the campus, with local, state and federal regulatory agencies in matters related to chemical hygiene.

3.2.9 Reviews new regulatory requirements for applicability to chemical safety, effectively communicates these new requirements, and assesses the impact of new or proposed regulations on laboratory safety resource needs.

3.3 Laboratory Safety Committee

3.3.1 The Laboratory Safety Committee (LSC) includes university faculty and staff that are representatives for each department and campus. The laboratory safety committee is responsible for reviewing chemical policies and procedures and evaluating needs of the university to constantly improve the chemical safety program. The LSC responsibilities also include reviewing incidents related to chemical use and serving as a forum to review laboratory practices and procedures to ensure protection of the personnel, environment and property of Kent State.

3.4 Department Chairperson, Director or Dean

3.4.1 Appoint a Department Chemical Hygiene Officer (DCHO) or Safety Coordinator.

3.4.2 Implement the University Laboratory Safety Plan (UCHLSP) and Department Chemical Hygiene Plan (DCHP).

3.4.3 Encourage formation of a departmental safety committee.

3.4.4 Establish departmental goals and objectives that incorporate health and safety performance.

3.4.5 Communicate health and safety information to the department.

3.4.6 Notify DCHO of Principal Investigators that are leaving, moving or retiring to ensure that proper lab decommissioning occurs.

3.5 Departmental or Campus Chemical Hygiene Officer

3.5.1 The Departmental Chemical Hygiene Officer (DCHO) is responsible for ensuring that health and safety compliance is achieved in the department. The responsibilities of the DCHO are:

3.5.2 Ensure all activities related to the use of hazardous chemicals in laboratories are conducted in a safe manner as well as in compliance with OSHA regulations as specified in 29 CFR Part 1910.1450.

3.5.3 Provide reports at the department safety committee meetings on chemical hygiene activities performed.

3.5.4 Work with Principal Investigator's (PI's) to develop, review and approve risk assessments and/or Standard Operating Procedures (SOP’s) detailing all aspects of proposed research activities that involve hazardous materials.

3.5.5 Work with the PI's on the approval process for the purchase of highly toxic, reactive, carcinogenic or other inherently hazardous materials.

3.5.6 Investigate and complete incident reports related to accidents, near misses and chemical exposures in their department.

3.5.7 Provide guidance with personal protective equipment selection based on the findings of the hazard risk assessment.

3.5.8 Work as a liaison with the University Chemical Hygiene Officer and the Department of Environmental Health & Safety to ensure compliance.

3.5.9 Distribute the University Laboratory Safety and Chemical Hygiene Plan and other related chemical safety information throughout their department via emails, posting, and other forms of communications.

3.5.10 Provide general chemical safety guidance to department staff, students and faculty.

3.5.11 Facilitate the use and maintenance of the University Chemical Inventory System.

3.5.12 Coordinate Hazardous Waste disposal for the facility.

3.5.13 Assist with Chemical Hygiene Plan training for all laboratory workers in the department. Make sure the department is complying with all University health and safety practices and programs.

3.5.14 Aid laboratory personnel in regard to training, guidelines or any other health and safety service requests in coordination with EHS.

3.5.15 Assist department leadership with the establishment of health and safety goals and objectives to continually improve the health and safety of the department occupants.

3.5.16 Conduct periodic lab walkthroughs and assist EHS with routine inspections. Facilitate corrective actions for any issues identified during inspections.

3.5.17 Identify health safety needs in conjunction with the department leadership to improve health and safety (e.g., training, personnel protective equipment, corrective measures).

3.5.18 Develop a departmental safety committee and participate in the Laboratory Safety Committee.

3.5.19 Notify EHS before a faculty member retires or leaves the University so proper laboratory decommissioning can occur.

3.6 Principal Investigators and Laboratory Supervisors

3.6.1 Establish guidelines and rules for their laboratories that meet minimum requirements that are in accordance with University Chemical Hygiene and Laboratory Safety Plan (UCHLSP), Departmental Chemical Hygiene Plan (DCHP), KSU policies, and federal, state and local regulations.

3.6.2 Ensure all lab personnel working in the labs comply with UCHLSP, DCHP, and LCHP.

3.6.3 Prepare Standard Operating Procedures (SOP) on equipment, procedures and hazards specific to the laboratory in which they will be working. Establish necessary training for lab personnel based on the lab responsibilities.

3.6.4 Ensure all lab workers in the laboratory have completed EHS required training. All lab workers must complete the laboratory safety checklist.

3.6.5 Enforce rules and requirements of the UCHLSP, DCHP and SOP's specific to the laboratory.

3.6.6 Ensure all lab personnel have the appropriate Personal Protective Equipment and are using it as required.

3.6.7 Participate in EHS laboratory inspections.

3.6.8 Notify the Departmental Chemical Hygiene Officer (DCHO) of laboratory construction projects or renovations.

3.6.9 Report all laboratory incidents to DCHO and EHS in a timely manner.

3.6.10 Maintain training documentation from Flashtrain and CITI.

3.6.11 Conduct routine housekeeping and chemical inspections to identify issues and correct them.

3.6.12 Ensure proper storage and disposal of chemicals in the lab.

3.7 Laboratory Personnel

3.7.1 Laboratory Personnel includes Principal Investigators, Graduate Assistants, Teaching Assistants, Students, Visiting Scientists, Volunteers, Staff, and Faculty.

3.7.2 Know the location of the UCHLSP, DCHP, LCHP, SOP's and SDS.

3.7.3 Follow all specifications, rules and requirements of the UCHSLP, DCHP, departmental SOPs and laboratory SOPs.

3.7.4 Complete all required EHS training and laboratory specific training prior to starting any work in the lab.

3.7.5 Obtain approval from the Principal Investigator prior to purchasing any high hazard chemicals and/ or restricted chemicals.

3.7.6 Perform risk assessments prior to beginning procedures to properly evaluate, plan and review material hazards and processes.

3.7.7 All laboratory personnel must be familiar with emergency response and spill response information.

3.7.8 Maintain clean and neat work areas.

3.7.9 Inspect all equipment to make sure it is operating correctly prior to use (e.g. fume hoods, electrical wiring, tubing and fittings and mechanical systems).

3.7.10 Use the appropriate Personal Protective Equipment (PPE) at all times in the lab.

3.7.11 Maintain personal protective equipment with training in appropriate cleaning and maintenance techniques. Lab personnel must also understand the limitations of PPE.

3.7.12 Report all incidents involving chemical spills, exposures, fires, work-related injuries, illnesses and unsafe conditions immediately to the Principal Investigator.

4. Hazard Communication

4.1. University Chemical Hygiene and Laboratory Safety Plan

4.1.1. A written program developed and implemented by Kent State University which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting lab workers while working in the laboratory environment with hazardous chemicals, equipment and other processes that may present a physical hazard or health hazard.

4.1.2. All laboratories must have a copy of the University Chemical Hygiene and Laboratory Safety Plan (UCHLSP) in the lab and all personnel must have read the plan.

4.2.Departmental Chemical Hygiene Plan

4.2.1. A written program that is developed and implemented by the department to outline the appropriate practices, procedures, equipment and facilities that will be adhered to by principal investigators, faculty, staff, students, visitors' and any other personnel working in the laboratory environment within the department. Included in this document will be guidelines that establish procedures, equipment, personal protective equipment and best work practices that have been shown to protect lab workers while working in the laboratory with hazardous chemicals, equipment and other processes that may present a physical hazard or health hazard.

4.3.Laboratory Chemical Hygiene Plan

4.3.1. A written plan will be developed and implemented for each lab to communicate best practices in the laboratory that are necessary for safe operation. These procedures will also minimize laboratory workers' exposure to physical and health hazards while working in the laboratory environment. The LCHP will provide instructions and guidelines to laboratory workers to ensure that Kent State University laboratories follow OSHA's Occupational Exposure to Hazardous Chemicals Laboratory Standard and its appendices (29 CFR 1910.1450), KSU Chemical Hygiene Plan, EPA and any other University guidelines.

4.3.2. All laboratories are required to develop a Laboratory Chemical Hygiene Plan (LCHP) **LCHP Template** which must be reviewed annually. The review date must be recorded on the document.

4.3.3. The LCHP must be signed by all lab workers to acknowledge understanding.

4.4.Safety Data Sheets (SDS)

4.4.1. An SDS is a sixteen section document that is developed by the chemical manufacturer to communicate the hazards of the chemical. The SDS includes information such as chemical and physical properties; hazards, first aid, handling

and storage, exposure control, personal protective equipment, transport, disposal and other protective measures and safety precautions when using the chemical.

4.4.2. All laboratory occupants must know how to access safety data sheets and a hard or electronic copy must be kept in the laboratory during use.

- **Note**: If the laboratory uses an electronic database to maintain SDS's then hard copies must be printed during work with the chemical(s) in the event of an accident, incident or injury for emergency response.

4.4.3. Safety Data Sheets (SDS) can be accessed through the university chemical inventory system at https://chemicalmgmt.kent.edu/.

4.4.4. Any materials synthesized at KSU that are transported offsite must be accompanied by SDS if it is not considered an article. If an SDS does not exist, one must be prepared prior to the transfer. Contact EHS for assistance with SDS generation.

- A ***article*** is a manufactured item other than a fluid or particle that is: (1) which is formed to a specific shape or design during manufacture, (2) which has end use function(s) dependent in whole or in part upon its shape or design during end use, and (3) which under normal conditions of use does not release more than very small quantities, and does not pose a physical hazard or health risk to employees.

4.4.5. The Principal Investigator is responsible for making sure that an SDS is shipped along with all materials being shipped off campus.

5. Training

5.1 Environmental Health and Safety Department Training (EHS)

5.1.1 All lab personnel are required to complete the initial laboratory safety training provided by EHS before beginning any work in the laboratory. Contact EHS at 2-1944 or visit the EHS website Kent State University EHS Website for training information.

5.1.2 The EHS training will cover general safety topics and Kent State University specific procedures. Training topics will include Kent State University Laboratory Chemical Hygiene and Safety Plan, chemical storage and segregation, emergency planning, chemical fume hoods, personal protective equipment, chemical transport, spill control, hazardous waste, safety data sheets (SDS), flammable and combustible liquids, compressed gas cylinders, hazard identification, risk assessment, and chemical security.

5.1.3 Additional general safety training modules can be assigned to specific laboratories based on the hazards present in the laboratory.

5.1.4 The EHS training must be taken every three years as a refresher by all laboratory workers (Principal Investigators, faculty, staff, students, graduate assistants, teaching assisting, visiting scholars and volunteers etc.).

5.2 Fire Extinguisher Training

5.2.1 All lab personnel must complete the facilitator led fire extinguisher training. The training will consist of a lecture describing fire extinguisher use and conclude with a demonstration exercise to provide each individual with firsthand experience on how to use and handle a fire extinguisher. Training can be scheduled by contacting the Kent State University Fire Prevention Office at 330-672-1962.

5.2.2 An annual online fire extinguisher refresher training will be required by all laboratory workers. The training can be completed in Flashtrain.

5.3 Laboratory Specific Training

5.3.1 All lab personnel must be trained by the Principal Investigator or designated lab staff before beginning any procedure or process in the lab. This includes departmental and lab specific training. The Principal Investigator or lab supervisor must establish and implement a laboratory-specific training program. This training is to be provided at the time of initial assignment to the laboratory, and prior to assignments involving new exposure situations and hazardous operations. Laboratory-specific training must be documented in the LCHSP.

5.3.2 This training must cover necessary work practices, procedures and policies to ensure that employees are protected from all potentially hazardous chemicals, biological pathogens, and dangerous equipment used in the workplace. Someone thoroughly knowledgeable of all the specific hazards and proper safety techniques is responsible for conducting laboratory-specific training.

5.3.3 Lab worker training should include hazard identification, exposure routes, and safe work practices to protect themselves and others while working in the laboratory.

6. General Laboratory Rules and Guidelines

6.1. Laboratory Rules and Guidelines

6.1.1 Appropriate PPE must be worn at all times. At a minimum, long pants, close-toed shoes, lab coats, gloves and safety glasses must be worn whenever hazards are present in the laboratory.

6.1.2 Long hair, neckties, or loose clothing should be tied back or otherwise secured. No shorts, sandals, open-toed or perforated shoes are permitted in the laboratory. Skirts must be ankle length when working with chemicals in a laboratory.

6.1.3 No eating, drinking, or cosmetic application is allowed in laboratories where hazardous chemicals are present. No smoking, vaping or smokeless tobacco are permitted on any properties owned, leased or operated by KSU (KSU Policy 5-21).

6.1.4 All laboratory personnel must know the location of safety data sheets (SDS), emergency showers, eyewash stations, first aid kits, emergency exits, spill kits, and fire alarm pull stations.

6.1.5 Never block any emergency equipment in the lab which includes safety showers, eyewash stations, emergency exits, fire alarm pull stations, circuit breaker panels, fire extinguishers, gas shutoffs etc.

6.1.6 Exposure to hazardous chemicals via any route (inhalation, ingestion, injection and / or absorption) will be minimized by use of substitution, engineering controls, administrative controls and then personal protective equipment.

6.1.7 The use of audio headphones (over-ear and in-ear) is prohibited when performing chemical procedures and highly hazardous operations.

6.1.8 Practice good housekeeping by keeping laboratories organized, uncluttered, and in hazard-free condition.

6.1.9 Any procedure or operation identified by EHS staff as imminently dangerous (i.e., the operation puts individuals at immediate serious risk of death or serious physical harm) must be immediately stopped until corrective action is taken.

6.1.10 Report fires to the Principal Investigator, Lab Supervisor, or Instructor, and Fire Prevention. In an emergency, call 911 from a campus or cell phone.

6.1.11 Injuries, accidents, spills, near miss events and exposures must be reported to the Principal Investigator, Lab Supervisor or Instructor, and Environmental Health and Safety. In an emergency, call 911 from a campus or cell phone.

- **Note**: A "**Near Miss**" is an incident where no property was damaged and no personal injury was sustained, but were given a slight shift in time or position damage and/or injury easily could have occurred.

6.1.12 Laboratories with special or unusual hazards must post signage on the laboratory entrance doors, equipment or spaces within the lab with appropriate warning signs. This includes use of lasers, radioactivity, biological agents, high hazard chemical use and other processes or procedures that could present a physical or health hazard when in operation.

6.1.13 All laboratory workers must comply with warning signs and labels.

6.1.14 Never smell or taste any chemical.

6.1.15 No mouth pipetting or siphoning of any materials.

6.1.16 All containers should be capped when not in use.

6.1.17 Laboratory personnel should only perform experiments that they are authorized to conduct by the lab owner.

6.1.18 Consult with the Principal Investigator, Instructor or Lab Supervisor if there are any questions regarding an experiment, equipment, procedure or process.

6.1.19 Never work alone in a laboratory unless there are appropriate communication plans in place in the event of incident to get assistance quickly. **(See Section 8.2.5 for more detail)**

6.1.20 Household equipment and appliances should never be modified from their intended use.

6.1.21 Never use equipment that has been decommissioned until repaired.

6.1.22 If any experiments will be left unattended throughout the day or continuing overnight the researcher must use appropriate safety precautions that are approved by the Principal Investigator. Safety Precautions must be employed when leaving equipment such as power stirrers, hot plates, heating mantles and water condensers unattended.

7. Chemical Identification

7.1. Risk Assessments

7.1.1 Prior to conducting any experiment, procedure, process or working with any equipment the lab personnel should perform a risk assessment. A risk assessment is a process that will assist the laboratory worker with identifying hazards and risk factors that will enable an evaluation of the risk associated with that hazard in an effort to eliminate or control the hazard during the procedure, process, experiment or any equipment use. Using a risk assessment approach will aid in ensuring that the laboratory environment maintains exposure limits that are below the permissible exposure limits established by the Occupational Safety and Health Administration (OSHA). It will also minimize the risk of accidents, injuries in the laboratory.

7.1.2 Kent State University is committed to minimizing exposure to health hazards, physical hazards, accidents and injuries that may be encountered in the laboratory work environment. All laboratory workers should review operations involving use of hazardous chemicals by taking a risk-based approach. EHS can provide guidance through consultation on the appropriate engineering, administrative and personal protective equipment. Contact EHS at x24347 to get assistance with a risk assessment. This is further discussed in Section 8 under administrative controls.

8. Hazard Controls

8.1.Engineering Controls

8.1.1. Engineering controls are mechanical modifications that are designed to reduce the hazard at its source, along the travel path or in the vicinity of the worker. Examples of engineering controls used in the laboratory are chemical fume hoods, canopy hoods, slotted hoods, general dilution ventilation, process enclosure, wet methods, spray paint booths, biosafety cabinets, local exhaust ventilation, shielding, downdraft tables, vacuum lines protection, gas cabinets, snorkels, air monitors, automatic shout offs, pressure relief valves, glove boxes, and perchloric acid hoods.

8.1.2. **Never modify** any laboratory engineering controls (ex. fume hoods) or **create** engineering controls before consulting with University Facilities Management and / or the Office of the Architects to ensure that proper building infrastructure and design is maintained.

8.1.2.2 **Chemical Fume Hoods**

8.1.2.2.1 Fume hoods are common laboratory engineering devices that are used to protect workers from exposure to hazardous chemicals while working when properly maintained. When operating the chemical fume hood the following guidelines must be followed, which are outlined in 29 CFR 1910.1450.

8.1.2.2.2 Make sure the fume hood is turned on and its airflow is 80-120 (fpm) feet per minute as indicated by the air flow monitor or magnehelic gauge. If you suggest the fume hood is not working, contact the lab safety coordinator or Facilities Mechanical System Specialist, whose contact information is on the fume hood.

8.1.2.2.3 Make sure the sash is at the proper position, which is usually indicated by an arrow at 18" or lower while working in the fume hood.

8.1.2.2.4 Always wear proper protective equipment (e.g., lab coat, safety glasses and disposable gloves) when working in the fume hood.

8.1.2.2.5 Keep the fume hood sash closed when it is not being used.

8.1.2.2.6 Store all materials inside the hood at a minimum of 6" from the air foil.

8.1.2.2.7 Elevate large pieces of equipment (e.g., centrifuges) above the base of the hood to prevent airflow blockages.

8.1.2.2.8 The fume hood shall not be used for the storage of chemicals, unless this is the safest option, such as in the case of storing bromine.

8.1.2.2.9 Do not write on the sash window or post signs to prevent obstruction of the view of the materials inside the fume hood.

8.1.2.2.10 Do place heat-generating equipment (e.g., Bunsen burners or hot plates) near the rear of the hood to prevent air currents that may cause upward drafts.

8.1.2.2.11 Never modify the fume hood by removing panels or any other parts.

8.1.2.2.12 Never put your head in the fume hood, unless there are no chemical hazards inside the hood.

8.1.2.2.13 Never use any biological agents in a chemical fume hood. Use a proper biosafety cabinet.

8.1.2.2.14 Do not block air foils with absorbent papers, containers, equipment and other materials.

8.1.2.2.15 Do not use chemical fume hoods for the use of perchloric acid or radionuclides unless it is specially designed for those applications.

8.1.2.2.16 Reduce electrical equipment or ignition sources in the fume hood while using flammable gases or liquids. Have only required equipment in the hood.

8.1.2.2.17 Never use canopy hoods for mixing or storage of chemicals.

8.1.2.2.18 If a fume hood alarms, malfunctions, or fails promptly stop work, close sash and contact the Principal Investigator or Lab supervisor and Facilities Mechanical Systems Specialist for Laboratories at 2-1990.

8.1.2.2.19 Chemical fume hoods are inspected annually in coordination with University Facilities Management and the date recorded on the fume hood.

8.2. Administrative Controls

8.2.1 Administrative controls are used in the workplace to reduce or limit the exposure to a specific hazard. This type of hazard control changes how work is carried out when elimination, substitution, or engineering controls is not achievable. Examples of administrative controls include training, procedures, policies, maintenance, housekeeping, signage, labeling, work hour restrictions, and experimental scale up requirements.

8.2.2 It is the responsibility of the Principal Investigator, then department and college to ensure that the appropriate practices and procedures (controls, personal protective equipment) are being utilized and documented to protect the lab workers from injury or overexposure during the use of hazardous chemicals, equipment and other procedures or processes that are conducted in the laboratory. EHS can assist with this process.

8.2.3. Safety in the laboratory setting requires a full team effort; understanding how to recognize hazards, assessing risk, and selecting appropriate control measures. The following are tools recommended by the American Chemical Society for use in hazard assessment. Each lab should choose a method suitable to their lab. A detailed description is found in the Appendix. Examples of each are also found in the Appendix.

8.2.3.1 Risk Rating & Assessment

8.2.3.2 What-If Analysis

8.2.3.3 Job Hazard Analysis

8.2.3.4. Checklists

8.2.3.5. Standard Operating Procedures

8.2.3.6. Control Banding

8.2.4 Hazard Assessment documents can be shared between research groups or can be obtained from the Hazard Assessment repository.

8.2.5. Housekeeping

8.2.5.1 All laboratories should maintain a clean and clutter free environment to reduce the risk of exposure, injuries and accidents. This includes routine cleaning of benches, fume hoods, refrigerators, cabinets, chemical storage cabinets, sinks and trash cans.

8.2.5.2 Keep all chemical containers closed when not in use.

8.2.5.3 Clean up all chemical spills immediately.

8.2.5.4 Keep all emergency equipment and devices (fire extinguishers, eyewash stations, emergency showers, electric power panels, fire alarm pull stations and spill cleanup kits) free of clutter for easy access.

8.2.5.5 A minimum of a three-foot clearance should be kept around emergency showers and electric panels.

8.2.5.6 All emergency exits must be clear of obstacles (e.g., bottles, boxes, equipment and electrical cords).

8.2.5.7 Combustible materials (e.g., paper, boxes) are not permitted to be stored in corridors, stairways, boiler rooms, mechanical or electrical equipment rooms.

8.2.5.8 Combustible material storage must be stored 24” below the ceiling in laboratories that do not have sprinklers. In laboratories that have sprinklers all storage of materials must be kept 18” below the head of the sprinkler.

8.2.5.9 A step ladder should be used for reaching all overhead storage.

8.2.5.10. Keep all aisles clear of obstructions.

8.2.6 Signage

8.2.6.1 All laboratories are required to post a laboratory entrance door sign that displays the lab owner contact information, hazards, personal protective equipment requirements, emergency response information and special hazards and fire hazard information. Contact EHS at 2-4347 to get sign template information.

Note: The laboratory hazard sign must be reviewed and printed annually.

8.2.6.2 Wall and floor signs should be posted to communicate hazards, equipment and conditions that could potentially lead to an exposure, injury, or incident.

8.2.6.3 Any experiment involving hazardous materials that will be left unattended during the day or will be continuing overnight, must complete and post a **"Unattended Experiment Notice"** on the main entrances to the laboratory. See the Appendix for the form.

8.2.7. Labeling

8.2.7.1 All primary containers must be labeled according to GHS requirements. This includes the signal word, pictograms, manufacturer information, precautionary statement, hazard statement and chemical name.

- Signal word indicates hazard level. "Danger" is used for the most severe instances, while "Warning" is less severe.
- Pictograms identify hazardous products grouped by chemical, physical, health and environmental risk.
- Manufacturer information identifies the company name, address and telephone number.
- Precautionary statements describe general preventive, response, storage or disposal precautions. These statements are found on the chemical safety data sheet (SDS).
- The hazard statement describes the nature of the hazardous product and the degree of the hazard. These statements are found on the chemical safety data sheet (SDS).
- A chemical name identifies the product.

8.2.7.2 The primary container label must not be removed or defaced until the container is empty. If the manufacturer label is damaged or becomes illegible, then the container should be relabeled in accordance with GHS requirements.

8.2.7.3 All primary containers must be labeled with a barcode to identify that chemical in the chemical inventory system.

8.2.7.4 All secondary containers must be labeled with the chemical name (in English), signal word, hazard statement, pictograms and date of transfer or preparation.

Secondary containers: one to which a chemical or chemical product is transferred or the container in which a new chemical product/reagent is made and stored.

Immediate Use containers: containers which are only expected to last one work shift and are not intended to leave the control of the person who filled them.

8.2.7.5.All primary and secondary containers that are stored in common use storage areas such as refrigerators, flammable cabinets, corrosive cabinets, and chemical storage rooms must have the lab worker's name on the container or have some other way of identification.

8.2.8. Working Alone

8.2.8.1 Laboratory personnel should avoid working alone when conducting research, especially if experiments involve hazardous substances and procedures. If workers need to work alone in the laboratory, then guidelines should be established to specify what procedures are permissible and approved by the Principal Investigator or laboratory supervisor.

8.2.8.2. Lab personnel that should never work alone include high school students and undergraduates, unless they are experienced in the lab setting, have the proper training, and have approval by the primary investigator(PI).

8.2.8. 3. Examples of activities where working alone would be permissible include:Office work such as writing papers, calculations, computer work, and reading. Housekeeping activities such as general cleaning, supply or equipment organization. **Note:** No large quantity of chemicals should be moved after normal business hours.

Modification or assembly of laboratory equipment can be done if there is no chemical, electrical or physical hazards present.

Lab functions that are outlined in SOP's that have been approved to be safe and do not involve hazardous materials.

8.2.8.4. Examples of activities where working alone requires a buddy system include:

- Experiments that require the use of toxic or other hazardous chemicals.
- High pressure equipment experiments
- Experiments that require large amounts of cryogenic material.
- Experiments that use unstable or explosive materials
- Class 3B or 4 laser experiments
- Transfers of large quantities of flammable, corrosive, toxic and other hazardous materials.
- Hazardous compressed gas cylinder exchanges

8.3.Personal Protective Equipment (PPE)

8.3.1. All individuals working in the laboratory environment must wear closed-toed shoes and long pants.

8.3.2. All lab workers that work in laboratories that use hazardous chemicals must wear a lab coat, safety glasses / goggles and disposable gloves at a minimum.

8.3.3. Personal protective requirements should be outlined in the Departmental Chemical Hygiene Plan (DCHP), Laboratory Chemical Hygiene Plan (LCHP) and in the Standard Operation Procedures (SOP's).

8.3.4. The type of PPE required must be based on a completed risk assessment of the hazards, exposure and the controls in place to protect lab workers during experiments or procedures. The **Laboratory Hazard Assessment Tool (LHAT)** can be used or workers can contact EHS at 330-672-4347 for assistance.

8.3.5. The Principal Investigator is responsible for ensuring that the appropriate PPE is always used.

8.3.6. Each laboratory is responsible for providing a sufficient supply of personal protective equipment for all workers.

8.3.7. All personal protective equipment should be inspected and cleaned on a routine basis to assess if there are any defects or potential problems. Each lab should outline in their laboratory chemical hygiene plan a description of PPE maintenance.

8.3.8. **Never** launder PPE at home, always use the facilities on campus if accessible or a commercial laundromat or contracted laundering service.

8.3.9. **Eye Protection**

8.3.9.1. Safety glasses with side shields must be used to provide the minimum protection for regular use to minimize the risk of eye injury.

8.3.9.2. Eye protection is required in any laboratory irrespective of whether the individual is performing a "chemical operation,".

8.3.9.3. Regular prescription glasses and contact lenses do not provide adequate protection against eye injury. Safety glasses should be worn over prescription glasses. Prescription safety glasses can also be purchased to perform your work.

8.3.9.4. Eye protection should be cleaned on a routine basis with water, lens cleaning towelettes or microfiber cloths. Appropriate storage of glasses in pouches is recommended to protect glasses from damage (e.g. scratches)

8.3.10. **Skin Protection**

8.3.10.1. Skin protection must always be used when working with substances, chemicals or materials that are corrosive or easily absorbed by the skin.

8.3.10.2. Skin protection includes protective clothing, shields, gloves, aprons, lab coats and other protective equipment that shield or provide a barrier between the hazard and the body.

8.3.10.3. Skin protection should be selected based on the type of work. Selection of the appropriate protection can be determined using the Ansell Guardian Protection Guide at Ansell Guardian Partner Body Protection Guide or https://www.ansellguardianpartner.com/. Contact EHS at 2-4347 if assistance is needed.

8.3.11. **Respirators**

8.3.11.1. Work that may generate dust, fumes, mists, gases, vapors, or aerosols, and /or expose workers to extreme temperatures or oxygen deficient environments may require the use of a respirator.

8.1.11.2. If a half mask, full mask or air supplied respirator is needed you must contact EHS at 2-4347 to get enrolled into the Kent State University Respiratory Protection Program before using the respirator. For more information contact EHS at 2-4347 or visit the EHS website.

8.3.12. **Hearing Protection**

8.3.12.1. If the noise or sound level in the work environment exceeds 85 decibels (dB) over an 8 hour day then hearing protection is required. The worker must be enrolled in the Kent State University Hearing Protection Program. For more information contact EHS at 2-4347 or visit the EHS website.

8.3.12.2. Examples of hearing protection may include earmuffs, earplugs or semi-insert earplugs.

8.3.12.3. Headphones and earbuds are not sufficient protection for these environments and should not be used.

9. Chemical Hazard Classification

9.1.Chemicals can be divided into several different hazard classes. The hazard class will determine how a chemical should be stored and handled and what special equipment and procedures are needed to use them safely.

9.2.Each chemical container, whether supplied by a vendor or produced in the laboratory, must include labels that clearly identify the hazards associated with that chemical. In addition to specific chemical labels, hazard information for specific chemicals can be found by referencing the Safety Data Sheet (SDS) for that chemical.

9.2.1. All secondary containers must be labeled with the chemical name (in English), signal word, hazard statement, pictograms and date of transfer or preparation.

9.2.2. Secondary containers are one to which a chemical or chemical product is transferred or the container in which a new chemical product/reagent is made and stored.

9.2.3.Immediate Use containers are containers which are only expected to last one work shift and are not intended to leave the control of the person who filled them.

9.3 It is essential that all laboratory workers understand the types of hazards, recognize the routes of exposure, and are familiar with the major hazard classes of chemicals. In many cases, the specific hazards associated with new compounds and mixtures will not be known, so it is recommended that all chemical compounds be treated as if they were potentially harmful and to use appropriate eye, inhalation and body protection equipment.

9.4. Corrosives

9.4.1 A corrosive substance is defined by OSHA as a chemical that can destroy skin tissue.

9.4.2. Acids and bases are the most commonly used corrosive materials in the laboratory.

9.4.3. When working with concentrated corrosive solutions, a full-length lab coat, splash goggles, and chemical resistant gloves must be worn. The use of a face shield over the goggles or glasses protects the entire face in the event of a splash.

9.4.4. These materials must always be used in the chemical fume hood to avoid the inhalation of the vapors.

9.4.5. Acid should always be added to water slowly to avoid splatter.

9.4.6. All labs using corrosive materials must install an eyewash and emergency shower that meets ANSI Z358.1 standard (See Eyewash Station and Emergency Shower Section for requirements).

9.4.7. Hydrofluoric Acid is a particularly hazardous corrosive substance and requires a SOP, with associated training. The antidote, calgonate, should also be placed in the first aid kit in each lab using hydrofluoric acid.

9.4.8. Perchloric acid is a powerful oxidizing agent that may react explosively with organic compounds and other reducing agents. It shall be used only in a perchloric-acid, water-wash-down fume hood of noncombustible construction.

9.4.9. Strong bases are all corrosive and can cause serious chemical burns. Bases generally have good warning properties: they typically have a slippery feeling on the skin. However, if it is not completely removed by rinsing, a solution of a strong base may not cause pain until the corrosive damage is quite severe.

9.4.10. Formaldehyde, formalin, paraformaldehyde, and phenol are corrosives that do not fall into the acid and bases categories discussed above. Formaldehyde is a colorless gas with a pungent odor and is most commonly used as a saturated aqueous solution called formalin. Formaldehyde is a suspected carcinogen.

9.4.11. Phenol is a colorless or pink crystalline solid or viscous liquid with a characteristic sweet, medicinal odor. It is corrosive and considered moderately toxic. Phenol is capable of rapidly penetrating the skin and causing severe burns. It is toxic and even fatal amounts of phenol can be absorbed through relatively small areas of skin.

9.4.12. Care should be taken when storing corrosive materials. The following protocol should be followed.

- Nitric acid should be stored separately or in secondary containment from other acids.
- Acids and bases shall be stored separately.
- Perchloric acid shall be stored separately from other acids.
- Glacial acetic acid, even though corrosive shall be stored with the flammable substances.

Table 1: Corrosives

Major classes of corrosive substances include:
• Acids – e.g., sulfuric, nitric, hydrochloric acids and hydrofluoric acids
• Bases – e.g., sodium hydroxide, potassium hydroxide and ammonium hydroxide
• Dehydrating agents – e.g., sulfuric acid, sodium hydroxide, phosphorus pentoxide and calcium oxide
• Oxidizing agents – e.g., hydrogen peroxide, chlorine and bromine.

9.5 Flammable and Combustible

9.5.1. A flammable liquid is a liquid with a flash point below 100 °F and a vapor pressure not exceeding 40 psi (absolute) at 100 °F. These are categorized as Class I liquids. A liquid with a flash point of 100 °F or greater is classified as a combustible liquid and may be referred to as a Class II or Class III liquid.

Table 2: Flammable Substances

CLASS	FLASH POINT (°F)	BOILING POINT (°F)
IA	Below 73(23 °C)	Below 100(38 °C)
IB	Below 73 (23 °C)	At or above 100(38 °C)
IC	At or above 73, below 100	NA
II	At or above 100, below 140(60 °C)	NA
IIIA	At or above 140, below 200(93 °C)	NA
IIIB	At or above 200 (93 °C)	NA

9.5.2. Flammable solids often encountered in the laboratory include alkali metals, magnesium metal, metallic hydrides, some organometallic compounds, elemental phosphorus, sulfur, and powdered metals. Many flammable solids are also considered highly reactive chemicals.

9.5.3. Flammable aerosols as a category are flammable gases compressed, liquefied, or dissolved under pressure, and fitted with a release device allowing the contents to be ejected as particles in suspension in a gas, or as a foam, paste, powder, liquid, or gas. They present multiple hazards including the flammability of the compressed material and hazards associated with compressed gases.

9.5.4. An oxidizing agent is a chemical that has the ability to oxidize other substances, in other words, to cause them to lose electrons. Some oxidizers can spontaneously evolve oxygen at room or slightly elevated temperatures, and can explode violently when shocked or heated. Because they possess varying degrees of chemical instability, oxidizing agents can be explosively unpredictable and, therefore, can be particularly hazardous. Examples of oxidizing agents includes peroxides, hyper peroxides, and peroxyesters.

9.5.5. Explosive and reactive (unstable) chemicals can be identified a few different ways. The label or SDS may include the pictograms shown above, the SDS may include the H codes and statements discussed below, or they may fall into one of the categories discussed further in this section. Some common examples are listed in the table below.

Table 3: Explosive and Reactive Chemicals

Examples of Explosive and Reactive (Unstable) Chemicals
Alkali metals
Metal and non-metal hydrides (borane, $LiAlH_4$)
Alkali metal hydrides
Metal azides
Alkali metal nitrides
Non-metal halides (BCl_3, BF_3, $BPCl_3$, $SiCl_4$)
Anhydrous metal halides ($AlCl_3$, $TiCl_4$)
Perchloric and Picric acid (dry)
Calcium hydride (H260)
Sodium Borohydride (H260)
2,4-Dinitropheylhydrazine (H228)
Sodium hydride (H228, 260)
Hydrazine (H226)
t-Butyllithium (H225, 250, 260)
Inorganic acid halides ($POCl_3$, $SOCl_2$, SO_2Cl_2)
White Phosphorous
Lithium aluminum hydride (H260)
Zinc and zinc nitrate

9.6 Irritants

9.6.1. Irritants are defined as non-corrosive chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact.

9.6.2. A wide variety of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are irritants. The most common example of an irritant may be ordinary smoke which can irritate the nasal passages and respiratory system.

9.6.3. Consequently, eye and skin contact with all laboratory chemicals should always be avoided. Symptoms of exposure can include reddening or discomfort of the skin and irritation to respiratory systems.

9.7 Sensitizers

9.7.1. A sensitizer (allergen) is a substance that causes exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance.

9.7.2. Examples of sensitizers include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, and many phenol derivatives. Sensitizer exposure can lead to all of the symptoms associated with allergic reactions, or can increase an individual's existing allergies.

9.8 Reactivity Hazards

9.8.1. Reactive and explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release large volumes of gases and heat.

9.8.2. Some materials, such as peroxide formers, may not be explosive, but may form explosive substances over time. These substances pose an immediate potential hazard and procedures which use them must be carefully reviewed.

9.8.3. These materials must also be stored in a separate flame-resistant storage cabinet or, in many cases, in a separate laboratory grade refrigerator or freezer that is designed for flammable/ reactive chemicals.

9.8.4. Peroxide formers can only be stored in refrigerators when unopened. Once used, they must be stored in a dry environment. Peroxide formers, such as diethyl ether, should also be dated when received and again when opened.

9.8.5. Pyrophoric chemicals are a special classification of reactive materials that spontaneously combust when in contact with air and require laboratory-specific training.

9.8.6. Flame-resistant laboratory coats or other appropriate flame-resistant protection must always be worn when working with pyrophoric chemicals, along with flame-resistant gloves and training.

9.8.7. When ordering picric acid, the PI must inform EHS. This substance should be stored separately and should be disposed of within two years of purchase.

9.9 Hazardous Substances with toxic effects on specific organs

9.9.1. Substances included in this category include items in Table 4.

Table 4: Specific Organ Toxicity

Hepatotoxins – i.e.	substances that produce liver damage such as nitrosamines and carbon tetrachloride

Nephrotoxins – i.e.	agents causing damage to the kidneys such as certain halogenated hydrocarbons
Neurotoxins – i.e.	such as mercury acrylamide and carbon disulfide
Agents which act on the hematopoietic system – e.g.	carbon monoxide and cyanides which decrease hemoglobin function and deprive the body tissues of oxygen
Agents which damage lung tissue – e.g.	asbestos and silica.

9.9.2. Symptoms of exposure to these materials vary. Personnel working with these materials should review the SDS for the specific material being used, take special note of the associated symptoms of exposure, and contact EHS for assistance.

9.10 Particularly Hazardous Chemicals

9.10.1. OSHA recognizes that some classes of chemical substances pose a greater health and safety risk than others. To differentiate this different risk characteristic, OSHA identifies two categories of hazardous chemicals.

- Hazardous chemicals.
- Particularly hazardous substances.

9.10.2. Substances that pose such significant threats to human health are classified as "particularly hazardous substances" (PHSs). The OSHA Laboratory Standard regulation require that special provisions be established to prevent the harmful exposure of researchers to PHSs, including the establishment of designated areas for their use.

- Use of containment devices such as fume hoods or glove boxes;
- Procedures for safe removal of contaminated waste; and
- Decontamination procedures.

9.10.3. Particularly hazardous substances are divided into three primary types:

9.10.3.1. Acute Toxins

Substances that have a high degree of acute toxicity are interpreted by OSHA as being substances that "may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration." These chemicals, associated chemical waste, and storage containers must be handled with care to prevent cross contamination of work areas and unexpected contact. These chemicals must be labeled as "Toxic." Empty containers of these substances must be packaged and disposed of as hazardous waste without rinsing trace amounts into the sanitary sewer system.

9.10.3.2. Reproductive Toxins

Reproductive toxins include any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Reproductive toxins can affect the reproductive health of both men and women if proper procedures and controls are not used. For women, exposure to reproductive toxins during pregnancy can cause adverse effects on the fetus; these effects include embryo lethality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects), and postnatal functional defects. For men, exposure can lead to sterility.

Examples of embryo toxins include thalidomide and certain antibiotics such as tetracycline. Women of childbearing potential should note that embryo toxins have the greatest impact during the first trimester of pregnancy. Because a woman often does not know that she is pregnant during this period of high susceptibility, special caution is advised when working with all chemicals, especially those rapidly absorbed through the skin (e.g., formamide). Pregnant women and women intending to become pregnant should consult with their laboratory supervisor and EHS before working with substances that are suspected to be reproductive toxins.

9.10.3.3. Carcinogens

Carcinogens are chemical or physical agents that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Chronic toxins are particularly insidious because they may have no immediately apparent harmful effects. These materials are separated into two classes:

Select carcinogens are materials which have met certain criteria established by the National Toxicology Program (NTP) or the International Agency for Research on Cancer (IARC) regarding the risk of cancer via certain exposure routes. It is important to recognize that some substances involved in research laboratories are new compounds and have not been subjected to testing for carcinogenicity. The following references that can be used to determine which substances are select carcinogens.

- OSHA Carcinogen List
- Annual Report on Carcinogens published by the National Toxicology Program (NTP), including all of the substances listed as "known to be carcinogens" and some substances listed as "reasonably anticipated to be carcinogens" based on the below standard
- IARC Monographs on the Identification of Carcinogenic Hazards to Humans, including all of Group 1 "carcinogen to humans," and some in Group 2A "probably carcinogenic to humans" or 2B, "possibly carcinogenic to humans" based on the below standard
- For substances listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP, to be considered a "select carcinogen" by OSHA, it must also cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
    - after inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;
    - after repeated skin application of less than 300 mg/kg of body weight per week;
    - after oral dosages of less than 50 mg/kg of body weight per day

Regulated Carcinogens fall into a higher hazard class and have extensive additional requirements associated with them. The use of these agents may require personal exposure sampling based on usage. When working with Regulated Carcinogens, it is particularly important to review and effectively apply engineering and administrative safety controls as the regulatory requirements for laboratories that may exceed long term (8 hour) or short term (15 minutes) threshold values for these chemicals are very extensive.

9.11 Nanomaterials

9.11.1. Nanomaterials: Exposure standards have been proposed for only a limited number of engineered nanomaterials (e.g. carbon nanofiber, silver, titanium dioxide) in the US. However, none have been adopted as regulatory standards. See Table 5 for types of nanomaterials.

9.11.2. Until more definitive standards are developed based on the understanding of nanomaterial toxicology, and the potential health risks associated with handling nanomaterials, researchers should take a conservative approach when planning to work with nanomaterials, and where applicable, implement a combination of advisory engineering controls, work practices, and PPE to minimize potential workplace exposures.

9.11.3. A detailed Standard Operating Procedure (SOP) for working with nanomaterials should be written to provide guidance on appropriate work practices, engineering controls,

personal protective equipment (PPE), and waste disposal practices depending on the risk level of a particular nanomaterial or process involving a nanomaterial.

9.11.4. For further information, see the "Nanotool kit: Working Safely with Engineered Nanomaterials in Academic Research Setting", the National Institute of Occupational Safety & Health's (NIOSH) "General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories" and the NIOSH "Current Strategies for Engineering Controls in Nanomaterial Production and Downstream Handling Processes."

Table 5: Common Nanomaterials

Carbon Based	Buckyballs or Fullerenes, Carbon Nanotubes*, Dendrimers Often includes functional groups like *PEG (polyethylene glycol), Pyrrolidine, N,N-dimethylethylene diamine, imidazole
Metals and Metal Oxides	Titantium Dioxide (Titania)**, Zinc Oxide, Cerium Oxide (Ceria), Aluminum oxide, Iron oxide, Silver, Gold, and Zero Valent Iron (ZVI) nanoparticles
Quantum Dots	ZnSe, ZnS, ZnTe, CdS, CdTe, GaAs, AIGaAs, PbSe, PbS, InP Includes crystalline nanoparticle that exhibits size-dependent properties due to quantum confinement effects on the electronic states (ISO/TS 27687:2008).

Table 6: Nanomaterial Risk Category

Category 1 Lower Exposure Potential	**Material State** • No potential for airborne release (when handling) • Solid: Bound in a substrate or matrix • Liquid: Water-based liquid suspensions or gels • Gas: No potential for release into air (when handling) **Type of Use** • No thermal or mechanical stress	• Non-destructive handling of solid engineered nanoparticles permanently bonded to a substrate
Category 2 Moderate Exposure Potential	**Material State** • Moderate potential for airborne release (when handling) • Solid: Powders or Pellets • Liquid: Solvent-based liquid suspensions or gels	• Pouring, heating, or mixing liquid suspensions (e.g., stirring or pipetting), or operations with high degree of agitation

	• Gas: Potential for release into air (when handling) **Type of Use** • Thermal or mechanical stress induced	involved (e.g. sonication) • Weighing or transferring powders or pellets • Changing bedding out of laboratory animal cages.
Category 3 Higher Exposure Potential	**Material State** • High potential for airborne release (when handling) • Solid: Powders or Pellets with extreme potential for release into air • Gas: Suspended in gas	• Generating or manipulating nanomaterials in gas phase or in aerosol form • Furnace operations • Cleaning reactors • Changing filter elements • Cleaning dust collection systems used to capture nanomaterials • High speed abrading/grinding nanocomposite materials

9.12 Compressed gases, liquified gases and cryogenic liquids and solids

9.12.1. Compressed gases, liquified gases, and cryogenic liquids have many uses in research. They should always be considered hazardous due to properties unique to compressed gases, like pressure, low flash points for flammable gases, and low boiling points, in addition to the hazards of the chemicals themselves.

9.12.2. Compressed gases can be toxic, corrosive, flammable, asphyxiating, oxidizing, pyrophoric, and/or reactive. Some have no visual and/or odor detection properties.

9.12.3. Improper pressure control can cause unsafe reaction rates due to poor flow control.

9.12.4. The flash point of flammable gases under pressure is always lower than ambient or room temperature.

9.12.5. Low boiling points can cause frostbite upon contact, especially for cryogenic liquids (nitrogen) or liquid phase of liquified gases (carbon dioxide, fluorocarbons, propylene).

9.12.6. Hazards associated with dry ice(solid carbon dioxide) include:

- Contact hazard, at -79 Celsius, skin contact can lead to frostbite. Dry ice should never be handled with bare hands.

- Asphyxiation hazard, since dry ice will subline at any temperature above -79 Celsius. This releases potentially dangerous volumes of carbon dioxide, causing dizziness, headaches, difficulty breathing, loss of consciousness and death. This is especially a concern in nonventilated or confined spaces.
- Over pressurization is a hazard due to the rapid emission of large volumes of carbon dioxide gas, any dry ice that is stored in a closed container can pressurize the container. Given enough time at normal room temperature, such a container may violently rupture if the gas is not able to escape.

9.12.7. All of these factors will impact the design of SOPs or other risk assessment and how gases are utilized.

10. Chemical Storage and Inventory

10.1 Regulatory Requirements

Implementation of the necessary work practices, procedures, and policies outlined in this chapter is required by the following:

- OSHA 1910.1450 “Occupational Exposures to Hazardous Chemicals in Laboratories”
- OSHA 1910.1200 “Hazard Communication”
- NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals.
- DHS CFATS, Chemical Facility Anti-terrorism Standard

10.2 Chemical Inventories

10.2.1. Faculty members and other supervisors with chemicals are required to use the campus inventory system to maintain a current, accurate and complete chemical inventory that includes the hazardous materials, solids, liquids, gases, and gels used and stored in the rooms to which they are assigned. The information maintained in the inventory includes the name of the chemical, the concentration, the chemical abstracts number, the size of the container, the amount on hand, the physical state, the type of the container, whether it is pure or a mixture and both the storage pressure and temperature. Chemical inventories are used to provide the required information to the fire department, ensure compliance with fire code storage limits, and homeland security reporting thresholds. The chemical inventory can also be used in an emergency to identify potential hazards for emergency response operations and more.

10.2.2. The chemical inventory list should be reviewed prior to ordering new chemicals and only the minimum quantities of chemicals necessary for the research should be purchased. As new chemicals are added to the inventory, each laboratory group can confirm that they have access to the Safety Data Sheet (SDS) for that chemical through UNHCEMS® (kent.edu). Where practical, each chemical should be dated so that expired chemicals can be easily identified for disposal. Inventory the materials in your laboratory at least annually to avoid overcrowding with materials that are no longer useful and note the items that should be replaced, have deteriorated, or show container deterioration. The Department of Homeland Security (DHS) maintains a list of “DHS Chemicals of Interest,” and requires a report to be submitted within 60 days if specific chemicals on that list exceed set threshold aggregate amounts. Unneeded items should be given to EHS and should be discarded as chemical waste. If substances are usable, these may be added to the CEMS database as surplus. Attributes that may indicate the materials need to be disposed are cloudiness in liquids, a change in color, evidence of liquids in solids, or solids in liquids, “puddling" of material around outside of containers, pressure build-up

within containers and obvious deterioration of containers in addition to exceeding a manufacturer's expiration date.

10.2.3. Access to hazardous chemicals, including toxic and corrosive substances, should always be restricted. These materials must be stored in laboratories or storerooms that are kept locked when laboratory personnel are not present. Locked storage cabinets or other precautions are always recommended, and in some cases may be required in the case of unusually toxic or hazardous chemicals. Unusually toxic chemicals may include those that are immediately dangerous to life or health (IDLH).

10.2.4. On termination or transfer of laboratory personnel, all related hazardous materials should be properly disposed of, or transferred to the laboratory supervisor or a designee.

10.2.5. To facilitate improved inventory management and reporting, Kent State has implemented a systemwide(https://chemicalmgmt.kent.edu/program for maintaining inventory. Information on how to use the Kent State Chemical Database system is available on the EHS page. This program allows Kent State to comply with both long more easily-standing and new regulations requiring chemical inventory maintenance and reporting. OSHA's "Hazard Communication" standard requires that employers develop and maintain a list of hazardous chemicals known to the workplace. This is a long-standing regulatory requirement and is an important component of lab safety evaluations. Maintenance of the chemical inventory by individual labs allows for accurate compliance with this mandate." requires that employers develop and maintain a list of hazardous chemicals known to the workplace.

10.3 Chemical Labeling

10.3.1. All containers (including diluted chemical solutions and those with abbreviations) of hazardous materials must be labeled with the identity of the hazardous substance and all applicable hazard warning statements or abbreviations. If abbreviations are used, a list of the abbreviations used, the full chemical names and the hazards warning statement associated with each, must be prominently displayed in each room. In either case, all containers not actively being used, in transfer, or a reaction must be labeled. New synthesized compounds must be labeled, to the best of your knowledge, with the appropriate hazard warnings based on the knowledge of the chemical and physical properties of that substance. Unlabeled compounds should be assumed as highly hazardous chemicals, until proved otherwise.

10.3.2. Labels must be legible, in English, and clearly displayed. Label the containers as thoroughly as possible. Lewis structure should be used if no other information is available. Secondary containers (such as spray bottles) must be labeled with the identity of the substance and appropriate GHS hazard warnings.

10.3.3. Symbols and/or other languages may be provided for non-English speaking employees. Use the symbols in the Globally Harmonized System of Classification and Labeling of Chemicals.

10.3.4. Peroxide forming chemicals (e.g., ethers) must be labeled with a date on receipt and the date when the bottle is first opened. Any unopened chemicals that are listed in Classes A

through D that have been listed in the chemical inventory for a minimum of one year must be opened and tested for peroxides. See appendix for a guide to peroxide formers. These chemicals can degrade to form shock sensitive, highly reactive compounds and should be stored and labeled very carefully.

10.3.5. Particularly Hazardous Substances require additional labeling to identify the specific hazard associated with each of these chemicals (carcinogen, reproductive toxin, acutely toxicant). In addition, the storage area where they are kept must be labeled with the type of hazard. These chemicals should be segregated from less hazardous chemicals to help with proper access control and hazard identification.

10.4. Chemical Storage & Segregation

Establish and follow safe chemical storage & segregation procedures for your laboratory.

10.4.1. Storage and segregation guidelines are included for materials that are flammable, oxidizing, corrosive, water reactive, explosive, and highly toxic.

10.4.2. For general guidelines on segregation and storage, EHS has developed a Chemical Segregtion Guidance Sheet to assist with developing storage plans for hazardous chemicals. The specific Safety Data Sheet (SDS) should always be consulted when doubts arise concerning chemical properties and associated hazards.

10.4.3. All procedures employed must comply with PERRP(Public Employee Risk Reduction Program), OSHA, Fire Code and building code regulations.

10.4.4. Always wear appropriate personal protective equipment (e.g., laboratory coat, safety glasses, gloves, safety goggles, apron) when handling hazardous chemicals.

10.4.5. Be aware of the locations of the safety showers and emergency eyewash stations. Each laboratory is required to provide appropriate laboratory-specific training on how to use this equipment prior to working with hazardous chemicals.

10.5. Safe Chemical Storage Priorities

Keep in mind that most chemicals have multiple hazards, and a decision must be made as to which storage area would be most appropriate for each specific chemical. First you must determine your priorities:

10.5.1. Flammability. When establishing a storage scheme, the number one consideration should be the flammability characteristics of the material. If the material is flammable, it should be stored in a flammable cabinet.

10.5.2. Isolate. If the material will contribute significantly to a fire (e.g., oxidizers), it should be isolated from the flammables. If there were a fire in the laboratory and response to the fire with water would exaggerate the situation, isolate the water reactive material away from contact with water.

10.5.3. Corrosivity. Next look at the corrosivity of the material, and store accordingly.

10.5.4. Toxicity. Finally, consider the toxicity of the material, with particular attention paid to regulated materials. In some cases, this may mean that certain chemicals will be isolated within a storage area. For example, a material that is an extreme poison but is also flammable, should be locked away in the flammable storage cabinet to protect it against accidental release.

10.5.5. There will always be some chemicals that will not fit neatly in one category or another, but with careful consideration of the hazards involved, most of these cases can be handled in a reasonable fashion.

10.6. General Recommendations for Safe Storage of Chemicals

10.6.1. Each chemical in the laboratory should be stored in a specific location and returned there after each use.

10.6.2. Acceptable chemical storage locations may include corrosive cabinets, desiccators, flammable cabinets, laboratory shelves, or appropriate refrigerators or freezers. In general, fume hoods should not be used as permanent storage areas for chemicals, as this may seriously impair the ventilating capacity of the hood.

10.6.3. Chemicals should not be routinely stored on bench tops or stored on the floor. Additionally, bulk quantities of chemicals should be stored in a separate storage area, such as a flammable cabinet or stockroom or supply room.

10.6.4. Laboratory shelves should have a raised lip along the outer edge to prevent containers from falling. Hazardous liquids, toxic or corrosive chemicals should not be stored on shelves above eye-level and chemicals which are highly toxic, or corrosive should be in unbreakable secondary containers.

10.6.5. Chemicals must be stored at an appropriate temperature and humidity level and should never be stored in direct sunlight or near heat sources, such as laboratory ovens.

10.6.6. Incompatible materials should be stored in separate cabinets, whenever possible. If these chemicals must be stored in one cabinet, due to space limitations, adequate segregation and secondary containment must be ensured to prevent adverse reactions.

10.6.7. All stored containers and research samples must be appropriately labeled and tightly capped to prevent vapor interactions and to alleviate nuisance odors. Caution should be used with flasks with only septa, cork, rubber or glass stoppers.

10.6.8. Laboratory refrigerators and freezers must be labeled appropriately with "No Food/Drink" and must **never** be used for the storage of food or drinks intended for human consumption. Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations. **Never** store flammables in a refrigerator not specifically designed for storage of flammable liquids.

10.7. Flammable and Combustible Liquids

10.7.1. In general, flammables should not be stored alongside combustible materials like paper and packaging plastic bags.

10.7.2. Large quantities of flammable or combustible materials should not be stored in the laboratory. The Fire Code limits specific volume of flammable materials or other classes of hazardous chemicals depending on the original design and construction of the facility and varies from building to building.

10.7.3. In most labs, the maximum total quantity of class 1A, 1B and 1C flammable liquids must not exceed 60 gallons, which must all be stored in a flammable storage cabinet.

10.7.4. The maximum quantity allowed to be kept outside a flammable storage cabinet, safety can, or approved refrigerator/freezer is 10 gallons per room. Class 1A solvents, such as ethyl ether, should be purchased only in one gallon (4 liter) or smaller containers.

10.7.5. Because of the extreme flammability of the Class 1 liquids, only quantities needed for immediate use should be present in the work area. The rest should be stored. Examples of equipment that can be used for storage include flammable storage cabinets, flammable storage refrigerators or freezers that are designed and UL approved for the storage of flammable substances, or approved safety cans or drums that are grounded.

10.7.6. Always segregate flammable or combustible liquids from oxidizing acids and oxidizers. Flammable materials must never be stored in domestic-type refrigerators/freezers.

10.7.7. Flammable or combustible liquids must not be stored on the floor or in any exit access.

10.7.8. Handle flammable and combustible substances only in areas free of ignition sources and use the chemical in a fume hood whenever practical. Only the amount of material required for the experiment or procedure should be stored in the work area.

10.7.9. Always transfer flammable and combustible chemicals from glass containers to glassware or from glass container/glassware to plastic. Transferring these types of chemicals between plastic containers may lead to a fire hazard due to static electricity. The transfer of flammable liquid from 5 gallon or larger metal containers should not be done unless the container is grounded and bonded.

Table 7: Classification of Flammables.

Hazard classification for flammable liquids			
Class	**Flash point**	**Boiling point**	**Examples**
I-A	below 73°F (23°C)	below 100°F (38°C)	diethyl ether, pentane, ligroin, petroleum ether

I-B	below 73°F (23°C)	at or above 100°F (38°C)	acetone, benzene, cyclohexane, ethanol
I-C	73-100°F (24-38°C)	----	p-xylene
Hazard classification for combustible liquids			
II	101-140°F (39-60°C)	----	diesel fuel, motor oil, kerosene, cleaning solvents
III-A	141-199°F (61-93°C)	----	paints (oil base), linseed oil, mineral oil
III-B	200°F (93°C) or above	----	paints (oil base), neatsfoot oil

10.8 Pyrophoric & Water Reactive Substances

10.8.1. The basic requirements for pyrophoric material usage are as follows:

The laboratory space must meet the requirements for safe use and storage of pyrophoric material.

- Ideally, material should be used and stored in a fully sprinklered lab, as approved by the Fire Marshal, and appropriate storage must be available and used. Use caution if labs are not sprinklered.
- Inventory must be regularly managed, and annually certified, using the CEMS system.
- Review of the Kent State SOP on pyrophorics.
- Users of pyrophoric materials are required to take the Pyrophoric training course in Flashtrain.
- Users must use flame resistant gloves based on the PPE section of the SDS.

10.8.2. Because pyrophoric substances can spontaneously ignite on contact with air and/or water, they must be handled under an inert atmosphere and in such a way that rigorously excludes air and moisture. Some pyrophoric materials are also toxic and many are dissolved or immersed in a flammable solvent. Other common hazards include corrosivity, teratogenicity, or peroxide formation.

10.8.3. Only minimal amounts of reactive chemicals should be used in experiments or stored in the laboratory. These chemicals must be stored as recommended in the SDS. Reactive materials containers must be clearly labeled with the correct chemical name, in English, along with a hazard warning.

10.8.4. Suitable storage locations may include inert gas-filled desiccators or glove boxes; however, some pyrophoric materials must be stored in a flammable substance approved freezer. If pyrophoric or water reactive reagents are received in a specially designed shipping, storage or dispensing container (such as the Aldrich Sure/Seal packaging system), ensure that the integrity of that container is maintained. Ensure that sufficient protective solvent, oil, kerosene, or inert gas remains in the container while pyrophoric materials are stored. Never store reactive chemicals with flammable materials or in a flammable liquid's storage cabinet.

10.8.5. *Storage of pyrophoric gases*

Gas cabinets, with remote sensors and fire suppression equipment, are required. Gas flow, purge and exhaust systems should have redundant controls to prevent pyrophoric gas from igniting or exploding. Emergency back-up power should be provided for all electrical controls, alarms and safeguards associated with the pyrophoric gas storage and process systems.

10.8.6. Never return excess reactive chemical to the original container. Small amounts of impurities introduced into the container may cause a fire or explosion. For storage of excess chemical, prepare a storage vessel in the following manner:

a. Dry any new empty containers thoroughly.

b. Insert the septum into the neck in a way that prevents atmosphere from entering the clean dry (or reagent filled) flask;

c. Insert a needle to vent the flask and quickly inject inert gas through a second needle to maintain a blanket of dry inert gas above the reagent;

d. Once the vessel is fully purged with inert gas, remove the vent needle then the gas line. To introduce the excess chemical, use the procedure described in the handling section of the SOP;

e. For long-term storage, the septum should be secured with a copper wire or hose clamp

f. For extra protection a second same-sized septa (sans holes) can be placed over the first; and

g. Use “Parafilm M®” or equivalent around the outer septa and remove the Parafilm M® and outer septum before accessing the reagent through the primary septum.

An SOP for pyrophoric materials can be found on the EHS website.

10.9. Oxidizers

Oxidizers (e.g., oxygen, ozone, hydrogen peroxide, and other inorganic peroxides; fluorine, chlorine, and other halogens; nitric acid and nitrate compounds; persulfuric acids; chlorite, chlorate,

perchlorate, and other analogous halogen compounds; hypochlorite and other hypohalite compounds, including household bleach; hexavalent chromium compounds such as chromic and dichromic acids and chromium trioxide, pyridinium chlorochromate, and chromate/dichromate compounds; permanganate compounds; sodium perborate; nitrous oxide; silver oxide; osmium tetroxide; Tollens' reagent; 2,2'-dipyridyldisulfide) should be stored in a cool, dry place and kept away from flammable and combustible materials (e.g., wood, paper, Styrofoam™, most plastics), flammable organic chemicals, and reducing agents (e.g. zinc, alkaline metals, and formic acid).

10.10. Peroxide Forming Chemicals

10.10.1. Peroxide forming chemicals are able to form shock sensitive peroxide crystals. Peroxide crystals can be explosive when concentrated or as solids, which can occur if peroxide forming material is allowed to dry on the outside of a container. Many organic solvents are peroxide formers to some degree.

- Ethers, acetals, and ketals, especially cyclic ethers and those with primary and/or secondary alkyl groups
- Aldehydes, including acetaldehyde and benzaldehyde
- Compounds containing benzylic hydrogens, and
- Compounds containing allylic hydrogens, including most alkenes, vinyl, and vinyl diene compounds and dienes.

10.10.2. Some of the more common peroxide forming chemicals used in research laboratories are tetrahydrofuran (THF), dioxane, diethyl ether, and isopropyl ether. All peroxide forming chemicals should be stored in airtight containers in a dark, cool, and dry place and must be segregated from other classes of chemicals that could create a serious hazard to life or property should an accident occur (e.g., acids, bases, oxidizers, highly toxic materials). The containers should be labeled with the date received and the date opened. This information, along with the chemical identity should face forward to minimize container handling during inspection. These chemicals must also be tested and documented for the presence of peroxides annually. Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation.

10.10.3. Carefully review all cautionary material supplied by the manufacturer prior to use. Avoid evaporation or distillation, as distillation defeats the stabilizer added to the solvents. Ensure that containers are tightly sealed to avoid evaporation and that they are free of exterior contamination or crystallization. Never return unused quantities back to the original container and clean all spills immediately.

10.10.4. If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), do not handle the container. If crystallization is present in or on the exterior of a container, do not handle the container. Secure it and contact EHS for pick-up and disposal.

10.11. Corrosives

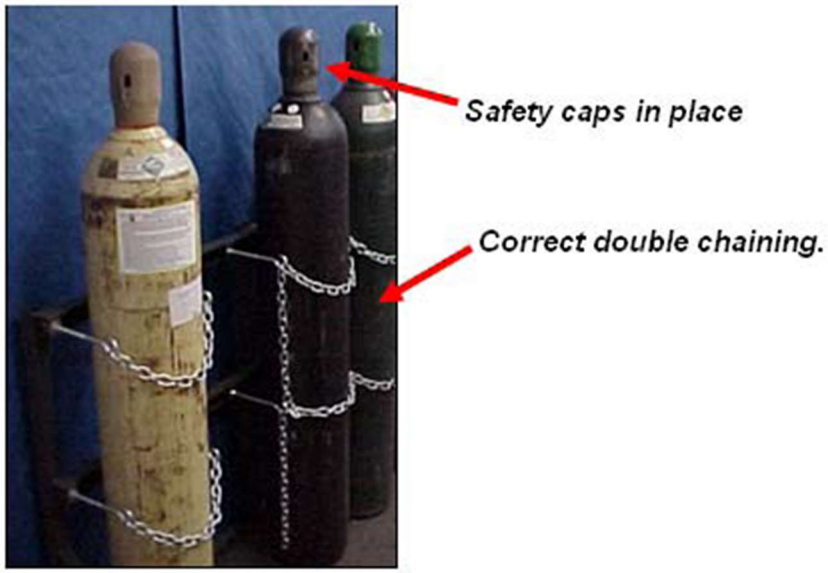
10.11.1. Corrosive materials cause irreversible damage to skin or metals. Store corrosive chemicals (i.e., acids, bases) below eye level and in secondary containers that are large enough to contain at least 10% of the total volume of liquid stored or the volume of the largest container, whichever is greater. Acids must always be segregated from bases and from active metals (e.g., sodium, potassium, magnesium) at all times and must also be segregated from chemicals which could generate toxic gases upon contact (e.g., sodium cyanide, iron sulfide).

10.11.2. Specific types of acids require additional segregation. Mineral acids must be kept away from organic acids and oxidizing acids must be segregated from flammable and combustible substances. Perchloric acid should be stored by itself, away from other chemicals. Picric acid is reactive with metals or metal salts and explosive when dry and must contain at least 10% water to inhibit explosion. Glacial acetic acid shall be stored in a flammable cabinet.

10.12. Special Storage Requirements

10.12.1. Compressed Gas Cylinders

Correct storage of compressed gas cylinders



10.12.2. Compressed gas cylinders that are stored in the laboratory must be chained to the wall or other stable building member, with the safety cap in place(if not in use). The cylinders must be restrained by a chain, two chains preferred; one chain should be placed at one third from the top of the cylinder, and the other placed at one third from the bottom of the cylinder. If this is not practical, contact EHS for guidance. Bolted "clam shells" may be used in instances where gas cylinders must be stored or used away from the wall. Store liquefied fuel-gas cylinders securely in the upright position.

Cylinders are not to be stored in a horizontal position. Do not expose cylinders to excessive dampness, corrosive chemicals, or fumes.

10.12.3. Certain gas cylinders require additional precautions. Flammable gas cylinders must use only flame-resistant gas lines and hoses which carry flammable or toxic gases from cylinders and must have all connections wired. Compressed oxygen gas cylinders must be stored at least 20 feet away from combustible materials and flammable gases.

10.12.4. Gas cylinder connections must be inspected frequently for deterioration and must never be used without a regulator. Never use a leaking, corroded or damaged cylinder and never refill compressed gas cylinders. When stopping a leak between cylinder and regulator, always close the valve before tightening the union nut. The regulator must be replaced with a safety cap when the cylinder is not in use. Move gas cylinders with the safety cap in place using carts designed for this purpose, and do not use carts for storage of cylinders. Please refer to the gas cylinder procedures on the EHS website for more details.

10.12.5. Liquid Nitrogen. Protection considerations should be addressed when storing liquid nitrogen in a laboratory. The primary risk to laboratory personnel from liquid nitrogen is skin or eye thermal damage caused by contact with the material. In addition, nitrogen expands 696:1 when changing from a cryogenic liquid to a room temperature gas. The gases usually are not toxic, but if too much oxygen is displaced, asphyxiation is a possibility. Consider an oxygen sensor in a small space. Always use appropriate thermally insulated gloves when handling liquid nitrogen. Face shields may be needed in cases where splashing can occur. A diffuser is recommended for dispensing liquid nitrogen.

10.13. Laboratory Security

10.13.1. Recently regulatory agencies have been implementing rules to ensure chemical security. While many of these rules are for large manufacturing facilities, it is critical that chemicals be secured to prevent theft from campus laboratories. Numerous federal agencies are involved in the maintenance of laboratory security, including the Drug Enforcement Agency, Federal Bureau of Investigations, and Department of Homeland Security. It is each laboratory's responsibility to prevent and report any theft of chemicals from their laboratory.

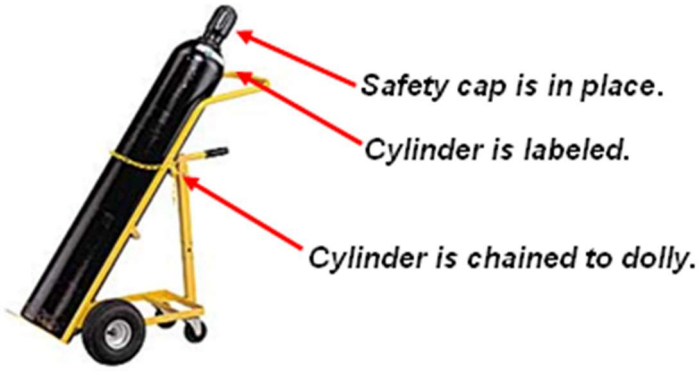
10.13.2. Laboratories can increase their security by simply keeping lab doors closed and locked when unoccupied, maintaining a current and accurate chemical inventory, training personnel on security procedures, and controlling access to keys. Labs should report any suspicious activity to the Kent State Police department and EHS.

10.14. On-Campus Distribution of Hazardous Chemicals

10.14.1 Precautions must be taken when transporting hazardous substances between laboratories. Chemicals must be transported between stockrooms and laboratories in break-resistant, secondary containers such as commercially available bottle carriers made of rubber, metal, or plastic, that include carrying handle(s) and which are large enough to hold the contents of the chemical container in the event of breakage. A cart is also recommended when transporting chemicals.

10.14.2. When transporting cylinders of compressed gases, always secure the cylinder with straps or chains onto a suitable hand truck and protect the valve with a cover cap. Avoid dragging, sliding, or rolling cylinders and use a freight elevator when possible. The figure below illustrates correct cylinder transport. Do not ride elevators with liquified gases.

Gas cylinder cart



Liquified Gas Cart

10.14.3. The transportation of hazardous chemicals and compressed gases over public roads, or by air, is strictly governed by international, federal, and state regulatory agencies, including the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA). Any person who prepares and/or ships these types of materials must ensure compliance with pertinent regulations regarding training, quantity, packaging, and labeling. Without proper training and packaging, it is illegal to ship hazardous materials. Those who violate the hazardous materials shipment regulations are subject to criminal investigation and penalties. Individuals who wish to ship hazardous materials off-campus must contact EHS.

11. Chemical Exposure Assessment

11.1. Regulatory Requirements

11.1.1. It is University policy to comply with all applicable health, safety and environmental protection laws, regulations and requirements. PERRP(Public Employee Risk Reduction Program) requires that all employers "measure an employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance exceed the action level (or in the absence of an action level, the exposure limit)." Repeated monitoring may be required if initial monitoring identifies employee exposure over the action level or exposure limit.

11.1.2. OSHA regulates Permissible Exposure Limits (PELs) for airborne contaminants to which "nearly all workers may be exposed daily during a 40-hour workweek for a working lifetime (of 40 years) without adverse effect", are based upon an 8-hour Time-Weighted Average (TWA) exposure. Thus, the PELs are the maximum permitted 8-hour TWA concentration of an airborne contaminant without respiratory protection. OSHA has also defined Short Term Exposure Limits (STELs) as the maximum TWA exposure during any 15-minute period, provided the daily PEL is not exceeded and Ceiling (C) exposures that shall not be exceeded at any time.

11.1.3. OSHA has listed established PELs, STELs and Ceiling exposures for chemical contaminants in the NIOSH Pocket Guide to Chemical Hazards. In the absence of a published Ceiling limit, OSHA requires employee exposure to concentrations above the PEL be controlled to prevent harmful effects. Further, OSHA has promulgated specific standards covering several regulated carcinogens, which may include an Action Level (AL), triggering medical surveillance requirements or the imposition of a specific Excursion Limit (such as for asbestos) with a unique measurement of the duration of an exposure.

11.2. Exposure Assessment Overview

11.2.1. All Kent State employees require protection from exposure to hazardous chemicals above PELs, STELs and Ceiling concentrations. The profession with expertise in exposure assessment monitoring is Industrial Hygiene. At Kent State, the person supervising, directing, or evaluating the exposure assessment monitoring must be competent in the practice of industrial hygiene. EHS employs personnel with this expertise or will use a consultant. General questions regarding exposure assessment can be directed to EHS.

11.2.2. Minimizing exposure may be accomplished using a combination of engineering controls, administrative controls and personal protective equipment, listed in order of priority. Assessing exposure to hazardous chemicals may be accomplished through several methods performed by EHS, including employee interviews, visual observation of chemical use, evaluation of engineering controls, use of direct reading instrumentation, or the collection of analytical samples from the employee's breathing zone.

11.2.3. Personal exposure assessment will be performed under either of the following situations:

11.2.3.1 Based on chemical inventories, review of Standard Operating Procedures (SOPs), types of engineering controls present, laboratory inspection results and/or review of the Laboratory Hazard Assessment Tool or other reasoning, EHS determines whether an exposure assessment is warranted; or user of a hazardous chemical has concern or reason to believe exposure is not minimized or eliminated through use of engineering controls or administrative practices and the potential for exposure exists. The user should then inform his or her PI/Laboratory Supervisor, who will in turn contact EHS. EHS will then determine the best course of action in assessing employee exposure, including visual assessment, air monitoring, medical evaluation, examination, or medical surveillance.

11.2.3.2. In the event of any serious injury or exposure, including chemical splash involving dermal or eye contact, immediately call 911 and obtain medical treatment immediately. Do not wait for an exposure assessment to be performed before seeking medical care. For minor injuries, such as a localized, small burn from hydrochloric acid, first aid in the lab may be sufficient. If you believe a call to 911 is necessary, do not hesitate. Seek immediate care if there are any concerns.

11.3. Exposure Assessment Protocol

11.3.1. EHS, or their delegate, can conduct exposure assessments for members of the campus community.

11.3.2. Employees have a right to observe testing, sampling, monitoring or measuring of employee exposure. They are also allowed access to the records and reports related to the exposure assessment.

11.3.3. Exposure assessments may be performed for hazardous chemicals, as well as for physical hazards including noise and heat stress to determine if exposures are within PELs or other appropriate exposure limits that are considered safe for routine occupational exposure.

11.3.4. The costs of exposure monitoring are the responsibility of the lab, department and organization in which the personnel are employed.

11.3.5. General protocol in conducting an exposure assessment may include any of the following:

- Employee interviews;
- Visual observation of chemical usage and/or laboratory operations;
- Evaluation of simultaneous exposure to multiple chemicals;
- Evaluation of potential for absorption through the skin, mucus membranes or eyes;
- Evaluating existing engineering controls (such as measuring face velocity of a fume hood);
- Use of direct reading instrumentation; and

- Collection of analytical samples of concentrations of hazardous chemicals taken from the employees breathing zone, or noise dosimetry collected from an employee's shirt collar or various forms of radiation dosimetry.

11.3.6. If exposure monitoring determines an employee's exposure to be over the action level (or the PEL) for a hazard for which OSHA has developed a specific standard (e.g., lead), the medical surveillance provisions of that standard shall be followed.

11.3.7. It is the responsibility of the PI/Laboratory Supervisor to ensure that any necessary medical surveillance requirements are met. When necessary, EHS will make recommendations regarding adjustments to engineering controls or administrative procedures to maintain exposure below any applicable PEL. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, Kent State will provide, at no cost to the employee(anyone being paid by the University), the proper respiratory equipment and training.

11.3.7.1. Respirators will be selected and used in accordance with the requirements of the University's Respiratory Protection Program.

11.3.7.2. In assessing exposure to hazardous chemicals for which OSHA has not published a PEL, STEL or Ceiling exposure, EHS defers to the Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or the Recommended Exposure Limits (RELs) established by the National Institute of Occupational Safety & Health (NIOSH). Please contact EHS for more information regarding these chemicals.

11.3.7.3. If a mask is worn for nuisance dust, or any contaminant below the PEL, a voluntary use form must be signed by the user.

11.4. Notification

11.4.1. EHS will promptly notify the employee and his/her PI/Laboratory Supervisor of the results in writing) after the receipt of any monitoring results. EHS will establish and maintain an accurate record of any measurements taken to monitor exposures for each employee. Records, including monitoring provided by qualified vendors, will be managed in accordance with OSHA guidelines.

11.5. Exposure Assessment Use to Determine and Implement Controls

11.5.1 EHS will use any of the following criteria to determine required control measures to reduce employee's occupational exposure:

- Verbal information obtained from employees regarding chemical usage;
- Visual observations of chemical use or laboratory operations;
- Evaluation of existing engineering control measures or administrative practices;
- Recommendations expressed in Safety Data Sheets;

- Regulatory requirements of OSHA;
- Recommendations from professional industrial hygiene organizations;
- Direct reading instrumentation results;
- Employee exposure monitoring results; and/or
- Medical evaluation, examination and/or surveillance findings.

11.5.2. Particular attention shall be given to the selection of safety control measures for chemicals that are known to be extremely hazardous. Per OSHA, the control of harmful exposures shall be prevented by implementation of control measures in the following order:

- Engineering controls, whenever feasible;
- Administrative controls whenever engineering controls are not feasible or do not achieve full compliance and administrative controls are practical; and
- Personal protective equipment, including respiratory protection, during:
    - The time necessary to install or implement feasible engineering controls
    - When engineering and administrative controls fail to achieve full compliance
    - In emergencies
    - As an extra precaution/option for employees

11.6. Medical Evaluation

11.6.1. All employees, including laboratory personnel, who work with hazardous chemicals shall have an opportunity to receive a free medical evaluation, including supplemental examinations which the evaluating physician determines necessary, under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which an employee may have been exposed in a laboratory;
- Where personal monitoring indicates exposure to a hazardous chemical is above an OSHA Action Level (AL) or Permissible Exposure Limit (PEL) or recommended exposure levels established by the National Institute for Occupational Safety & Health (NIOSH) or the American Conference of Governmental Industrial Hygienists (ACGIH) in the event OSHA has not established an AL or PEL for a particular hazardous chemical;
- Whenever an uncontrolled event takes place in the work area such as a spill, leak, explosion, fire, etc., resulting in the likelihood of exposure to a hazardous chemical; or
- Upon reasonable request of the employee to discuss medical issues and health concerns regarding work-related exposure to hazardous chemicals.

11.6.2. All work-related medical evaluations and examinations will be performed by Deweese Health Clinic during the normal work hours of 8 am until 5 pm. Employees may seek a medical evaluation elsewhere. Evaluations and examinations will be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

11.6.3. Any laboratory employee or student worker who exhibits signs and symptoms of adverse health effects from work-related exposure should file a Report of Injury to EHS. At the sign or symptoms of exposure, the student should seek medical treatment from the Deweese Health Clinic or University Hospitals in Ravenna.

11.6.4. Information to Provide to the Clinician

At the time of the medical evaluation, the following information shall be provided:

- Personal information such as age, weight and University employee ID number;
- Common and/or IUPAC name of the hazardous chemicals to which the individual may have been exposed;
- A description of the conditions under which the exposure occurred;
- Quantitative exposure data, if available;
- A description of the signs and symptoms of exposure that the employee is experiencing, if any;
- A copy of the Safety Data Sheet (SDS) of the hazardous chemical in question;
- History of exposure including previous employment and non-occupational (recreational) hobbies; and
- Any additional information helpful in assessing or treating an exposure or injury such as a biological component of exposure or existence of an antitoxin.

11.6.5. Physician's Written Opinion

For evaluation or examinations required by OSHA, the employer shall receive a written opinion from the examining physician which shall include the following:

- Recommendation for further medical follow-up;
- Results of the medical examination and any associated tests, if requested by the employee;
- Any medical condition which may be revealed during the examination which may place the employee at increased risk because of exposure to a hazardous chemical found in the workplace; and
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
- Confidentiality & Individual's Access to Personal Medical Records

11.6.6. All patient medical information is protected by Ohio and federal law and is considered strictly confidential. The medical facility is prohibited from disclosing any patient medical information not directly related to the work-related exposure under evaluation and should not reveal any diagnosis unrelated to exposure. Any patient information disclosed by the medical facility to the employee's supervisor will be limited to information necessary in assessing an employee's return to work, including recommended restrictions in work activities, if any. Any patient information disclosed by the medical facility to EHS will be limited to information necessary to develop a course of exposure monitoring, or perform hazard assessments and incident investigations, if appropriate, the medical facility will otherwise disclose patient medical information only as required by Ohio and Federal law, such as for Worker's Compensation Insurance claims. Each employee has the right to access their own personal medical and exposure records. The medical facility will provide an employee with a copy of their medical records upon written request.

11.7. Medical Surveillance

11.7.1. Medical surveillance is the process of using medical examinations, questionnaires and/or biological monitoring to determine potential changes in health because of exposure to a hazardous chemical or other hazards. Certain OSHA standards require clinical examination as part of medical surveillance when exposure monitoring exceeds an established Action Level or PEL.

11.7.2. Kent State uses the Deweese Health Clinic for medical surveillance. Medical surveillance is required of employees routinely exposed to certain hazards as part of their job description (such as silica) and may be offered to other employees based on quantifiable or measured exposure. Examples of hazards that are monitored through the medical surveillance program may include: Asbestos, Beryllium, Formaldehyde, Lead, Methylene Chloride, Noise (Hearing Conservation Program), Radioactive Chemicals (Bioassay Program), Respirator Use (Respirator Protection Program), Silica (Respirable Silica Program), and other particularly hazardous substances. Individuals with questions regarding work-related medical surveillance are encouraged to contact EHS for more information.

Section 12: Hazardous Waste Management

12.1 Regulatory Requirements

12.1.1. In Ohio, hazardous waste is regulated by the Ohio EPA.

12.1.2. Federal EPA regulations also govern certain aspects of hazardous waste management, since some of our waste is treated and disposed of out of state.

12.1.3. These hazardous waste regulations are part of the Resource Conservation and Recovery Act, or RCRA. Local enforcement authority is administered by the Kent City Health Department.

12.2 Hazardous Waste Program

12.2.1. The EHS Hazardous Waste Program manages the shipment and disposal of all hazardous waste generated on campus.

12.2.2. Each laboratory employee must comply with the campus Hazardous Waste Management Program requirements and all applicable regulations. Hazardous waste pick up service is provided to all hazardous waste generators in research buildings on campus, as well as to regional campuses.

12.2.3. Laboratory personnel are responsible for identifying hazardous waste, segregating, labeling, and storing it properly in the laboratory.

12.2.4. Laboratory clean-outs and disposal of high hazard compounds must be scheduled at least 4 weeks in advance. The PI/Laboratory Supervisor is responsible for coordinating the disposal of all hazardous materials from his/her/their laboratories prior to closing down laboratory operations. Review the Laboratory Clearance document for more information. This can be found in the Appendix.

12.3. Definition of Hazardous Waste

12.3.1. Federal and State regulations define hazardous waste as a substance which poses a hazard to human health or the environment when improperly managed. A chemical waste is considered hazardous if it is either listed on one of the lists found in Federal or State regulations or if it exhibits one or more of the four following characteristics:

- **Ignitable** - ignitable wastes generally are liquids with a flash point below 60°C or 140°F (however, just because a material has a higher flash point, it still cannot be drain disposed).
- **Corrosive** - corrosive wastes are generally aqueous wastes with a pH less than or equal to two (2) or greater than or equal to (12.5). Solutions with a pH out of this range can be hazardous. Please contact EHS for clarification.

- **Reactive** - reactive wastes are those wastes that are unstable, explosive, and capable of detonation or react violently with water.
- **Toxic** - a chemical that poses a hazard to health or the environment

    - Has an acute oral LD50 less than 2,500 mg/kg
    - Has an acute dermal LD50 less than 4,300 mg/kg
    - Has an acute inhalation LC50 less than 10,000 ppm as a gas or vapor
    - Has an acute aquatic 96-hour LC50 less than 500 mg/L
    - Has been shown through experience or testing to pose a hazard to human health or environment because of its ability to cause cancer or mutation (carcinogen, mutagen, teratogen), acute toxicity, chronic toxicity, bio-accumulative properties, or persistence in the environment

12.3.2. The EPA definition of hazardous waste also extends to the following items:

- Abandoned chemicals
- Unused or unwanted chemicals
- Chemicals in deteriorating containers
- Empty containers that have visible residues
- Containers with conflicting labels
- Unlabeled or unknown chemicals

12.3.3. Chemicals not in frequent use must be carefully managed to prevent them from being considered a hazardous waste. This is especially true for certain compounds that degrade and destabilize over time and require careful management so that they do not become a safety hazard. Be cautious of substances that are corrosive or reactive. If there is any degradation of the bottle, disposal should occur.

12.4. Extremely Hazardous Waste

12.4.1. Certain compounds meet an additional definition known as “extremely hazardous waste”.

12.4.2. This list of compounds includes carcinogens, pesticides, and reactive compounds, among others (e.g., formaldehyde, chloroform, and hydrofluoric acid).

12.4.3. The Federal EPA refers to this waste as “acutely hazardous waste”, but EPA has published a more detailed list of extremely hazardous waste.

12.4.4. Both the State and the Federal lists are included in the EHS list of extremely hazardous waste. NOTE: While there is some overlap with the list of Particularly Hazardous Substances, the extremely hazardous waste list is specific to hazardous waste management.

12.5 Proper Hazardous Waste Management

12.5.1. Training

All personnel who handle, manage, or dispose of hazardous waste must complete training prior to working with these materials. The EHS online Hazardous Materials and Waste Management training course covers the hazardous waste program requirements and includes training on container labeling. To complete the Waste Management training, log into Flashtrain. This training is required every three years.

12.6. Waste Identification

12.6.1. All the chemical constituents in each hazardous waste stream must be accurately identified by knowledgeable laboratory personnel.

12.6.2. This is a critical safety issue for both laboratory employees that handle the waste once it is turned over to EHS.

12.6.3. Mixing of incompatible waste streams has the potential to create violent reactions and is a common cause of laboratory accidents.

12.6.4. If there is uncertainty about the composition of a waste stream resulting from an experimental process, laboratory workers must consult the PI/Laboratory Supervisor or the Chemical Hygiene Officer. In most cases, careful documentation and review of all chemical products used in the experimental protocol will result in accurate waste stream characterization.

12.6.5. The manufacturer's SDS provides detailed information on each hazardous ingredient in laboratory reagents and other chemical products, and also the chemical, physical, and toxicological properties of that ingredient. The SDS library provides an extensive library of research chemicals. Waste streams that have a large percentage of ingredients listed as proprietary information should be discussed with EHS.

12.7. Labeling

12.7.1. Hazardous waste labels must be placed on the hazardous waste container upon the **start** of accumulation.

12.7.2. Kent State University utilizes the CEMS system for submitting hazardous waste pickup requests.

12.7.3. Each label must be completed accurately and updated as the contents of the waste container change. Product names or abbreviations for waste container ingredients should not be used. Information on how to use CEMS is available on the EHS website under Hazardous Waste Pickup.

12.8. Waste Tracking System UNH CEMS

- Go to UNHCEMS®. Select Login button under the Welcome Guest Profile.
- Select KSU Single Sign On and Login with KSU Flashline Credentials.
- Select Hazardous Waste Dashboard and then select request waste removal
- Fill in the department, location, waste name, storage state, quantity and comments (optional). Save the request. If you want an email confirmation of the submission (select the box).

12.9. Storage

12.9.1. Waste generated from Smith, Science Research Building (SRB) and Williams Hall labs are to be stored in the hazardous waste storage room in the basement of Williams Hall near the loading dock.

12.9.2. Waste generated from Cunningham Hall and Cunningham Annex labs are to be stored in the Waste Storage Room in the Cunningham Annex (A013) basement.

12.9.3. Wastes from the Liquid Crystal Institute (LCI) building, Centennial Park, Lowry Hall, McGilvrey Hall and the Aeronautics and Technology Building (ATB), Center for the visual Arts (CVA) and Art Building are to be kept in the generating lab until picked up by the waste hauler.

12.9.4. Unknown waste presents a significant hazard due to the unknown composition and characteristics. They also cost the University additional monies to dispose of because they must be analyzed to determine their contents which is why the university emphasizes labeling of all containers with the name of the substances to avoid this situation.

12.10. Satellite Accumulation Area Requirements

12.10.1. A satellite accumulation area (SAA) is a term that refers to the storage location of hazardous waste at another location that is either at or near the point of hazardous waste generation which is owned and operated by the generator of the hazardous waste. Satellite accumulation areas are regulated under the Environmental Protection Agency (EPA) and the Resource Conservation and Recovery Act (RCRA) hazardous waste management program.

12.10.2. Satellite Accumulation Area Rules and Responsibilities

- All waste must be labeled with the designation “HAZARDOUS WASTE”.
- The Accumulation Date Field on the label must be filled in as soon as any waste is added to the container.
- All containers must be labeled with contents.
- Do not mix incompatible materials in containers. Storage containers must be separated by a partition or wall.
- There should never be more than 55 gallons of hazardous waste allowed to accumulate in any satellite accumulation area.
- Hazardous waste should never be poured down drains or sinks.
- Hazardous waste should never be stored over drains or in sinks.
- Hazardous waste must be stored in the immediate vicinity of the laboratory or work area . The hazardous waste storage location should always be clean and inspected on a routine basis.
- Hazardous waste should not be stored with facility chemicals. Only compatible hazardous waste is permitted to be stored together in the same containers as waste accumulates.
- Transfer full hazardous waste containers to permanent waste storage room.
- Waste from discontinued projects, experiments, cleanouts and storage areas should always be transferred to the permanent waste storage area. Note: For large scale cleanouts (ex. laboratories) prior arrangements must be made with the EHS.

12.10.3. The hazardous waste storage area in each laboratory is considered a Satellite Accumulation Area (SAA). According to EPA requirements, this area must remain under the control of the persons producing the waste. This means that it should be in an area that is supervised and is not accessible to the public. Other SAA requirements include:

- Hazardous waste containers must be always labeled with a Waste tag.
- Waste must be collected and stored at or near the point of generation.
- The maximum amount of waste that can be stored in a SAA is **55 gallons of a hazardous waste or 1 quart of acutely/extremely hazardous waste**. If you reach these volumes for acutely/extremely hazardous waste, you must have the waste removed within 3 days of reaching these set volumes.
- All hazardous waste containers in the laboratory must be kept closed when not in use, unless temporary venting of a container is necessary or to prevent dangerous situations, for instance buildup of extreme pressure. Self venting caps can also be used in this case.
- Hazardous waste streams must have compatible constituents and must be compatible with the containers in which they are stored.
- Hazardous waste containers should be stored in secondary containment.
- Containers must be in good condition with leakproof lids.
- Containers should have 1 to 2 inches of headspace in each container. Do not overfill.
- Dry wastes must be double-bagged in clear, 3-mil plastic bags
- Do not dispose of chemicals by pouring them down the drain or placing them in the trash.

12.11. Segregation

12.11.1.All hazardous materials must be managed in a manner that prevents spills and uncontrolled reactions. Stored chemicals and waste should be segregated by hazard class. Examples of proper segregation are:

- Segregate acids from bases
- Segregate oxidizers from organics
- Segregate cyanides from acids
- Segregate solids from liquids

12.11.2. Segregation of waste streams should be conducted in a similar manner to segregation of chemical products.

12.12. Incompatible Waste Streams

12.12.1. Mixing incompatible waste streams or selecting a container that is not compatible with its contents, is a common cause of accidents in laboratories and waste storage facilities.

12.12.2. Reactive mixtures can rupture containers and explode, resulting in serious injury and property damage. All chemical constituents and their waste byproducts must be compatible for each waste container generated. Waste tags must be immediately updated when a new constituent is added to a mixed waste container, so that others in the laboratory will be aware and manage it accordingly.

12.12.3. Some common incompatible waste streams include:

- Oxidizers added to any fuel can create an exothermic reaction and explode. The most frequent is acids oxidizing flammable liquids. For this reason, all flammable liquids are pH tested before they are consolidated.
- Piranha etch solution is a specific waste stream that contains sulfuric acid and hydrogen peroxide, which form a reactive mixture that is often still fuming during disposal. For this waste stream, and other reactive mixtures like it, vented caps are mandatory.
    - Use poly-coated bottles for these types of waste streams

12.13. Wastes That Require Special Handling

12.13.1. Unknown

Unlabeled chemical containers and unknown/unlabeled wastes are considered unknowns, and additional fees must be paid to have these materials analyzed and identified. These containers must be labeled with the word “unknown”. To help prevent this, label all your products and use a Waste label as soon as one drop of waste is placed into a container.

12.13.2.Peroxide Forming Chemicals

12.13.2.1. Peroxide forming chemicals, or PFCs, include substances that can react with air, moisture or product impurities and undergo a change in their chemical composition during normal storage. The peroxides that form are highly reactive and can explode upon shock or spark. Peroxides are not particularly volatile and thus tend to precipitate out of liquid solutions. It is dangerous to allow a container of these materials to evaporate to dryness, leaving peroxide crystals on the container's surfaces.

12.13.2.2. Each container of peroxide forming chemicals should be dated with the date received and the date first opened. There are three classes of peroxide forming chemicals, with each class having different management guidelines. A review of the safety information provided by the manufacturer can be used as a guide to managing PFCs.

12.13.2.3. Ensure containers of PFCs are kept tightly sealed to avoid unnecessary evaporation, as this inhibits the stabilizers that are sometimes added. Visually inspect containers periodically to ensure that they are free of exterior contamination or crystallization. PFC containers must be disposed of prior to expiration date. If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), **do not handle the container**. If crystallization is present in or on the exterior of a container, **do not handle the container**. Secure it and contact the EHS.

12.13.4. Dry Picric Acid

12.13.4.1. Picric acid (also known as trinitrophenol) must be kept hydrated at all times, as it becomes increasingly unstable as it loses water content. When dehydrated, it is not only explosive but also sensitive to shock, heat and friction. Picric acid is highly reactive with a wide variety of compounds (including many metals) and is extremely susceptible to the formation of picrate salts. Be sure to label all containers that contain picric acid with the date received, and then monitor the water content every 6 months. Add distilled water as needed to maintain a consistent liquid volume.

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

12.13.5. Explosives and Compounds with Shipping Restrictions

12.13.5.1.A variety of other compounds that are classified as explosives or are water or air reactive are used in research laboratories. These compounds often have shipping restrictions and special packaging requirements.

12.12.5.2. When disposing of these compounds, employees must ensure that they are stored appropriately for transport.

12.13.5.3. Flammable metals must be completely submerged in oil before they are brought to a waste pick-up.

12.13.5.4. Many pyrophoric and reactive compounds can be stabilized using a quenching procedure prior to disposal. Chemicals classified by the Department of Transportation (DOT) as explosives (e.g., many nitro- and azo- compounds) will require special packaging and shipping and may require stabilization prior to disposal.

12.13.5.5. Consult EHS at for disposal considerations of these compounds.

12.14. Managing Empty Containers

12.14.1. Empty containers that held Extremely Hazardous waste must be managed as hazardous waste. Do not rinse or reuse these containers.

12.14.2. All other hazardous waste containers should either be reused for hazardous waste collection, or should be cleaned and discarded or recycled. Proper cleaning involves triple rinsing the container, with the first two rinses collected as hazardous waste. Then the labels should be completely defaced (remove it or mark it out completely).

12.14.3. EHS has developed a fact sheet as guidance for the handling of empty containers.

12.15. Transportation

12.15.1. It is a violation of DOT regulations to transport hazardous waste in personal vehicles, or to carry hazardous waste across campus streets that are open to the public. There are two accumulation points on campus. One is in Williams Hall and the other Cunningham Annex. Waste can be transported on a cart to these locations.

12.15.2. The transportation of hazardous waste between buildings, rooms on campus or through hallways and other public spaces always poses a risk of accidental release or exposure. To minimize the risk of harm to faculty, staff, students, visitors and the environment the following guidelines listed below will be used for transporting hazardous waste by University personnel, visitors or students. Contact EHS if there are any questions.

- ALL waste containers have a proper "HAZARDOUS WASTE" Label with Initial Accumulation Date.
- ALL contents are listed. List the pH on the disposal tag.
- The bottle or jar has a cap that fits tightly.
- There are no old or extraneous labels on the container.
- There is at least 1" to 2" of head space in liquid containers to allow for expansion and reduce the potential for spillage.
- The outside of the bottle is clean and dry.
- Use secondary containers or utility service carts to transport waste to designated areas.

  Note: If transporting individual waste bottles outside of the laboratory always use secondary containment (Ex. Plastic Paint or Nalgene Buckets with secure lids, Rubber Bottle Carrier or Original Shipping Containers).

  If transporting multiple, large or heavy containers use a utility service cart with large wheels that are 4 to 6 inches in diameter and have a chemical resistant tray or surface and 3-inch lips on all sides to keep chemicals from sliding off the cart.

  Always wear the appropriate personal protective equipment (PPE) for the chemicals being transported in the event of a spill or splash to the skin or eyes.

12.17. Accumulation and Disposal

Frequent disposal will ensure that hazardous waste accumulation areas in labs are managed properly, and that accumulation limits are not exceeded. Hazardous chemical waste can be stored in a laboratory for up to 180 days. Once a waste container is 80% full or it is near the 180-day time limit, it should be transported to the waste rooms in Williams Hall or Cunningham Annex.

12.18. Hazardous Waste Minimization

12.18.1. Kent State University is a small quantity generator of hazardous waste.

12.18.2. To reduce the amount of chemicals that become waste, administrative and operational waste minimization controls can be implemented.

12.18.3. Usage of chemicals in laboratory areas should be reviewed to identify practices which can be modified to reduce the amount of hazardous waste generated.

12.18.4. To minimize the costs, health hazards, and environmental impacts associated with the disposal of hazardous waste, follow waste minimization guidelines, found in the rest of this section.

12.18.2. Purchasing Control:

Check the inventory UNH CEMS before new products are ordered. When ordering chemicals, be aware of any properties that may preclude long term storage, and order only exact volumes to be used. Using suppliers who can provide quick delivery of small quantities can assist with reducing surplus chemical inventory.

12.18.3. Inventory Control:

Rotate chemical stock to keep chemicals from becoming outdated. Identify surplus/unused chemicals and attempt to redistribute these to other users.

12.18.4. Operational Controls:

12.18.4.1. Review your experimental protocol to ensure that chemical usage is minimized.

12.18.4.2. Reduce total volumes used in experiments; employ small scale procedures when possible.

12.18.4.4. Instead of wet chemical techniques, use instrumental methods, as these generally require smaller quantities of chemicals. Evaluate the costs and benefits of off-site analytical services. Avoid mixing hazardous and non-hazardous waste streams. Use less hazardous or non-hazardous substitutes when feasible. Some examples include:

- Specialty detergents can be substituted for sulfuric acid/chromic acid cleaning solutions
- Gel Green and Gel Red are recommended in place of ethidium bromide

12.19. Drain Disposal

Kent State does not permit drain disposal of chemical wastes, unless a specific dilution and/or neutralization method for a consistent waste stream has been reviewed and approved by EHS.

See the hazardous waste guide for more information.

Drain disposal of properly disinfected infectious or biohazardous liquids is acceptable, if disinfection is conducted as specified by the EHS Biosafety Program, and the liquids disposed contain no other hazardous constituents.

12.20. Bench Top Treatment

EPA regulations allow some limited bench top treatment of certain chemical waste streams in laboratories, provided that specific procedures are followed. Due to the stringent nature of these requirements, any treatment of hazardous waste in labs must be reviewed and approved by EHS.

13. Accidents, Emergencies, and Chemical Spills

13.1 Overview

Laboratory emergencies may result from a variety of factors, including serious injuries, fires and explosions, spills and exposures, and natural disasters. All laboratory employees should be familiar with and aware of the location of their laboratory's emergency response plans and safety manuals. Before beginning any laboratory task, know what to do in the event of an emergency situation. Identify the location of safety equipment, including first aid kits, eye washes, safety showers, fire extinguishers, fire alarm pull stations, and spill kits. Plan ahead and know the location of the closest fire alarms, exits, and telephones in your laboratory.

For all incidents requiring emergency response, call the police at 911.

13.2 Medical Emergencies

13.2.1 In the event of any medical emergency:

Check the scene to see that it is safe and that you and the victim are not in danger.

Call the Kent State Police by dialing 9-1-1 from a campus phone and give the following information:

- The location of the incident
- The type of injury or incident
- If the victim is conscious or unconscious
- If an ambulance is needed

13.2.2 If the injury is severe enough to be an emergency, do not leave the scene or attempt to move the injured person from the scene. Moving the injured person from where Kent State PD knows the person to be can delay care and worsen outcomes.

13.2.3 Get first aid kit and use as directed or to the level of your first aid training.

13.2.4 If injury came from chemical exposure or there is a potential for chemical exposure, wear appropriate PPE and do not expose yourself while assisting.

13.2.5 Do not move the victim if unsure about a head or neck injury.

13.2.6 If someone has a foreign object lodged in them, do not remove it.

13.2.7 If there is a chemical exposure as well as an injury, if the person can move themselves to wash the area at the sink or eyewash, have them do so.

13.2.8 Remain calm and reassure the victim while waiting for emergency personnel.

13.2.9 Once the area is secured and the scene/victim has been transferred to emergency responder care, notify the PI/Supervisor and report the injury to EHS using the "Report an Incident or Safety Concern" tool on the EHS main page. The campus has a requirement to report work related serious injuries to PERRP within 8 hours of the incident occurring, so the prompt reporting of the incident and relevant details is vital for EHS to follow up.

13.2.10 Accidents/Injuries that are not Medical Emergencies

PI/Laboratory Supervisors are responsible for ensuring that their employees receive appropriate medical attention in the event of an occupational injury or illness. Local medical treatment facilities can be found at the Deweese Health Clinic or UH in Ravenna. All accidents and near misses must be reported to the supervisor and EHS. An injury, incident or safety concern can also be reported to EHS online. EHS will conduct an accident investigation and develop recommendations and corrective actions to prevent future accidents. At a minimum, each laboratory must have the following preparations in place:

- Fully stocked first aid kit
- Posting of emergency telephone numbers and locations of emergency treatment facilities
- Training of staff to accompany injured personnel to medical treatment site and to provide medical personnel with copies of SDS(s) for the chemical(s) involved in the incident

13.3. Laboratory Safety Rules

13.3.1 Familiarize yourself with the lab, location and operation of the safety features (exits, fire extinguishers, safety showers, eye wash facility, and first aid and spill kits).

13.3.2 Complete training in Flashtrain on all aspects of lab safety relevant to your work prior to beginning potentially hazardous activities and when changes are made to the procedures.

13.3.3 Wear appropriate Personal Protective Equipment (PPE), such as: approved gloves, safety glasses or goggles, lab coat or apron, long pants that cover your ankles, and closed-toe shoes that cover your entire foot. PPE requirements will be designated by the hazards associated with the lab space.

13.3.4 Work in properly-ventilated areas and in a safe manner according to any relevant Standard Operating Procedures.

13.3.5 Do not eat, drink, chew gum, smoke, or apply makeup while working in laboratory spaces where chemical, radioactive, or biological hazards are present.

13.3.6 Store all chemicals and other hazardous materials according to prudent practices and Kent State policy. Know your chemical compatibilities/incompatibilities, stability, shelf life and recommended storage conditions.

13.3.6 Dispose of all waste in the correct manner in accordance with Kent State policy. There are specific protocols for chemicals, contaminated and broken glass and plastic, sharps, radioactive

isotopes and biological agents. Refer to Lab Safety Manuals for additional information on working with hazardous materials in the lab.

13.3.7 Know how to respond properly in an emergency. Clean up all spills safely and promptly, and report them to the Lab supervisor. If unsure how to safely clean up a spill, ask PI/ Lab Supervisor or EHS for assistance.

13.3.8 Report to Lab Supervisor and EHS of all incidents (spills, splashes, fires, etc.), injuries, and accidents, right away, even if the incident seems small or unimportant.

13.3.9 Report to PI/Lab Supervisor of any unsafe conditions in the laboratory as soon as possible.

13.3.10 If an employee has a severe or life threatening injury, call for emergency response at 911. Employees with minor injuries should be treated with first aid kits as appropriate(by those with proper training), and sent to the appropriate facility for further evaluation and treatment. The Deweese Health Clinic is open during normal business hours from 8AM until 5 PM. After normal business hours, treatment can be obtained at UH Hospitals in Ravenna.

13.3.11 Serious occupational injuries, illnesses, and exposures to hazardous substances must be reported to the supervisor and EHS within 8 hours. EHS will report the event to PERPP, investigate the accident, and complete exposure monitoring, if necessary. Serious injuries include those that result in permanent impairment or disfigurement, or require hospitalization. Examples include amputations, lacerations with severe bleeding, burns, concussions, fractures and crush injuries. As soon as Faculty/ Laboratory Supervisors are aware of a potentially serious incident, they must contact EHS.

13.4. Fire-Related Emergencies

If you encounter a fire, or a fire-related emergency (e.g., abnormal heating, smoke, burning odor), immediately follow these instructions:

13.4.1. Pull the fire alarm pull station and call 911 to notify the Kent State University Police Department.
13.4.2 Evacuate and isolate the area
13.4.2. Use portable fire extinguishers to facilitate evacuation and/or control a small fire (i.e., size of a small trash can), if safe to do so.
13.4.3 If possible, shut off equipment before leaving
13.4.4 Close doors and/or fume hood sash
13.4.5 Remain safely outside the affected area to provide details to emergency responders; and
13.4.6 Evacuate the building when the alarm sounds. It is against state law to remain in the building when the alarm is sounding. If the alarm sounds due to a false alarm or drill, you will be allowed to re-enter the building as soon as the Fire Department determines that it is safe to do so. Do not go back into the building until the alarm stops and you are cleared to reenter.

13.4.7 If your clothing catches on fire, go to the nearest emergency shower immediately. If a shower is not immediately available, then stop, drop, and roll. A fire extinguisher may be used to extinguish a fire on someone's person as last resort. Report any burn injuries to the supervisor immediately and seek medical treatment. Report to EHS within 8 hours every time a fire extinguisher is discharged. The fire extinguisher will also need to be replaced.

13.5 Chemical Spills

Chemical spills can result in chemical exposures and contaminations. Chemical spills become emergencies when:

13.5.1. The spill results in a release to the environment (e.g., sink or floor drain)
13.5.2 The material or its hazards are unknown
13.5.3 Laboratory staff cannot safety manage the hazard because the material is too hazardous or the quantity is too large
13.5.4 Effective emergency response to these situations is imperative to mitigate or minimize adverse reactions when chemical incidents occur.
13.5.5 Factors to Consider before Spill Clean-Up

- Size of spill area
- Quantity of chemical
- Toxicity
- Volatility
- Clean up materials available
- Training of responders

13.5.6 In the event of a significant chemical exposure or contamination, immediately try to remove or isolate the chemical if safe to do so. When skin or eye exposures occur, remove contaminated clothing and flush the affected area using an eye wash or shower for at least 15 minutes. If a chemical is ingested, follow the instructions on the SDS. Obtain medical assistance as indicated. Remember to wear appropriate PPE before helping others. Faculty/Laboratory Supervisors must review all exposure situations, make sure affected employees receive appropriate medical treatment and/or assessment, and arrange for containment and clean-up of the chemical as appropriate.

13.5.7 Small chemical spills can be cleaned up by laboratory personnel who have been trained in spill clean-up and with the appropriate materials. A small spill is generally defined as < 1 liter of chemical that is not highly toxic, does not present a significant fire or environmental hazard, and is not in a public area such as a common hallway. Large chemical spills include spills of larger quantities, spills of any quantity of highly toxic chemicals, or chemicals in public areas or adjacent to drains. Large spills require emergency response. Call 911 for assistance.

13.6. What to do with a Small Chemical Spill (<1 Liter)

13.6.1. Evacuate all non-essential persons from the spill area
13.6.2. If needed, call for medical assistance by dialing 911
13.6.3. Help anyone who may have been contaminated. Use emergency eyewashes/showers to flush the skin or eyes for at least 15 minutes
13.6.4. Post someone just outside the spill area to keep people from entering. Avoid walking through contaminated areas
13.6.5. You must have the proper protective equipment and clean-up materials to clean-up spills. Check the chemical's Safety Data Sheet (SDS) in your laboratory or online in the CEMS database.
13.6.6. Turn off sources of flames, electrical heaters, and other electrical apparatus, and close valves on gas cylinders if the chemical is flammable (stop ongoing processes if necessary)
13.6.7. Confine the spill to a small area. Do not let it spread
13.6.8. Avoid breathing vapors from the spill. If the spill is in a non-ventilated area (confined space), do not attempt to clean it up. Call for emergency personnel to respond and clean up the spill
13.6.9. Wear personal protective equipment, including safety goggles, gloves, and a laboratory coat or other protective garment to clean-up the spill (consult with SDS)
13.6.10. Work with another person to clean-up the spill. Do not clean-up a spill alone
13.6.11. DO NOT ADD WATER TO THE SPILL
13.6.12. Replenish supplies after a spill.

13.6.13 Use an appropriate kit to neutralize and absorb inorganic acids and bases. For other chemicals, use the appropriate kit or absorb the spill with sorbent pads, paper towels, vermiculite, dry sand, or diatomaceous earth. For mercury spills and for all other spills requiring specialized clean-up procedures, contact EHS. Collect the residue and place it in a clear plastic bag. Double bag the waste and label the bag with the contents and label it to be picked up as chemical waste.

13.7. What to do with a Large Chemical Spill (>1 Liter)

Large chemical spills require emergency response. Call 911. If the spill presents a situation that is immediately dangerous to life or health (IDLH) or presents a significant fire risk, activate a fire alarm, evacuate the area, and wait for emergency response to arrive.

13.7.1. Remove the injured and/or contaminated person(s) and provide first aid
13.7.2. Call for emergency medical response/medical assistance by dialing 911
13.7.3. Help anyone who may have been contaminated. User emergency eyewash/showers by flushing the skin or eyes for at least 15 minutes
13.7.4. As you evacuate the laboratory, close the door behind you, and:
13.7.5. Post someone safely outside and away from the spill area to keep people from entering
13.7.6. Confine the spill area if possible and safe to do so
13.7.7. Leave on exhaust ventilation
13.7.8. If possible, turn off all sources of flames, electrical heaters, and other electrical equipment if the spilled material is flammable

13.7.9. Avoid walking through contaminated areas or breathing vapors of the spilled material

13.7.10. Any employee with known contact with a particularly hazardous chemical must shower, including washing of the hair as soon as possible unless contraindicated by physical injuries

13.7.11. Replenish supplies after a spill.

13.8. Highly Toxic Chemical Spills

Do not clean up by yourself! All spills of these chemicals require emergency response:

- Aromatic amines
- Hydrazine
- Bromines
- Nitriles
- Carbon disulfide
- Nitro-compounds
- Cyanides
- Organic halides

13.9. Other hazards from spills

- Biological hazard
- Radioactive hazard(See radiation safety plan)
- Consult EHS in the event of either of these issues. Please also refer to the Radiation safety manual and biosafety manual.

14. Lab Audits and Compliance

14.1 Regulatory Requirements

14.1.1 Implementation of the necessary work practices, procedures, and policies outlined in this chapter is required by the following:

14.1.2 Applicable regulations include those promulgated by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

14.2 Laboratory Safety Audits

14.2.1 EHS has a comprehensive laboratory safety audit program to assist laboratories and other facilities that use, handle or store hazardous chemicals to maintain a safe work environment. This program helps to ensure compliance with regulations and to fulfill Kent State's commitment to protecting the health and safety of the campus community.

14.2.2 As part of this laboratory safety program, EHS conducts periodic inspections of laboratories and other facilities with hazardous chemicals to ensure the laboratory is operating in a safe manner and to ensure compliance with all federal, state and university safety requirements. The primary goal of lab audits is to identify both existing and potential accident-causing hazards, actions, faulty operations and procedures that can be corrected **before** an accident occurs. EHS will work with the Department Chair, Divisional Dean and University Administration to suspend or restrict any operation that "presents a significant imminent hazard associated with life safety, or the health and welfare of campus personnel or the public" until that hazardous condition or activity is abated.

14.2.3 The laboratory safety audit is comprehensive in nature and investigates all key aspects of working with hazardous chemicals. While audits are a snapshot in time and cannot identify every accident-causing mistake, they do provide important information on the overall operation of a particular laboratory. Laboratory audits categories include:

- Documentation and Training;
- Emergency and Safety Information;
- Fire Safety;
- General Safety;

- Use of personal protective equipment (PPE);
- Housekeeping;
- Chemical Storage;
- Fume Hoods;
- Chemical Waste Disposal and Transport;
- Mechanical and Electrical Safety.

14.2.4. Once the audits are completed, EHS issues a Laboratory Audit Report via Flashtrain. The report identifies deficiencies in the laboratory, both critical and non-critical. Critical deficiencies are those that have the potential to lead to serious injuries or be of critical importance in the event of an emergency. These deficiencies must be **immediately** corrected. Non-critical deficiencies must be corrected within 30-days. Any deficiency that requires a "UFM Work Order" for completion should be added to the Facilities Services Work Order system so that it can be expedited by University Facility Services(UFM). Lab personnel should know how to obtain a copy of the most recent Laboratory Audit Report. For guidance on setting up a safe and successful lab, reference the PI and Lab Supervisors Checklist.

14.3 Notification and Accountability

The laboratory audit program requires that Faculty/ Laboratory Supervisors and other responsible parties take appropriate and effective corrective action upon receipt of written notification of audit findings. Critical deficiencies are required to be corrected within 48 hours; non-critical deficiencies should be corrected within 30 days. Failure to take corrective actions within the required timeframe may result in an escalation of the notification to the Department Chair , Dean and Provost. Depending on the severity of the deficiency, the EHS Director, in consultation with the Department Chair, Divisional Dean, and Provost, may temporarily suspend research activities until the violation is corrected. In some cases, the PI may be required to provide a corrective action plan to the EHS Director prior to resumption of research activities.

14.4. Recordkeeping Requirements

Accurate recordkeeping demonstrates a commitment to the safety and health of the Kent State community, integrity of research, and protection of the environment. EHS is responsible for maintaining records of inspections, accident investigations, and training conducted by EHS staff. Documentation of training conducted by EHS staff can be accessed via Flashtrain. Departments or laboratories must document lab specific health and safety training, including safety meetings, one-on-one training, and classroom and online training. Additionally, the following records must be retained in accordance with the requirements of state and federal regulations:

- Accident records – 30 years past the date of last employment
- Laboratory audit reports – 5 years
- Measurements taken to monitor employee exposures over the Permissible exposure limit– 30 years past the date of last employment

- Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations
- Inventory for Chemical substances
- Medical records must be retained in accordance with the requirements of state and federal regulations – duration of employment plus 30 year(Maintained by Deweese and Human Resources)

Appendix

Appendix : Risk Assessment

The following are tools recommended by the American Chemical Society for use in hazard assessment. Each lab should choose a method suitable to their lab.

Checklists

Checklists are a structured process for hazard/risk assessment. The most used method.

Chemical Safety Levels (CSLs):

Defined levels of hazard (1 through 4), based on a risk assessment conducted by a qualified individual:

CSL Level 1: Minimal health or physical hazard from chemicals. No concentrated acids or bases, toxics, carcinogens, or teratogens. Less than 4 liters of flammable liquids. No fume hood required and no general ventilation rate specified. Typical examples include: temperature-controlled rooms; K–12 science teaching and demonstration labs; research labs with chemical usage in prepackaged kits; or less than 500 milliliters (mL) of chemicals with the Globally Harmonized System (GHS) "danger" signal words, laser labs (below Class 2B), and microscopy rooms.

CSL Level 2: Low health or physical hazard from chemicals. Small amounts, less than 1 liter, of concentrated reagent strength acids or bases, possesses none or limited amounts of toxic or high hazard materials. Less than 40 liters of flammable liquids stored. May need a fume hood for specific activities. Typical examples include: undergraduate chemistry or biochemistry teaching and demonstration labs, and standard biomedical research labs.

CSL Level 3: Moderate chemical or physical hazard. Lab work with concentrated acids, bases, toxic, other high hazard chemicals, or cryogenic liquids. Carcinogens or reproductive toxins are handled. Corrosive, flammable, or toxic compressed gases are present in cabinets or fume hoods. Larger volumes (> 40 liters) of flammable liquids are stored in the lab. High hazards in limited quantities may be in the lab with Environmental Health and Safety (EHS) approval (for example, hydrofluoric acid, pyrophoric chemicals, or cyanides). Labs are fume hood or local exhaust intensive. Some uses of a glove box for air or water reactive chemicals. Examples include: chemistry research, pharmacology, chemical engineering, and pathology labs, as well as other chemical intensive research labs.

CSL Level 4: High chemical or physical hazard. Work with explosives or potentially explosive compounds, or frequent use of larger quantities of pyrophoric chemicals. Use of large quantities or high hazard materials with significant potential for Immediately Dangerous to Life and Health (IDLH) conditions in the event of uncontrolled release or foreseeable incident. Use of glove box for pyrophoric, or air or water reactive chemicals.

PIs and lab managers need to establish the upper limit on the quantity of high hazard materials that are used. For example, use of more than 5 grams of a pyrophoric material, or 150 mL of 2 molar t-butyllithium (in pentane) could be considered larger quantities.

Control Banding

Control Banding is a form of risk assessment and rating that prioritizes hazards based on levels of risk and exposure, which leads to appropriate control selection. Control banding divides laboratory materials and processes into "bands" based on chemical properties, processes or other logical groupings.

Failure modes and effects analysis (FMEA):

An evaluation of the means that equipment can fail or be used improperly, and the effects this failure can have on the process.

Fault tree analysis (FTA):

A graphical model that illustrates combinations of failures that will cause one specific failure of interest. It is a deductive technique that uses Boolean logic symbols to break down the causes of an event into basic equipment or human failure.

Hazard analysis:

A term used to express the complete process of hazard identification, evaluation, and control.

Hazard control:

A barrier, such as a device, measure, or limit, used to minimize the potential consequences associated with a hazard.

Hazard evaluation:

The qualitative and, whenever possible, quantitative description of the inherent properties of an agent or situation having the potential to cause adverse effects. The definition of "hazard characterization" is adapted from the World Health Organization (WHO).

Hazard identification:

The identification of the type and nature of adverse effects from an agent, operation, or equipment, which has an inherent capacity to cause in an organism, system, or (sub) population.

Hazard operability (HazOp) analysis:

A technique whereby a multidisciplinary team uses a described protocol to methodically evaluate the significance of deviations from the normal design intention.

High hazard materials (to consider for used in the application of chemical safety levels):

Can be defined in two ways: (1) materials which pose a high health hazard, and (2) those which pose a high physical hazard. High health hazard materials are substances with high acute toxicity (described below) and those which are known carcinogens as identified by the International Agency for Research on Cancer (IARC) Group 1 and Group 2A agents. Group 1 agents are carcinogenic to humans and Group 2A agents are probably carcinogenic to humans. Materials with the following GHS hazard statements are presumed to be a high physical hazard and subject to a risk assessment of its actual use:

- H201: Explosive; mass explosion hazard
- H202: Explosive, severe projection hazard
- H203: Explosive; fire, blast, or projection hazard
- H220: Extremely flammable gas
- H240: Heating may cause an explosion
- H241: Heating may cause a fire or explosion
- H242: Heating may cause a fire
- H250: Catches fire spontaneously if exposed to air
- H251: Self-heating: may catch fire
- H252: Self-heating in large quantities; may catch fire
- H260: In contact with water, releases flammable gases which may ignite spontaneously
- H270: May cause or intensify fire; oxidizer
- H271: May cause fire or explosion; strong oxidizer
- Immediately Dangerous to Life and Health (ILDH):
- Any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects.

Job Hazard Analysis:

A systematic approach to address hazards by looking at a task and focusing on the relationship between the laboratory worker, the task, the tools, and the work environment to identify the hazards and reduce the risks.

Risk Rating & Assessment

Risk Rating and Assessment rates risks using probability of occurrence and severity of consequences scales. This type of assessment should be incorporated early in the experimental process and requires a higher degree of user training.

Standard Operating Procedures (SOP):

A written series of steps that can be followed to correctly and safely obtain a desired outcome. In laboratories, SOP are typically developed for repetitive procedures which are known to have associated hazards where injury, property loss, or productivity loss could result if the steps were not followed precisely.

Structured What-if Analysis (SWIF):

A system-based risk identification technique that employs structured brainstorming, using predetermined guidewords and headings (for example, timing, amount, and so forth) in combination with prompts elicited from participants (which often begin with the phrases "What if…" or "How could…"), to examine risks and hazards at a systems or subsystems level.

What-if/HazOp:

A combination of What-if and HazOp techniques, deriving the benefits of both methods for a more comprehensive review.

What-if/HazOp/checklist:

A combination of What-if, HazOp, and checklist analysis techniques, deriving benefits from each methodology for a more comprehensive review.

Hazard Assessment templates are found below, including SOP, risk matrix, risk assessment for a chemical, and what-if analysis. The PI and lab may choose to use any method suitable for hazard assessment.

Standard Operating Procedure

A Standard Operating Procedure (SOP) is a written set of instructions that document how to safely perform work involving hazardous materials or hazardous operations. SOPs may focus on any of the following:

Process (e.g., peptide synthesis, distillation)
Hazardous chemical (e.g., carbon monoxide, perchloric acid)
Class of hazardous chemical (e.g., organic solvents)

Print out the completed SOP and keep a hard copy in the lab safety binder (an electronic copy should also be kept).
Attach SDS for all chemicals used.

Date

SOP Title

Principal Investigator

Building and Room #:

Lab Phone Number:

Section 1 – Process

List the process or type of process involving hazardous chemicals - for example, "atomic absorption spectroscopy for heavy metals." Include any unique equipment used. If the term "process" does not apply, proceed to Section 2.

Section 2 – Hazardous Chemicals

List the hazardous chemicals (or class of chemicals) involved, including any hazardous products or by-products. Safety Data Sheets (SDSs) for all chemicals should be readily accessible. MSDSs for most chemicals are available through the chemical manufacturer or CEMS. UNHCEMS® (kent.edu)

Click here to enter text.

Section 3 – Potential Hazards

Describe the potential dangers for each hazardous chemical for each element of the hazardous process or procedure by consulting the SDS. Include physical, health, and environmental hazards. Sigma-Aldrich has technical bulletins that provide detailed information about various processes, equipment and classes of chemicals

Click here to enter text.

Section 4 – Approvals Required

List the circumstances under which a particular laboratory operation, procedure, activity requires prior approval from the Principal Investigator (PI), laboratory supervisor, or other personnel.

Click here to enter text.

Section 5 – Designated Area

Consider establishing a designated area for this operation within the laboratory. A fume hood, portion of the laboratory, or the entire laboratory may be the designated area.

Click here to enter text.

Section 6 – Special Handling Procedures and Storage Requirements

Describe special handling procedures and storage requirements including, (but not limited to): specific laboratory techniques; ventilation requirements; temperature controls; chemical incompatibilities; special containment devices; and access restrictions. If applicable, describe safe methods to transport the chemicals.

Click here to enter text.

Section 7 – Personal Protective Equipment

List the PPE required for each activity or chemical. PPE includes gloves, laboratory coats, safety glasses, goggles, face shields, and respirators. If applicable, indicate the type of PPE (e.g., gloves, splash protection) needed for each phase of a process. For help with PPE selection or to determine if respirator use may be necessary, contact EH&S at 2-4347.

Click here to enter text.

Section 8 – Engineering/Ventilation Controls

List any engineering controls used. An engineering hazard control is generally defined as equipment or physical infrastructure that reduces or removes hazards from the laboratory. It can include specifically selected and arranged experimental equipment. Common engineering controls include the fume hood, glove box, biosafety cabinet and laser interlock.

Click here to enter text.

Section 9 – Spill and Accident Procedures

Describe procedures for handling potential emergencies related to this chemical or process such as accidental releases to the sanitary sewer, spills, fires, chemical burns to skin or eyes, shattered glassware, etc. **Note** the location of emergency equipment such as spill kits, emergency eyewash/showers, fire extinguishers, etc. Describe any special procedures for dealing with personal exposures (e.g., calcium gluconate should be used for HF exposures). Identify the location of emergency response phone numbers and emergency contact phone numbers.

Section 10 – Waste Disposal

Describe any unique waste disposal procedures for the chemicals.

Click here to enter text.

Section 11 – Decontamination

Discuss any appropriate decontamination procedures for equipment, glassware, and clothing.

Section 12 – Protocol

This section is for particularly complex or multi-step processes. List each step of the process or procedure chronologically and the corresponding process steps. List precautionary safety measures to be taken, including the use of specific laboratory techniques and PPE. If possible, describe indicators (visual or otherwise) which show whether the reaction, equipment, etc. is working safely as intended or that a hazardous situation may be developing.

Click here to enter text.

Training Documentation

Name (Printed)	Signature	Date

Laboratory hazard risk assessment matrix

Table F-2

Laboratory Information
Laboratory Director / Principal Investigator: **Location:**

Hazard and Exposure Category	How could you be exposed to this hazard?	Given the exposure, what is negative outcome?	Severity of Consequences		Probability of Occurrence		Risk Rating (CV*OV)
			What is the expected harm?	(CV) Value (1,5,10,20)	Existing Control Measure In Place	(OV) Value (0,1,2,3,4)	
Training and Documentation							
Personnel are appropriately trained (hazard communication, waste handling, process and chemical specific hazards and risks and mitigation, emergency procedures)				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Personnel are aware of all activities in the lab and associated hazards and risks				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Average experience of lab personnel				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
SDSs and other hazard documentation are available as appropriate				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Hazard communication program is in place				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0

Process-specific risk assessment has been conducted for all processes and processes optimized				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Process-specific risk assessments are reviewed periodically				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Average value of process-specific risk assessment for all processes				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Spill and Emergency Planning							
Emergency response equipment is available and appropriate (spill kits, showers, etc.)				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Means of egress				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate emergency response materials available and accessible				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
What is the worst thing that could happen in the lab?				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Personal Protection Clothing, Equipment and Engineering Controls							
Skin / Hand Hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Eye / Face Hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Respiratory Hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0

Eye Hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Cut or Puncture Hazards from Sharp Objects				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Chemical Safety							
Hazard level of materials stored in lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Amount of hazardous materials stored in lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Adequate space and proper types of storage for materials				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Condition of containers and contents				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate material segregation				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate security measures are in place				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Current Comprehensive Inventory				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Containers are appropriately labeled				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Biological Safety							
Hazard level of materials stored in lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Amount of hazardous materials stored in lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0

Adequate space and proper types of storage for materials				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Condition of containers and contents				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate material segregation				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate security measures are in place				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Current Comprehensive Inventory				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Containers are appropriately labeled				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Radiation Safety							
Hazard level of materials stored in lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Amount of hazardous materials stored in lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Adequate space and proper types of storage and shielding for materials				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Condition of containers and contents				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate material segregation				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate security measures are in place				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0

Current Comprehensive Inventory				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Containers are appropriately labeled				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Compressed and Cryogenic Gas Safety							
Hazard level of materials stored in lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Amount of hazardous materials stored in lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Adequate space and proper types of storage for materials				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Condition of containers and contents				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate material segregation				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Appropriate security measures are in place				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Current Comprehensive Inventory				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Containers are appropriately labeled				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Equipment and Physical Hazards Safety							
Sharps Hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Trip hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0

Electrical hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Temperature extreme hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Pressure Extreme Hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Moving Parts Hazards				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
General Laboratory Safety							
Facilities are adequate for types and quantities of chemicals present				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Facilities are adequate for types and quantities of processes occurring in the lab				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
Waste Management							
All waste is stored and segregated appropriately				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
All waste is appropriately labeled				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
All waste is removed on a regular basis				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0
All waste containers and contents are in good condition				No=1 Minor=5 Mod=10 High=20		N/A=0 Rare=1 Poss=2 Likely=3 Certain=4	0

This file is excerpted from “Identifying and Evaluating Hazards in Research Laboratories: Guidelines developed by the Hazard Identification and Evaluation Task Force of the American Chemical Society’s Committee on Chemical Safety”.

Hazard assessment for a chemical

Table F-5

Laboratory Chemical Hazard Assessment and Overview
Laboratory Director / Principal Investigator:
Location:
Chemical Name:
Description:

HIGH HAZARD SUBSTANCE (HHS) CHECKLIST			
High Hazard Classification:	☐ High Acute Toxicity	☐ Carcinogen	☐ Reproductive Toxin
	☐ Air Reactive / Pyrophoric	☐ Water Reactive	☐ Explosive / Unstable
Physical state/concentration:			
Maximum quantity kept on hand:		Estimated rate of use (e.g., grams/month):	
Toxicity: LD_{50} Oral (Rat)_____ LD_{50} Skin (Rabbit)_____ Other_____			
Reactivity and Incompatibility:			
SIGNIFICANT ROUTE(S) OF EXPOSURE (CHECK ALL THAT APPLY)			
☐ Inhalation	☐ Skin contact	☐ Percutaneous injection	☐ Eye contact ☐ Ingestion
ADDITIONAL MATERIALS FOR REVIEW (ATTACHED)			
☐ Safety Data Sheet (SDS)	☐ Laboratory/Experimental Protocol		
☐ Other:			
EXPOSURE CONTROLS			
Ventilation/Isolation: Personnel must work under/in the following equipment to minimize personal exposure: ☐ Chemical hood ☐ Glove box/AtmosBag ☐ BioSafety Cabinet ☐ Balance Enclosure ☐ Other (list): If Glove box or AtmosBag, identify gas environment:			
Personnel Protective Equipment (PPE)/Clothing: Laboratory coats, close-toed shoes, clothing that covers the legs and gloves (disposable latex or nitrile) are the minimum PPE requirements for all personnel working in the laboratory. Identify additional PPE requirements for work with HHS:			
Protective clothing:	☐ Disposable laboratory coat ☐ Fire-resistant laboratory coat (e.g., Nomex) ☐ Others (list): _____		
Face / Eyes:	☐ Face shield	☐ Safety goggles	☐ Safety glasses
Gloves (type): _____			☐ Respirator (type): _____
USE AND STORAGE			

Authorized personnel: Identify categories of laboratory personnel who could obtain approval to handle and use this HHS:

☐ Principal Investigator ☐ Employees/Staff ☐ Students ☐ Volunteers
☐ Postdoctoral Employees ☐ Other (describe):

☐ Personnel must not work alone in the laboratory while handling this material

Procedure: In additional to the institution's chemical hygiene plan, identify what procedures/guidelines are available for the safe handling and use of this HHS. Check all that apply and list below.
☐ Laboratory procedure(s) ☐ Journals ☐ Manufacturer Guidelines ☐ Other
List all procedures:

Vacuum system used? ☐ Yes ☐ No If yes, ☐ Cold trap ☐ Filter ☐ other (list):
Administered to animals? ☐ Yes ☐ No

Use Location:	**Storage Location:**
Bldg(s)/ Room(s): Identify location(s) where HHS is used (check all that apply): ☐ Entire laboratory ☐ Chemical hood ☐ Designated area ☐ Other (list): _____	Bldg(s)/ Room(s): Identify location(s) where HHS is stored (check all that apply): ☐ Refrigerator/freezer ☐ Hood ☐ Double containment ☐ Vented cabinet ☐ Flammable liquid storage cabinet ☐ Other (list): _____

Hazard Communication and Signage: Confirm that the hazards of the HHS are communicated to laboratory personnel and visitors where HHS is stored and used.
☐ All containers are clearly labeled with the identity of the High Hazard Substance.
☐ Designated storage and use locations within laboratory have signage identifying the HHS hazards present in those locations.

MEDICAL ATTENTION AND FIRST-AID

Laboratory personnel should seek medical attention when:

- signs or symptoms associated with a hazardous chemical exposure are experienced, or
- exposure monitoring reveals an exposure level routinely above acceptable levels, or
- a spill, leak, explosion or other event results in the likelihood of a hazardous exposure.

Emergency Medical Provider:
Location:
Contact Information:

Are specific first-aid supplies/procedures required (e.g., antitoxin) for work with this material? ☐ Yes ☐ No
If yes, attach the specific procedures to be followed post exposure to this form.

DECONTAMINATION

Are special decontamination procedures required for this HHS? ☐ Yes ☐ No If Yes, provide information below:
Identify items that require decontamination:
☐ Work areas ☐ Nondisposable equipment ☐ Glassware ☐ Disposable laboratory equipment and supplies
☐ Other (list):

Decontamination Method (describe):

EMERGENCY PROCEDURES AND SPILL RESPONSE
Emergency Safety Equipment: In addition to an eyewash station, emergency shower and ABC fire extinguisher, are any other specialized emergency spill control or clean-up supplies required when working with this HHS? ☐Yes ☐ No If yes, list all required supplies/equipment with locations:
WASTE MANAGEMENT AND DISPOSAL
Identify waste management methods for all research and waste byproducts associated with this HHS: ☐ Chemicals wastes are collected and disposed as EPA hazardous waste including chemically contaminated sharps. ☐ Neutralization or deactivation in laboratory prior to disposal (describe method; this method requires EHS preapproval). ☐ HHS is EPA Acutely Toxic Chemical. Collect Sharps and used containers as Hazardous Waste. ☐ Other disposal method (describe method; this method requires EHS preapproval). Chemical Waste Storage Location: _____
TRAINING
All laboratory personnel must at a minimum completed safety training on an annual basis. Additionally, laboratory personnel who handle or use the High Hazard Substance must demonstrate specific competency and familiarity regarding the safe handling and use of this HHS prior to purchase or use. The Principal Investigator is responsible for ensuring all laboratory personnel handling and using this HHS are trained in the following: ☐ Review of HHS Checklist and associated documentation including Exposure Controls and PPE. ☐ Review Safety Data Sheet including Signs and Symptoms of Exposure. ☐ Hands-on training with the Principal Investigator or other knowledgeable and experienced senior laboratory staff member on the safe handling and use of the High Hazard Substance. ☐ New personnel must work under close supervision of Principal Investigator or other knowledgeable and experienced senior laboratory staff member. ☐ Other (list): _____

This file is excerpted from "Identifying and Evaluating Hazards in Research Laboratories: Guidelines developed by the Hazard Identification and Evaluation Task Force of the American Chemical Society's Committee on Chemical Safety".

Basic template for What-if analysis

Table 10-1

Division:	Description of Operation:	By: Date:

What if?	Answer	Probability	Consequences	Recommendations

This file is excerpted from "Identifying and Evaluating Hazards in Research Laboratories: Guidelines developed by the Hazard Identification and Evaluation Task Force of the American Chemical Society's Committee on Chemical Safety".

Appendix: Chemical Storage

Chemical Segregation Chart

This chart assists with proper segregation of chemicals in storage and waste. With all chemicals: **Check the SDS** (Section 7: Handling and Storage, Section 10: Stability and Reactivity) for specific storage requirements. **Label** all storage areas with the hazard present. Use **secondary containment** whenever possible for hazardous chemicals, and is **required** for all waste. Secondary should be large enough to contain **110% of the largest container**. For assistance with chemical storage questions, contact *complaince@kent.edu*, and for all lab and research safety needs, visit **https://www.kent.edu/compliance/research-safety-and-compliance**

Cat.	GHS Symbol	Chemical Hazard	Examples	Storage	Store away from
Compressed Gas		**Flammable** 	Methane Acetylene Propane	• Cool, dry area • 20 ft. away from oxidizing gases or separated by 5 ft. high wall with 0.5hr fire resistance • Secure cylinders upright with two chains/straps	Oxidizing gases Toxic gases Oxidizing solids
		Oxidizing 	Oxygen Chlorine Fluorine mixtures	• Cool, dry area • 20 ft. away from flammable gases or separated by 5 ft. high wall with 0.5hr fire resistance • Secure cylinders upright with two chains/straps	Flammable Gases
		Poisonous 	Carbon monoxide Hydrogen sulfide	• Cool, dry area • Away from flammable gases and liquids • Secure cylinders upright with two chains/straps	Flammable Gases Oxidizing Gases
Corrosives		**Inorganic Acids**	Hydrochloric acid Sulfuric acid Phosphoric acid	• Separate acid storage cabinet • Use a chemically resistant secondary container • Metal shelves not recommended due to corrosion	Flammables Bases Oxidizers Organic acids
		Organic Acids	Acetic acid Trichloroacetic acid Lactic acid	• Separate acid storage cabinet • Use a chemically resistant secondary container • Metal shelves not recommended due to corrosion	Flammables Bases Oxidizers Inorganic acids
		Oxidizing Acids	Nitric Acid Perchloric acid Chromic acid	• Separate acid storage cabinet • Use a chemically resistant secondary container • Away from flammables and other acid types • Metal shelves not recommended due to corrosion	Flammables Inorganic acids Organic acids Bases
		Bases	Ammonium hydroxide Potassium hydroxide Sodium hydroxide	• Storage cabinet separate from all acids • Use a chemically resistant secondary container	Flammable liquids Oxidizers Poisons Acids
Reactives		**Explosives**	Picric acid (dry) Tri-nitro compounds Heavy metal azides	• Secure location • Away from all other chemicals • Protect from falls, impacts, and shocks • Contact EH&S for specific guidelines	All other chemicals
		**Flammable Liquids**	Acetone Benzene Methanol	• Flammable storage cabinet • Separate, dry, cool area • Away from oxidizers and corrosives • Peroxide forming chemicals must be dated when opened	Acids/Bases Oxidizers Poisons
		Flammable Solids	Phosphorous Carbon Charcoal		

		**Oxidizers**	Hydrogen peroxide Potassium dichromate Halogens Nitrate compounds	• Non-combustible cabinet • Use a chemically resistant secondary container • Away from flammables	Reducing agents Flammables Organic materials
	No GHS symbol	**Water Reactive Chemicals**	Sodium metal Potassium metal Lithium Metal	• Dry, cool location • Use a chemically resistant secondary container • Label location "water reactive"	All aqueous solutions Oxidizers
Other		**Poisons**	Cyanides Heavy metal compounds	• Cool, dry area • Well ventilated area • Use a chemically resistant secondary container	Flammables Corrosives *Check Sections 7 & 10 of SDS*
		**Skin/Eye Irritants Acute Toxicity Narcotic Effects Respiratory Tract Irritants**	Tris Base Dichloromethane Polyvinylpyrrolidone		
		**Carcinogens Mutagens Respiratory Sensitizers Target Organ Toxicity Aspiration Toxicity**	Acrylamide Chloroform Formaldehyde	• Secure location, limit access to only trained users • Use a chemically resistant secondary container • Store separate from flammable and corrosive materials to avoid damage to container	Flammables Corrosives *Check Sections 7 & 10 of SDS*

Appendix : Laboratory Safety Audit Checklist

Department:	Date:
Building:	Room #:
Principal Investigator / Lab Manager:	
Auditor:	

Section A: General Safety

Hazard Communication *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
1. Hazard Warning Signs posted at the entrance door with Emergency Contact Information listed.	☐	☐	☐	☐	
2. Material Safety Data Sheet (MSDS) / Safety Data Sheet (SDS) for chemical use in the laboratory are located in the laboratory in case of an emergency.	☐	☐	☐	☐	
3. Kent State University Chemical Hygiene Plan in the laboratory.	☐	☐	☐	☐	
4. Chemical Hygiene Plan for the laboratory.	☐	☐	☐	☐	
5. Chemical Inventory Records centrally located and accessible.	☐	☐	☐	☐	
6. SOP's accessible and available for general, hazardous or experimental activity and signed training records for all individuals working in the laboratory.	☐	☐	☐	☐	
7. All personnel have taken the online safety courses for Chemical Safety Introduction or Biosafety Introduction or both?	☐	☐	☐	☐	
8. Lab procedure for flow alarms and audible alarms indicators when they go off in the laboratory.	☐	☐	☐	☐	
Housekeeping & Maintenance *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
9. Bench tops and workspaces free of clutter.	☐	☐	☐	☐	
10. No Food, Drink or Cosmetic Application in the areas where chemicals are used.	☐	☐	☐	☐	

11. Floors free of debris, spilled liquids or other obstructions that may cause a trip or slip and fall.	☐	☐	☐	☐	
12. Safety Shower & Eyewash Stations unobstructed and inspection records up to date. (monthly inspections)	☐	☐	☐	☐	
13. Equipment calibrations are current. (gas monitors, Geiger counters)	☐	☐	☐	☐	
14. First Aid Kits fully stocked with no expired contents.	☐	☐	☐	☐	
15. Chemical Spill Kit available and accessible.	☐	☐	☐	☐	
16. Is any office space located inside the lab separated from the other work areas and labeled as an office area?	☐	☐	☐	☐	
17. Are the machines or equipment guarded at their point of operation that have power transfer or moving parts guarded to protect employees and others in the area.	☐	☐	☐	☐	
Electrical Safety *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
18. Electrical plugs, cords and outlets are in good condition.	☐	☐	☐	☐	
19. All electrical tools and instrumentation shall be double insulated, properly grounded and connected to a ground fault circuit interrupter (GFCI).	☐	☐	☐	☐	
20. Circuit breaker panels are unobstructed.	☐	☐	☐	☐	
21. Are extension cords used as a replacement for permanent wiring?	☐	☐	☐	☐	
22. Power strips secured to the floor and no daisy chained power strips.	☐	☐	☐	☐	
23. Rheostats outside the hood.	☐	☐	☐	☐	
Fire Safety *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
24. Appropriate fire extinguisher in the workroom located near the door or along egress path.	☐	☐	☐	☐	
25. Ceiling storage clearance from water sprinklers should be 18”.	☐	☐	☐	☐	
26. Two separate exit doors clearly marked and unobstructed.	☐	☐	☐	☐	
27. Have lab workers taken fire extinguisher training?	☐	☐	☐	☐	
Section B: Chemical Safety					
Chemical Storage *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
28. Hazardous Material containers labeled with content (Name, Date, and Hazard Warning).	☐	☐	☐	☐	

29. Chemical waste containers in good condition and kept sealed – (no damage, leaks, rust or bulging).	☐	☐	☐	☐	
30. Chemical storage cabinets are labeled.	☐	☐	☐	☐	
31. Flammables and oxidizers are stored separately.	☐	☐	☐	☐	
32. Flammable substances placed in laboratory refrigerators are labeled flammable only or explosion proof.	☐	☐	☐	☐	
33. Laboratory refrigerators and low (-20˚C) and ultra-low freezers (-80˚C) with biological specimen or samples are alarmed?	☐	☐	☐	☐	
34. Flammable or combustible materials are restricted to no more than 10 gallons in each laboratory unless stored in a flammable cabinet.	☐	☐	☐	☐	
35. Strong acids and bases are stored in separate cabinets or separated in the cabinet using secondary containers.	☐	☐	☐	☐	
36. Water reactive chemicals are labeled and contained in designated area.	☐	☐	☐	☐	
37. Pyrophoric chemicals are labeled and placed in designated storage.	☐	☐	☐	☐	
38. Peroxide formers and ethers need to be labeled and dated.	☐	☐	☐	☐	
39. Carcinogens labeled.	☐	☐	☐	☐	
40. Compressed gas cylinders secured with chain in an upright position and capped when not being used.	☐	☐	☐	☐	
41. Are cylinders legibly marked to identify the gas contained in them?	☐	☐	☐	☐	
42. Are flammable gases separated from oxidizing gases in storage areas?	☐	☐	☐	☐	
43. Do all compressed gas cylinders have safety pressure relief valves?	☐	☐	☐	☐	
44. Are hydrofluoric acid (HF) safety procedures posted and observed? Are first aid procedures and fresh calcium gluconate gel available? HF Spill Kit in the lab?	☐	☐	☐	☐	
45. Are procedures involving heated perchloric acid prohibited except in a perchloric acid hood?	☐	☐	☐	☐	
Hazard Waste *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
46. All hazardous waste must be labeled with Name, Date and the words “HAZARDOUS WASTE”.	☐	☐	☐	☐	
47. No hazardous materials found in the regular trash.	☐	☐	☐	☐	

48. Dry hazardous waste is double bagged within a clear bag.	☐	☐	☐	☐	
49. Hazardous chemicals transported utilizing secondary containers – carts, carriers, boxes.	☐	☐	☐	☐	
50. Glass waste receptacle contains broken glass or glass waste (Pasteur pipettes) and not overfilled?	☐	☐	☐	☐	
51. Used needles, syringes and other sharps are located in puncture resistant container and less than ¾" full. Non-hazardous sharps containers labeled "Sharps Container Only" with no biohazard symbol.	☐	☐	☐	☐	
52. Are all Hazardous Waste Containers closed with a properly securing lid?	☐	☐	☐	☐	
Ventilation *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
53. Fume hoods are free of clutter and stored chemicals.	☐	☐	☐	☐	
54. Fume hoods maintaining 80-120fpm face velocity with the sash at 18".	☐	☐	☐	☐	
55. Fume Hoods are equipped with flow monitoring devices. ex. (Magnehelic Gage)	☐	☐	☐	☐	
56. Fume hoods inspected annually and inspection records are current.	☐	☐	☐	☐	
57. Sash stoppers on fume hoods are working properly.	☐	☐	☐	☐	
58. The lab is under negative pressure with respect to the corridor.	☐	☐	☐	☐	
59. Laboratory doors are kept close.	☐	☐	☐	☐	
60. All materials located in the fume hood should be 6"away from the vertical plane of the sash.	☐	☐	☐	☐	
61. Equipment located in the hood is elevated 1-2" to maintain proper airflow.	☐	☐	☐	☐	
62. Sash lowered or closed when not in use.	☐	☐	☐	☐	
63. All plaster mixes performed under a ventilated hood.	☐	☐	☐	☐	
64. Easels located approximately 3 feet away from a window that has fan exhaust at working level.	☐	☐	☐	☐	
65. Window exhaust fan used for acrylic paints and mixing casein paints using ammonium hydroxide.	☐	☐	☐	☐	
Personal Protective Equipment (PPE) *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
66. Appropriate chemical laboratory / workroom clothing – long pants and closed shoes.	☐	☐	☐	☐	

67. PPE is easily accessible and worn when appropriate. Type of PPE present: Lab Coats or Gowns ☐ Disposable Gloves ☐ Safety Glasses ☐ Hearing Protection ☐ Goggles ☐ Booties ☐ Face Shield ☐ Respirators ☐	☐	☐	☐	☐	
68. Sufficient supply of PPE.	☐	☐	☐	☐	
69. Have participants been trained on the proper use, cleaning and maintenance of their PPE?	☐	☐	☐	☐	
70. NIOSH-approved respirators with HEPA filters are to be used when carving all stones.	☐	☐	☐	☐	
71. Neoprene gloves are to be used while cleaning art brushes with mineral spirits or turpentine.	☐	☐	☐	☐	
Section C: Biosafety					
Biosafety Documentation *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
72. If no biohazard handling, storage or waste is generated in this area then select **N/A** in the next column. If biological agents are handled select **Type** and **Yes** in the next column: BSL - 1 ☐ rDNA ☐ BSL - 2 ☐ Animals ☐	☐	☐	☐	☐	
73. Biohazards signs posted at the entrance with agent information.	☐	☐	☐	☐	
74. Biosafety manual available and accessible to all laboratory employees.	☐	☐	☐	☐	
75. Exposure Control Plan available and accessible to all laboratory employees.	☐	☐	☐	☐	
76. Emergency procedures posted.	☐	☐	☐	☐	
77. Biohazard signs posted on all equipment utilized for infectious materials – (centrifuges, sonicators, blenders, shakers, homogenizers etc.).	☐	☐	☐	☐	
Biosafety Standard Microbiological Practices *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
78. Laboratory sink accessible for hand washing.	☐	☐	☐	☐	
79. Used needles, syringes and other sharps are located in puncture resistant container and less than ¾" full.	☐	☐	☐	☐	

80. Biosafety Cabinets (BSC) have been certified within the last year and located away from heavily traveled areas such as doors.	☐	☐	☐	☐	
81. The autoclave is validated by spore testing or other approved method.	☐	☐	☐	☐	
82. Autoclave log available.	☐	☐	☐	☐	
83. Mechanical pipetting devices are always used; no mouth pipetting.	☐	☐	☐	☐	
Biosafety Facility – BSL2	Yes	No	N/A	CAI	Comments
84. Controlled access to workrooms – self-locking doors.	☐	☐	☐	☐	
85. Biosafety Cabinets have been certified within the last year and located away from heavily traveled areas such as doors.	☐	☐	☐	☐	
86. Research animals are contained in approved housing or cages.	☐	☐	☐	☐	
87. Disinfectants readily available for surface cleaning and spills.	☐	☐	☐	☐	
88. Biological and liquid biohazard waste autoclaved prior to disposal.	☐	☐	☐	☐	
89. Non-autoclaved biohazardous waste is collected within durable, leak-proof containers, labeled with a biohazard symbol, lined with two red biohazard bags and held in waste room for off-site disposal.	☐	☐	☐	☐	
90. Biological spill kit present and accessible.	☐	☐	☐	☐	
Bloodborne Pathogens: Human blood, Body fluids, Cell lines, Unfixed tissues) *CAI – Corrected At Time of Inspection	Yes	No	N/A	CAI	Comments
91. All employees working with Bloodborne Pathogens have taken a Hepatitis B shot or signed the required KSU waiver form.	☐	☐	☐	☐	
92. Bloodborne Pathogen training documentation.	☐	☐	☐	☐	
Additional Comments					
References					
Hazard Communication					
1. Reference: CFR 1910.1450 (f), NFPA 45 & KSU Chemical Hygiene Plan **Recommendation**: The lab is required to provide a sign containing the following information: Principle Investigator Name, Emergency Contact Information, GHS laboratory hazard information, required PPE and any special hazard information pertinent to the lab.					

2. Reference: CFR 1910.1450 (f),(e)(4), 1910.1450(h)(1)(ii) , Ohio Fire Code 1301:7-7-27 & KSU Chemical Hygiene Plan

Recommendation: According to OSHA 1910.1200 the Hazard Communication Regulation, all hazardous chemicals produced or imported must have a SDS because it provides chemical hazard communication and safe handling of hazardous substances. They provide the information needed to work with the material safely, therefore all employees must have access to these documents.

3. Reference: KSU Chemical Hygiene

Recommendation: A copy of the chemical hygiene plan for the university should be kept in the laboratory so that all laboratory staff understand general laboratory practices that are necessary to protect workers from exposure to hazardous chemicals.

4. Reference: KSU Chemical Hygiene Plan

Recommendation: A laboratory chemical hygiene plan should be developed and be accessible to all individuals working in the laboratory so they understand specific laboratory procedures and practices that are specific to that lab to protect the workers from exposure to hazardous chemicals and minimize the risk of injury.

5. Reference: CFR 1910.1450 (f),(e)(4), OSHA Laboratory Standard Appendix A Section D.2 Chemical Inventory (a)(b), Ohio Fire Code 1301:7-7-27, Department of Homeland Security Chemical Facility Anti-Terrorism Standards

Recommendation: The chemical inventory allows the university to provide essential information for emergency response and reporting. In order to provide effective emergency response according to OSHA 1910.1200 the Hazard Communication Regulation, all hazardous chemicals information for produced or imported chemicals is to be accessible and transmitted to all employees. This information should be reviewed annually by the PI to ensure the information is true and accurate.

6. Reference: CFR 1910.1450(f)(4)(i)(c) & KSU Chemical Hygiene Plan

Recommendation: Standard Operating Procedures are required as a part of the OSHA Standard for a Chemical Hygiene Plan and the KSU Chemical Hygiene Plan which defines the measures necessary for individuals to protect themselves from exposure to chemical hazards, which includes specific procedures such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

7. Reference: CFR 1910.1450(f) & KSU Chemical Hygiene Plan

Recommendation: Employee training is required according to OSHA and the KSU Chemical Hygiene Plan to ensure employees have the correct information and instruction to make certain that they are familiar with the chemicals hazards in their work area and to safely handle and work with the hazards. Training includes any instruction on topics that are related to working in the laboratory and can come in the form of online instruction, group instruction or a one on one session.

Housekeeping & Maintenance

8. Reference: KSU Chemical Hygiene Plan

Recommendation: Flow and audible alarms warn fume hood users that the exhaust ventilation is no longer adequate so the alarm should be reported to the proper personnel and procedures in the fume hood must cease until the cause for the alarm is resolved.

9. Reference: Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards(2011) (pg. 113) & KSU Chemical Hygiene Plan

Recommendation: Laboratory bench tops must be cleaned and free of clutter. Bench tops should be cleaned up at the end of each operation and at the end of the day to minimize surface contamination.

10. Reference: OSHA Laboratory Standard 29 CFR 1910.1450, Appendix A, KSU Chemical Hygiene Plan

Recommendation: No food, drinking, smoking or cosmetic application should be performed in the laboratory. The consumption of food should only be done in designated areas which will be identified by the department or done outside the laboratory.

11. Reference: CFR1910.1450(e)(3)(viii)(C) & KSU Chemical Hygiene Plan

Recommendation: Debris or spills should be cleaned up immediately from floors or work areas to minimize contamination and prevent slip or trip injuries.

12. Reference: 29 CFR 1910.1450, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011)(pg. 180),KSU Chemical Hygiene Plan, ANSI Z358.1-2009

Recommendation: Eyewash stations & safety showers should be reached within 10 seconds of travel and inspected monthly. Safety showers should maintain a 16" diameter area that must be kept free from any obstruction.

13. Reference: OSHA 29 CFR 1910.146 "permit-required confined spaces" paragraph (c)(5)(ii)(C) explicitly states that, "Before an employee enters the space, the internal atmosphere shall be tested, with a calibrated direct-reading instrument." OSHA Compliance Directive CPL 2.100, "Application of the Permit-Required Confined Spaces (PRCS) Standards, 29 CFR 1910.146" defines "calibrated": "A testing instrument calibrated in accordance with the manufacturer's recommendations meets this requirement. The best way for an employer to verify calibration is through documentation."

Recommendation: Instrument users are held accountable to calibrating and/or testing the performance of their instruments in accordance with the manufacturer's instruction manual. OSHA expects instrument users to be able to document that their procedures match the requirements listed. The instructions, cautions and warnings listed in the owner's manual are governed not by OSHA, but by the standards to which the instrument is Classified, Listed or Marked by Nationally Recognized Testing Laboratories such as Underwriters Laboratories®.

14. Reference: 29 CFR 1910.266 App A, KSU Chemical Hygiene Plan

Recommendation: First aid kits and supplies should be available to provide treatment to minor injuries that occur in the lab or for temporary treatment until medical assistance can be attained. The first aid kits should be checked on an annual basis to ensure that all supplies are current and not expired. The first aid kits should contain items adequate for the hazards in the lab.

15. Reference: 29 CFR 1910.1450, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011)(pg. 120 & 177), Ohio Fire Code 1301:7-7-27(A)(3)

Recommendation: If a chemical spill were to occur, the laboratory should have the necessary supplies to clean up a 1 gallon or less chemical spill. The necessary chemical spill kit supplies required are based on the chemical hazards present in that laboratory.

16. Reference: 29 CFR 1910.1450, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011)(pg. 120 & 177), Ohio Fire Code 1301:7-7-27(A)(3)

Recommendation: Laboratory space should be physically separated from personal desk space, meeting space and eating areas and labeled as such.

17. Reference: 29 CFR 1910.212 (a)(3), KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011)(pg. 163)

Recommendation: The point of operation machines that expose employee to injury should be guarded to prevent operator's body parts from being in the danger zone during operation. If the standard is not available for the machine the machine design should be constructed so that the operator does not have any body parts in the danger zone during operation. If possible use special hand tools or attach guard elsewhere if it cannot be attached to the machine.

Electrical Safety

18. Reference: 29 CFR 1926.416 (e)(1), KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011)(pg. 151), NFPA 70 National Electrical Code

Recommendation: Extension cords should not be used as permanent wiring. Never overload electrical outlets and remove damaged electrical cords from service.

19. Reference: 29 CFR 1926.416 (e)(1), KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011)(pg. 152), NFPA 70 National Electrical Code

Recommendation: To minimize the risk of electrical shock all equipment should be grounded and connected to a GFCI.

20. Reference: KSU Chemical Hygiene Plan, NFPA 70 National Electrical Code

Recommendation: Utility controls, exit doors or emergency equipment access should never be obstructed.

Reference: 29 CFR 1910.303 (b) (2), KSU Chemical Hygiene Plan, NFPA 70 National Electrical Code
Recommendation: Power strips are not designed to be connected to one another per the Underwriters Laboratory (UL) listing. They should also be secured to the floor to prevent a trip hazard when being used.

21. Reference: KSU Chemical Hygiene Plan, NFPA 70 National Electrical Code

Recommendation: Utility controls, exit doors or emergency equipment access should never be obstructed.

Reference: OSHA (29 CFR §1910.303(a), 29 CFR 1910.303 (b) (2), KSU Chemical Hygiene Plan, NFPA 70 National Electrical Code
Recommendation: Power strips are not designed to be connected to one another per the Underwriters Laboratory (UL) listing. They should also be secured to the floor to prevent a trip hazard when being used.

Fire Safety

22. Reference: KSU Chemical Hygiene Plan, NFPA 45

Recommendation: Rheostats inside the hood can overcrowd the hood and can also be ignition sources.

23. Reference: 29 CFR 1910.303 (b) (2), KSU Chemical Hygiene Plan, NFPA 45, 10

Recommendation: Fire extinguishers should be easily accessible and situated along the exit path.

24. Reference: 29 CFR 1910.159(c)(10), KSU Chemical Hygiene Plan, NFPA 13

Recommendation: To avoid the interruption of water discharge from the sprinklers, ceiling storage should be 18" below the sprinkler deflector.

25. Reference: OSHA 29 CFR 1910.37(f)(3), KSU Chemical Hygiene Plan, NFPA 45

Recommendation: In the case of a hazard release or explosion which may restrict access to one outlet there is a second exit route.

Chemical Storage

26. Reference: 29 CFR. 1910.1450 (h) (1), KSU Chemical Hygiene Plan, EPA, RCRA Regulations, NFPA 45
Recommendation: Chemical waste will be treated, handled and disposed of according to regulations set forth by the EPA. Processes that generate laboratory waste should be stored, labeled and disposed of in a streamline manner.

27. Reference: 29 CFR 1910.1450 (h) (1), KSU Chemical Hygiene Plan
Recommendation: Chemical waste containers are to be labeled and securely fastened. Chemical waste containers should not be stored on the floor to avoid container puncture which could result in leakage or a trip and fall hazard. Any chemicals in containers that are leaking, rusting, damaged or bulging should be removed.

28. Reference: 29 CFR 1910.1450 App A, KSU Chemical Hygiene Plan, NFPA 45, 30, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011)(pg. 114), Ohio Fire Code 1301:7-7-27 (2703.8.7.2)
Recommendation: Chemical storage cabinet labeling communicates hazards to anyone that enters the laboratory and prevents accidental misuse or inadvertent mixing of incompatible chemicals.

29. Reference: 29 CFR 1910.1450 (h) (1), KSU Chemical Hygiene Plan, NFPA 45, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011) (pg. 96), Ohio Fire Code 1301:7-7-27 (2703.9.8)
Recommendation: To prevent contact with each other and avoid and explosion, incompatible materials having a capacity of 5 lbs. or 2 L should be separated by a distance of not less than 20 feet or by a noncombustible partition extending not less than 18 inches above and to the sides of the stored material or by storing liquid and solid materials in hazardous material storage cabinets Ohio Fire Code 1301:7-7-27 (2703.9.8).

30. Reference: 29 CFR 1910.1450 App A, KSU Chemical Hygiene Plan, NFPA 45, Ohio Fire Code 1301:7-7-27 (2703.9.8)
Recommendation: Laboratory-grade, explosion proof refrigerators and freezers should be used to store closed chemical containers of flammable liquids that require cool storage. Do not store food or beverages in the laboratory refrigerator. Incompatible materials having a capacity of 5 lbs. or 2 L should be separated by a distance of not less than 20 feet or by a noncombustible partition extending not less than 18 inches above and to the sides of the stored material or by storing liquid and solid materials in hazardous material storage cabinets Ohio Fire Code 1301:7-7-27 (2703.9.8).

31. Reference: KSU Chemical Hygiene
Recommendation: Alarm installation and monitoring process are designed to protect important substances that have temperature specific requirements.

32. Reference: NFPA 45
Recommendation: Due to the laboratory classification in NFPA and fire separation standard only 10 gallons of flammables are permissible outside a flammable cabinet.

33. Reference: 29 CFR 1910.1450 App A, KSU Chemical Hygiene Plan, NFPA 45, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011) (pg. 96), Ohio Fire Code 1301:7-7-27 (2703.9.8)
Recommendation: To prevent contact with each other and avoid explosion, incompatible materials having a capacity of 5 lbs. or 2 L should be separated by a distance of not less than 20 feet or by a noncombustible partition extending not less than 18 inches above and to the sides of the stored material or by storing liquid and solid materials in hazardous material storage cabinets Ohio Fire Code 1301:7-7-27 (2703.9.8).

34. Reference: 29 CFR 1910.106(d)(7)(iv), KSU Chemical Hygiene Plan, NFPA 45, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011) (pg. 96), Ohio Fire Code 1301:7-7-27 (2703.9.8)

Recommendation: Water reactive materials should be protected and isolated from water and other chemicals such as flammables to avoid explosion. Incompatible materials having a capacity of 5 lbs. or 2 L should be separated by a distance of not less than 20 feet or by a noncombustible partition extending not less than 18 inches above and to the sides of the stored material or by storing liquid and solid materials in hazardous material storage cabinets Ohio Fire Code 1301:7-7-27 (2703.9.8).

35. Reference: 29 CFR 1910.1450 App A, KSU Chemical Hygiene Plan, NFPA 45, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011) (pg. 96), Ohio Fire Code 1301:7-7-27 (2703.9.8)

Recommendation: Pyrophoric chemicals ignite when exposed to air so therefore these should be protected and isolated from air by keeping them under inert atmospheres, in solvents or gas cabinets. Incompatible materials having a capacity of 5 lbs. or 2 L should be separated by a distance of not less than 20 feet or by a noncombustible partition extending not less than 18 inches above and to the sides of the stored material or by storing liquid and solid materials in hazardous material storage cabinets Ohio Fire Code 1301:7-7-27 (2703.9.8).

36. Reference: 29 CFR 1910.1450 App A, KSU Chemical Hygiene Plan, NFPA 45, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011) (pg. 96).

Recommendation: Peroxide formers should be dated upon receipt, and dated anytime upon opening, and stored away from heat and light with fitted, nonmetal lids. These materials should also be tested at least every 3 months for peroxide formation.

37. Reference: 29 CFR 1910.1450 (e)(3)(viii) , App A , KSU Chemical Hygiene Plan, NFPA 45, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011) (pg. 96).

Recommendation: Carcinogens are cancer causing agents and should be labeled as such and sealed and stored in an unbreakable primary container.

38. Reference: 40 CFR 1910.1450 App A, KSU Chemical Hygiene Plan, NFPA 45.

Recommendation: Compressed gas cylinders should always be stored in an upright position and chained to a stable structure such as a wall.

39. Reference: KSU Chemical Hygiene Plan

Recommendation: Hydrofluoric acid is corrosive, but also highly toxic because of the fluoride ion ability to travel throughout the body. Due to the toxicity of this acid, it should always be used in a compatible fume hood with a warning notice that HF is being used. The first aid kid must contain calcium gluconate gel and emergency response procedures should be posted. In case of a spill a HF Spill Kit must be available.

40. Reference: Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011) (pg. 233), KSU Chemical Hygiene Plan, NFPA 45.

Recommendation: Perchloric acid when heated will evolve acid vapors that can condense inside the fume hood exhaust system. The condensed acid can react with organics present in the area to form, shock-sensitive perchlorate salts and esters which can be explosive. Therefore perchloric acid can only be used in hoods designed with a wash down feature to remove the perchlorates left over in the system.

Hazard Waste

41. Reference: Hazardous Waste Generators Regulation 40 CFR §262.34(a) (2) (3), DOT, KSU Chemical Hygiene Plan.

Recommendation: The container must be marked with the date the hazardous waste completely fills the container. In addition, you must clearly mark all containers holding hazardous waste with the words "HAZARDOUS WASTE" and comply with Department of Transportation (DOT) labeling requirements on the container before the waste can be shipped off site which requires identification of the waste, including name and characteristics.

42. Reference: KSU Chemical Hygiene Plan, EPA, RCRA Regulations, NFPA 45.

Recommendation: The regulations require that chemical waste will be handled and disposed of according to regulations set forth by the EPA. Processes that generate laboratory waste should be stored, labeled and disposed of in a streamline manner.

43. Reference: KSU Chemical Hygiene Plan, EPA, RCRA Regulations, NFPA 45.

Recommendation: The regulations require that chemical waste will be treated, handled and disposed of according to regulations set forth by the EPA. Processes that generate laboratory waste should be stored, labeled and disposed of in a streamline manner.

44. Reference: KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory Practices: Handling and Management of Chemical Hazards (2011) (pg. 90).

Recommendation: Chemicals must be transported in secondary containers with a handle that are able to contain the materials in the event of a breakage or a spill. Approved secondary containers are usually made of rubber, plastic or metal.

45. Reference: KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory Practices: Handling and Management of Chemical Hazards (2011) (pg. 114).

Recommendation: Laboratory glass and plastic waste which are not considered sharps but could puncture regular waste bags and therefore endanger waste handlers. Examples are broken glass, glass slides, cover slips, Pasteur Pipettes or test tubes.

46. Reference: KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory Practices: Handling and Management of Chemical Hazards (2011) (pg. 111, 114).

Recommendation: Placing sharps in a sharps container will reduce the risk of needle sticks, cuts, and punctures from loose sharps. Overfilling a sharps disposal container increases the risk of an accidental needle-stick injury. The biohazard symbol is not required for sharps containers not containing bio hazardous sharps.

Ventilation

47. Reference: KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory Practices: Handling and Management of Chemical Hazards (2011) (pg. 223), NFPA 45.

Recommendation: Keep the fewest amount of chemicals needed to conduct experiments in the hood. Items stored in the fume hood can block airflow and interfere with the containment of vapors.

48. Reference: OSHA 19.10.1450, KSU Chemical Hygiene Plan, ANSI/AIHA Z9.5, NFPA 45.

Recommendation: ANSI/AIHA Z9.5: "Each hood shall maintain an average face velocity of 80-120 fpm with no face velocity measurement more than plus or minus 20% of average."

49. Reference: OSHA 1910.1450 Appendixes A, KSU Chemical Hygiene Plan, ANSI/AIHA Z9.5, NFPA 45.

Recommendation: OSHA "Each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use". ANSI/AIHA Z9.5: "New and remodeled hoods shall be equipped with a flow-measuring device." NFPA 45 "New and remodeled hoods shall be equipped with a flow-measuring device.

50.

51. Reference: OSHA 1910.1450 Appendixes A, KSU Chemical Hygiene Plan, ANSI/AIHA Z9.5, NFPA 45.
Recommendation: OSHA: "Quality and quantity of ventilation should be evaluated on installation, regularly monitored (at least every 3 months), and re-evaluated whenever a change in local ventilation devices is made." ANSI/AIHA Z9.5: "A routing performance test shall be conducted on every fume hood at least annually or whenever a significant change has been made to the operational characteristics of the system". NFPA 45: "When installed or modified and as at least annually thereafter, laboratory hoods, laboratory hood exhaust systems, and laboratory special exhaust systems shall be inspected and tested."

52. Reference: Prudent Practices in the Laboratory Practices: Handling and Management of Chemical Hazards (2011) (pg. 223), KSU Chemical Hygiene Plan.
Recommendation: The sash should be kept closed, except when working within the hood is necessary, to contain and protect from chemical vapors, splashes, or explosions. Keep the hood sash closed as much as possible to maximize the hood's performance and the maximize energy conservation. The sash or panels should not be removed except for apparatus set-up. Prior to beginning work in the fume hood replace sash or panels and ensure they are operating correctly.

53. Reference: OSHA 1910.1450 Appendix A, KSU Chemical Hygiene Plan Prudent Practices in the Laboratory Practices: Handling and Management of Chemical Hazards (2011) (pg. 219).
Recommendation: When negative pressure exists, a continuous air current enters the room under the door, which prevents airborne particles generated in the room from escaping into the corridor.

54. Reference: OSHA 1910.1450, KSU Chemical Hygiene Plan.
Recommendation: Laboratory doors must be kept close to maintain the correct differential pressure necessary to maintain the negative pressure in the room with respect to the hallway which prevents chemical vapors from leaving the laboratory.

55. Reference: OSHA 1910.1450, KSU Chemical Hygiene Plan
Recommendation: Materials kept at this distance from the sash ensure that no contaminant will escape from the fume hood and enter the operator's breathing zone. It also allows the air to flow freely through the airfoil.

56. Reference: OSHA 1910.1450, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory (2011) (pg. 110)
Recommendation: When using large equipment in the hood they should be elevated 1-2" using blocks or other stable support devices to allow air flow beneath it. Also be sure to use scrubbers, condensers, traps and other fittings to collect waste solvents, vapors and dusts.

57. Reference: OSHA 1910.1450, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory (2011) (pg. 110)
Recommendation: Mixing plasters generates dust which may be irritating to the eyes and respiratory system therefore this process should be carried out in a fume hood.

58. Reference: OSHA 1910.1450 Appendix A,
Recommendation: The fan will pull the solvent vapors away from your breathing zone to minimize inhalation and contact with skin.

59. Reference: OSHA 1910.1450, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory (2011) (pg. 110)
Recommendation: The fan exhaust will provide ventilation to keep the solvent vapors away from your breathing zone and minimize inhalation and contact with skin.

Personal Protective Equipment (PPE)
60. Reference: OSHA 1910.132 (A), KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory (2011) (pg. 108-113) **Recommendation**: The use of appropriate PPE helps to minimize workplace injury and illness and it is required for all individuals that handle chemical, radiological, biological hazards or blood borne pathogens, recombinant microorganisms and other process hazards.
61. Reference: OSHA 1910.132 Appendix A, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory (2011) (pg. 108-113) **Recommendation**: The use of appropriate PPE helps to minimize workplace injury and illness and it is required for all individuals that handle chemical, radiological, biological hazards or blood borne pathogens, recombinant microorganisms and other process hazards and should be suited for the hazards present in the work area.
62. Reference: OSHA 1910.132 Appendix A, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory (2011) (pg. 108-113) **Recommendation**: There should be an adequate amount of appropriate PPE for each student or employee working in the area so that each individual has the appropriate protection to help minimize workplace injury and exposure to process hazards present in the work area.
63. Reference: OSHA 1910.132 Appendix A, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory (2011) (pg. 178-179) **Recommendation**: The dust particles generated from this process can range from 0.1 um to 10um which is small enough to be transported throughout the body once inhaled, therefore requiring a respirator with a HEPA filter to be used during this procedure.
64. Reference: OSHA 1910.132 Appendix A, KSU Chemical Hygiene Plan, Prudent Practices in the Laboratory (2011) (pg. 108-113) **Recommendation**: These types of gloves are much heavier and the neoprene compounds are more resistant to strong chemicals used in such chemical strippers to cleaning parts.
Biosafety Documentation
65. No Reference
66. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition **Recommendation**: The universal biohazard symbol is posted at the laboratory door entrance with principal investigator, secondary emergency and EHS contact information.
67. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition **Recommendation**: The biosafety manual is a resource for information, guidelines, protocols, policies, and procedures that will enable individuals working in the laboratory environment with biological agents to work safely and eliminate or reduce the potential for exposure to biological hazards.
68. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition, OSHA Bloodborne Pathogens Standard, 29 CFR 1910.1030 **Recommendation**: The exposure control plan is designed to eliminate or minimize employee occupational exposure to human blood or other infectious body fluids such as semen, vaginal secretions, saliva in dental procedures, and any body fluid visibly contaminated with blood.

69. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: Emergency procedures should be posted to inform personnel of the procedures in place to handle biological spills in the laboratory.

70. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition, OSHA 1910.1030 Bloodborne Pathogens
Recommendation: The biohazard symbol must be present on any equipment or apparatus in which infectious material is used to alert individuals working in the laboratory.

Biosafety Standard Microbiological Practices

71. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: To avoid cross contamination and contaminating surfaces outside of the lab individuals must wash their hands after working with potentially hazardous materials and before leaving the laboratory.

72. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: Placing sharps in a sharps container will reduce the risk of needle sticks, cuts, and punctures from loose sharps. Overfilling a sharps disposal container increases the risk of an accidental needle-stick injury.

73. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: BSC's must be certified annually to ensure that they are working properly to protect laboratory personnel and the environment from exposure to biohazards. The ideal location for any BSC is away from the laboratory entry because air movement parallel to the face of a BSC can disrupt the air curtain. So, open windows, air supply registers, or laboratory equipment that creates air movement, such as centrifuges and vacuum pumps, should not be located near the BSC's.

74. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: To verify that the autoclave sterilization process is working correctly.

75. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: The spore testing record sheets are to be completed each month and then placed in a record keeping notebook. The records must be maintained for 3 years.

76. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: Due to a high risk of injury that could occur if hazardous substances are introduced to the body, mouth pipetting is prohibited.

Biosafety Facility – BSL2

77. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: The objective of controlled access to biosafety labs is to prevent loss, theft or misuse of microorganisms, biological materials and research-related information.

78. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition
Recommendation: BSC's must be certified annually to ensure that they are working properly to protect laboratory personnel and the environment from exposure to biohazards. The ideal location for any BSC is away from the laboratory entry because air movement parallel to the face of a BSC can disrupt the air curtain. So, open windows, air supply registers, or laboratory equipment that creates air movement, such as centrifuges and vacuum pumps, should not be located near the BSC's.

79. Reference: Institutional Animal Care and Use Committee (IACUC)
Recommendation: Primary enclosures used for research animals should be constructed with materials that balance the needs of the animal with the ability to provide for sanitation.

80. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition **Recommendation**: Decontaminate work surfaces after completion of work and after any spill or splash of potentially infectious material.
81. Reference: Ohio EPA **Recommendation**: Decontaminate or deactivate all biological and liquid biological waste prior to disposal down the drain.
82. Reference: Ohio EPA **Recommendation**: This method of containment should be used to ensure that bio hazardous waste that is not able to be autoclaved is protected and it also prevents leakage or a spill while being stored in the hazardous waste room until disposal.
83. Reference: Biosafety in Microbiological and Biomedical Laboratories 5th edition **Recommendation**: Biological spill kit should be present in all labs that work with biological agents or infectious materials in case a spill occurs then the necessary materials are available to clean up immediately.
Bloodborne Pathogens: (Human blood, Body fluids, Cell lines, Unfixed tissues)
84. Reference: Bloodborne Pathogens standard, 29 CFR 1910.1030 **Recommendation**: The HBV virus can cause life threatening diseases in humans. The standard requires employers to offer the vaccination series to all workers who have to the potential to exposure.
85. Reference: Bloodborne Pathogens standard, 29 CFR 1910.1030 **Recommendation**: Bloodborne Pathogen training is required to train individuals working in these environments what the appropriate procedures and requirements are for items such as exposure control plans, universal precautions, engineering and work practice controls, personal protective equipment, housekeeping, laboratories, hepatitis B vaccination, post exposure follow-up, hazard communication and training, and recordkeeping.

Appendix: Unattended Experiment Notice

WARNING!!!

UNATTENDED EXPERIMENT NOTICE

An unattended experiment is any reaction (i.e. chemical, biological, biochemical) that is initiated by a researcher and then left unattended for a period of time. This includes leaving the lab for a lunch break, attending class, restroom breaks, etc. A reaction may be left unattended for one or multiple hours, overnight or for multiple days. Examples of unattended reactions include organic and inorganic syntheses, DNA extractions, Radiation, Analytical Equipment as well as automated processes.

Contact Information

Researcher Name	Emergency Phone Number
Principal Investigator	Emergency Phone Number

Primary Hazards

☐ Corrosive	☐ Flammable	☐ Oxidizer	☐ Explosive	☐ Combustible	☐ Poison
☐ Carcinogen	☐ Respiratory	☐ Reproductive	☐ Irritant	☐ Infectious	☐ Other

Required Building Services

☐ Water	☐ Electricity	☐ Fume Hood	☐ Compressed Gas	☐ Other

Emergency Shutdown

☐ None - Leave Alone and contact Researcher	☐ Close Fume Hood or Biosafety Cabinet Sash	☐ Evacuate Laboratory	☐ Shut off power, gas or vacuum	☐ Other

Additional Comments (Please add additional information if other is selected):

Appendix: Emergency Numbers/ Medical Facilities

EMERGENCY PHONE NUMBERS

Fire, Police, Ambulance	911
Kent State Police	330-672-3070
Environmental Health and Safety	330-672-1944
University Health Services	330-672-2322
University Hospitals Ravenna	330- 235-1251
Poison Control	800-222-1222

MEDICAL TREATMENT

Deweese Health Center
1500 Eastway Dr.
Kent, OH 44240
Phone:(330)672-2322

University Hospitals
6847 N Chestnut St
Ravenna, OH 44266
Phone: (330) 297-0811

KENT STATE

Appendix: Lab Closeout Procedures

EHS
310 Harbourt Hall
615 Loop Road, Kent,
OH 44242
Phone: (330)
672-4347

Lab Closeout or Transfer Checklist

Check all applicable procedures that have been completed to ensure that the safety of the vacated, relocated, renovated or closed lab is accordance with KSU guidelines and applicable federal, state and local regulations

✓	Chemicals	Comments
	Label all chemicals and containers including "unknowns" with full chemical names.	Dispose of all unknowns, expired and outdated chemicals or materials no longer in use (Contact EHS at x24347).
	Redistribute unopened or unused chemicals to the other laboratories or stockrooms if they are not expired or past their shelf life.	To locate other laboratories in need of chemicals use the surplus function in CEMS.
	Package **compatible** chemical containers in secondary containment. See Appendix A for compatible chemicals.	Use sturdy partitioned boxes and cushion containers with absorbent materials in the event of a spill.
	Clean and decontaminate benchtops, furniture, fume hoods, storage cabinets, freezers, refrigerators and any other equipment or surfaces.	
	Remove all labels and warning stickers.	
	Package and label all hazardous waste appropriately and transport to hazardous waste storage area.	No chemicals should be disposed of in the trash or by pouring them into sinks or drains or by evaporating them in the chemical fume hoods.
	Chemical transport	Transport **sealed** secondary containers using utility carts that have 3" lips on all sides. Never stack materials to high on the cart. Always use freight elevators or indoor corridors when transporting chemicals. If transporting hazardous chemicals off campus contact EHS at x24347.
	The chemical inventory list of the chemicals moved to a new location must be updated in CEMS.	

✓	Gas Cylinders (Empty and Full)	Comments
	Cap all gas cylinders.	
	Remove regulators and manifolds.	
	Return cylinder to supplier or department.	

✓	Biohazard Materials	Comments
	Package all materials being transferred or moved in secondary containment.	Empty all beakers, flasks, evaporating dishes and other containers that cannot be sealed with cap. If shipping or transferring biological agents or materials off campus or another Principal Investigator contact EHS at x24347.
	Decontaminate and dispose of all biohazardous waste & sharps (use clear autoclave bags for these materials).	Autoclave and dispose of in trash receptacle in a secured black trash bag.
	Disinfect all biohazardous work surfaces and equipment (benchtops, fume hoods, storage cabinets, freezers, refrigerators, centrifuges, gloveboxes and any other equipment or surfaces).	Use 10% Bleach, 70% ethanol, Cavicide, or disinfectants listed in your IBC protocol for: BSCs, incubators (drain H20), centrifuges, refrigerators, freezers, water baths & any other small equipment labeled and/or used for biohazardous work.
	Remove all biohazardous labels.	
	Transport or Ship Biological Agents	Transport sealed secondary containers using utility carts that have 3” lips on all sides. Never stack materials to high on the cart. Always use freight elevators or indoor corridors when transporting chemicals. If transporting hazardous chemicals off campus contact EHS at x24347.
	Collect biohazardous materials that cannot be autoclaved or sterilized in red biohazard bags (carcasses, tissues).	Contact EHS at x24347 to get waste hauler information.
	Notify EHS of the new lab location.	

✓	Radiation	
	Sort and package all radioactive materials for the move to a new area or disposal.	Cap all containers or bottles and use secondary containment.

	Decontaminate all surfaces, survey, wipe test all equipment and surfaces used with radioactive materials (refrigerators, freezers, benchtops.	
	Remove all radiation signs, stickers and postings.	
	Return dosimeters and holders (if terminating authorized user status).	
	Notify Radiation Safety Officer (RSO).	The RSO must be present during the transfer of materials to another facility.