Directory of Services and Emergency Providers

Phone Number	Agency
911 or 785-532-6412	ANY EMERGENCY Kansas State University Police Department
785-532-6544	STUDENT CARE ONLY Lafene Health Center
785-532-5856	ALL SAFETY ISSUES EHS
785-532-5648 785-532-2318	ANY EMERGENCY INVOLVING ANIMALS Dr. Denver Marlow, University Attending Veterinarian Cheryl Doerr, Associate VP Research, Compliance
785-776-2800 785-776-2864	EMERGENCY MEDICAL TREATMENT Via Christi Health – Admissions Via Christi Health – Emergency Room (To call off campus from a campus line, dial 91 and then the number. Example: to call the Via Christi Emergency Room 91-785-776-2864)
800-332-6633	Mid-America Poison Control Center

Table of Contents

Introduction

In accordance with Kansas State University policy [Laboratory Safety Chapter 3730.030], the Division of Public Safety/Department of Environmental Health and Safety (EHS) publishes safety measures and procedures in the form of the Laboratory Safety Manual.

To improve overall campus and laboratory safety, the President of Kansas State University annually appoints a Campus Environmental Health and Safety Committee. EHS collaborated with this institutional committee, the University Research Compliance Office, and college safety representatives to prepare the 2018 revision of the Laboratory Safety Manual.

This manual describes general standards and provides guidelines that must be followed to prevent laboratory incidents and to comply with applicable regulations and standards of care. The information has been collected from the most current Federal and State regulations and safety best practices. Investigators and staff are expected to use these guidelines as one part of a comprehensive program to avoid injury, adverse health impacts, lost time, and incident or compliance related expense. Students should initiate safe habits and practices that will ensure their safety and take safety awareness into their future workplace. The requirements and recommendations contained in this manual apply to all laboratories at Kansas State University. There may be more stringent program or laboratory-specific requirement that are not identified herein.

Additional requirements for Faculty, Staff and Principal Investigators participating in research or academic pursuits in laboratory settings are directed by the following institutional committees as applicable to the nature of the work performed and/or funding entity or accrediting board expectations and agreements.

Institutional Biosafety Committee (IBC)

Radiation Safety Committee (RSC)

Laser Safety Committee (LSC)

Institutional Animal Care and Use Committee (IACUC)

Institutional Review Board (IRB)

Institutional Review Entity (IRE)

Reactor Safeguards Committee

University Environmental Health and Safety Committee (EHSC)

Regulations

The federal Occupational Safety and Health Administration (OSHA) developed the Occupational Exposure to Hazardous Chemicals in Laboratories standard [29 CFR 1910.1450] specifically for non-production laboratories typical at KSU. Additional OSHA standards provide rules that protect workers in laboratories from chemical hazards as well as biological, physical and safety hazards. This federal standard and others may be specifically identified within contractual agreements with federal funding entities. Accrediting bodies will frequently identify OSHA and other federal regulations as a standard of care or specific expectation for accreditation. These expectations can incorporate professional standards and codes not specifically incorporated by reference within the regulations.

The Kansas Department of Labor is responsible for oversight of compliance to Article 6 of Kansas statute, which states:

> The secretary of labor shall have power to enter any factory or mill, workshop, private works, public works or state agency or institution, mercantile establishment, laundry or any other place of business where labor is or is intended to be performed for any purpose, when the same are open or in operation, for the purpose of gathering facts and statistics such as are contemplated by this act, and to examine into the methods of protection from danger to employees and the sanitary conditions in and around such buildings and places and to keep a record thereof of such inspection.

The Kansas Department of Health and Environment (KDHE) is responsible for the oversight of compliance to state regulations pertaining to the protection of public health from environmental threats resulting from mismanagement and/or contamination of natural resources. It is important to note that laboratory activities can result in the generation of hazardous waste and hazardous effluent and/or emissions. Both KDHE and the federal Environmental Protection Agency (EPA) may restrict, postpone or prevent laboratories activities that are not compliant with federal, state or local regulations and codes and those that pose imminent danger to the public, infrastructure or environmental resources.

Therefore, it is important to adhere to procedures related to the proper management and disposal of hazardous materials and Contact EHS for guidance when initiating activities that can or will release emissions, effluent, or solid wastes. Guidance on proper disposal procedures are provided in the Laboratory Safety guidance.

Responsibilities

Environmental Health and Safety Department

The role of Environmental Health and Safety is to ensure uninterrupted research and learning in a safe, healthy environment. In carrying out this charge, EHS is responsible for development and implementation of campus safety standards. Division personnel will also serve as consultants to assist departments with environmental health and safety issues. EHS will designate an internal employee as the university's Chemical Hygiene Officer and will manage the university’s Hazard Communication Program, and will update the Laboratory Safety manual and related policies.

EHS will employ the following institutional officers as required by policy, regulation or license:

Radiation Safety Officer

The radiation safety officer (RSO) provides oversight to all groups who use radiation sources on campus. This includes: assisting those interested in applying for permission to the Radiation Safety Committee to use radioisotopes under the university’s State of Kansas Radioactive Materials License, conducting inspections to ensure compliance with relevant policies and radiological health practices, providing dosimetry and record keeping services, managing the radioactive waste program, ensuring security of licensed material, establishing and overseeing radiation emergency procedures, and developing, reviewing, and revising the university:

Radiation Safety Manual

Laser Safety Officer

The laser safety officer (LSO) maintains an accurate inventory of all class 3-4 lasers on campus, inspects locations where class 3-4 lasers are in use to ensure compliance with standards of care and procedures identified in the Laser Safety Manual, and develops, reviews, and revises the university:

Laser Safety Manual

Chemical Hygiene Officer

EHS will designate an employee as the university's Chemical Hygiene Officer. The Chemical Hygiene Officer will provide technical guidance and assistance for the implementation of the Chemical Hygiene Plan. This individual will work with departments to ensure proper compliance with the laboratory safety rules of Kansas State University, which include but are not limited to:

Laboratory Safety Manual

Chemical Hygiene Program

Hazard Communication Program

Respiratory Protection Program

Safety with Chemical Carcinogens in Research and Teaching

Blood Borne Pathogens Program

University Research Compliance Office

The University Research Compliance Office (URCO) helps researchers meet university, state and federal regulatory requirements, by providing support and oversight of research involving human subjects, laboratory animals, and recombinant or synthetic nucleic acid molecules and biohazards. Additionally, URCO administers online training related to research compliance and oversees institutional biosafety and export control programs as well as an Occupational Health and Safety Program for individuals who work with animals.

Institutional Review Committees

Institutional Biosafety Committee

The Institutional Biosafety Committee (IBC) is responsible for the oversight of all activities involving research with microbiological agents, recombinant or synthetic nucleic acid molecules, or toxins of biological origin. The IBC is mandated by federal laws and regulations, providing a compliant biosafety program for researchers and students.

Radiation Safety Committee

The Radiation Safety Committee (RSC) is responsible for formulating University policies concerning the acquisition, use, and disposal of radioactive material and radiation producing machines. The RSC investigates incidents and ensures regulatory compliance with University, State, and Federal laws. Additionally, the RSC reviews and approves radioactive material related project proposals and updates the Radiation Safety Manual as needed.

Laser Safety Committee

The Laser Safety Committee (LSC) reports to the Radiation Safety Committee. The LSC is responsible for the University's compliance with the most up-to-date standards for the safe use of lasers and updates the Laser Safety Manual as needed.

Institutional Animal Care and Use Committee

The Institutional Animal Care and Use Committee (IACUC) is responsible for providing a humane and compliant environment for research animals at Kansas State University. The IACUC is administered by the University Research Compliance Office, supporting the efforts of researchers and students in collaborative research and teaching environments.

Institutional Review Board

The Institutional Review Board (IRB) is committed to providing a comprehensive and compliant Research with Human Subjects program for researchers, students, and potential human subjects. At K-State, the Committee on Research Involving Human Subjects serves as the IRB and is mandated by federal laws and regulations for oversight of all activities involving research with human subjects.

Institutional Review Entity

The Institutional Review Entity (IRE) is responsible for ensuring KSU compliance with Federal policies requiring regular review of government-funded or government-conducted research with 15 high-consequence pathogens and toxins for their potential to be dual use research of concern (DURC) to mitigate risks where appropriate and collect information needed to inform the development of an updated policy, as needed, for the oversight of DURC.

EHS Committees

University EHS Committee

The University Environmental Health & Safety Committee is responsible for acting as the oversight committee for the administrative units (Provost, VP for Administration & Finance, and VP for Institutional Advancement). Additionally, EHS committee is charged with evaluating college Environmental Health & Safety Committees and developing university-wide policies for Environmental Health & Safety.

College or Department EHS Committees

Every College must have an active safety committee. This must be a goal of each Dean. If the Dean desires, departments within a College may also have safety committees. The University Environmental Health & Safety Committee recommends that large departments or departments with high hazards have a safety committee.

The College Environmental Health & Safety Committee aids and advises the dean or department head and the faculty, staff, and students on matters of safety and health pertaining to Kansas State University operations. It performs essential monitoring, educational, investigative, and evaluative tasks.

Attendance by nonmembers should be encouraged. The College Environmental Health & Safety Committee is responsible for:

a. actively participating in safety and health instruction programs and evaluating the effectiveness of these programs
b. assisting supervisors with enforcement of safety policies by educating fellow employees in proper procedures
c. regularly inspecting the facility to detect unsafe conditions and practices and hazardous materials and environmental factors
d. assuring safety inspections of operations and facilities including shops, storage and storeroom areas, teaching and research laboratories, and offices, are conducted
e. planning improvements to existing safety and health rules, procedures, and regulations
f. review hazards for all department/unit activities to determine requirements for personal protective equipment
g. periodically reviewing and updating existing work practices and hazard controls
h. assessing the implications of changes in work tasks, operations, and processes
i. monitoring and evaluating the effectiveness of safety and health recommendations and improvements
j. compiling and distributing safety and health and hazard communications to the employees
k. investigate workplace accidents with prevention in mind
l. studying and analyzing incident and injury data

Dean

The Dean of each college is responsible for appointing a College Environmental Health & Safety Committee and to ensure that personnel adhere to current safety standards. Ensuring corrective actions are taken when concerns are identified.

Department Head

The Department Head is responsible for appointing a Department Safety Coordinator, if necessary, and informing EHS whenever a new DSC is appointed.

College or Department Safety Coordinator

If a College or Department Safety Coordinator (SC) has been appointed, the SC would serve as a liaison to assist EHS with inspecting laboratories for chemical safety, chemical spill notification, emergency contingency plans, communicating with PIs and lab supervisors, and documenting necessary training.

These required functions may also be performed by other departmental faculty or staff, as assigned by the College or Department's EHS committee.

Principal Investigator

The Principal Investigator (PI) is responsible for the training of employees and students in assigned work duties, maintaining a written Chemical Hygiene Program, Hazard Communication Standard Program, and other safety documentation that may be required by institutional entities (ex. Biosafety Manual), and for seeing that safe practices are followed. This individual is responsible for general laboratory safety, hazardous waste disposal, and liaison with EHS to include **Laboratory Registration** under their oversight.

The **Hazard Communication Standard Program** includes an inventory of every hazardous chemical on campus, proper chemical labels, collections of Safety Data Sheets with Right-to-Know access, training, and a written program detailing how each portion of the Hazard Communication Program operates. The PI is responsible for fulfilling these requirements within their area of control.

The **Chemical Hygiene Program** includes creating written Standard Operating Procedures, taking necessary precautions to limit employee exposures below OSHA’s permissible exposure limits, providing employees with exposure monitoring and medical surveillance in the event that these levels (OSHA’s action level for certain hazardous chemicals, or OSHA’s short term exposure limits) may be reached, inspecting laboratories for safety, and safety training.

Teaching Laboratory Instructors or Coordinator

Laboratory instructors and teaching assistants are responsible for incorporating safety controls into laboratory experimental or teaching procedures and adhering to hazard communication and hazardous waste management requirements. Training appropriate with the responsibilities may include, but not be limited to receiving one time or annual training in the areas of hazard communication, laboratory safety and hazardous waste awareness.

Employees and Students

Employees and students working in or using laboratory facilities in the course of their employment or studies are responsible for knowing and following all safety procedures. This includes completing all required training and reviewing safety documents prior to work.

Laboratory Registration and Close Out

A record of laboratory spaces on campus is maintained by EHS emergency response, chemical inventory management, and regulatory purposes. In order to maintain the integrity of this record, laboratories must be registered with EHS and notify EHS when laboratories are closed out.

Laboratory Registration

Each room or space that is designated as laboratory space, must register with EHS. Registration is accomplished by *submitting* the Laboratory Sign Form. Any change in the laboratory contacts or hazard level designation (i.e., Chemical Safety Level, Biosafety Level, Radiation use, or laser class as applicable), requires re-submitting the form.

Lab Signs

Each exterior laboratory door to the corridor must be posted with current contact information, emergency and hazard information in compliance with the KSU Laboratory Signage requirements. These signs will be posted on the door or on the wall immediately adjacent to the door. Additional laboratory hazard or warning signage may be required, but should be reviewed by EHS or the KSU Fire Marshal as applicable. These include, but are not limited to additional radiation signage, laser warning signage, energy hazards, or similar warning or danger instructions required by regulation or policy.

Signs must be reviewed for accuracy and updated annually or more frequently as procedures, requirements, contacts or information changes. If a sign become damaged, faded, or vandalized, they must be replaced. The date of revision must be visible.

Limited radiation signs are provided by the Radiation Safety Officer. All other signs are the responsibility of the laboratory.

Laboratory Close-Out Procedures

Departing researchers and staff responsible for laboratories should go through a laboratory check out process to ensure that hazardous substances and regulated materials in their labs are properly managed upon departure. It is the responsibility of department heads to ensure this process is conducted during planning of, or upon separation of faculty and student researchers. A similar process should be employed when academic laboratory programs end.

Use of a Laboratory Closeout form will aid in ensuring research and laboratories are properly decommissioned. The executed form serves as documentation that a formal process was completed and may aid in obtaining support services such as cleaning, renovation, equipment removal and moving services.

Chemicals left unmanaged can become unstable and potentially dangerous, posing a risk of personnel exposure, fire or explosion. Equipment may contain hazardous materials or radiological sources, which are regulated and must be properly managed for disposal. Animals may not be left un-tended. Review the Laboratory Closeout form for guidance.

Laboratory Chemical Cleanouts

Departments are responsible for ensuring laboratory chemicals are properly disposed through EHS. Chemical cleanouts should be done by the laboratory manager, principal investigator or researcher leaving the university. This will maximize the safety of KSU faculty and staff and ensure accurate and complete labeling of chemicals. When the responsible faculty/staff is not available the department head is responsible for ensuring chemicals are properly identified and disposed. Costs for handling unknown or improperly managed chemicals may be charged to the responsible department so it is important to address laboratory chemicals promptly to avoid costs and hazardous conditions.

A laboratory cleanout is defined as the removal of a large number of chemicals (greater than 30). A cleanout can be the result of:

1. a researcher retiring from the University
2. a researcher moving to another laboratory or University
3. completion of graduate study or other research
4. end of academic lab activities
5. moving lab activities to a new location
6. construction activities within the laboratory
7. numerous excess or expired chemicals need to be removed from the lab

Procedure

Complete the Lab Cleanout form two months prior to needing disposal of chemicals. The form includes contact information for the lab and an inventory of all chemicals to be picked up. This should be done by the faculty or researcher assigned to the lab.

EHS will schedule a review and sorting date and a pickup date for all chemicals.

General Laboratory Safety Practices

Laboratory spaces are often dense with hazards. For this reason, general safety practices should be adopted whenever entering a laboratory, no matter the type of work being performed.

a. Consult the signage at the entrance of a lab before entering for the first time. A Lab Sign should be present on the outside of the laboratory door indicating the types of hazards present and the recommended PPE.
b. Wear appropriate attire. The minimum required attire when entering a laboratory is closed toe shoes and long pants. To perform work in a laboratory, the additional attire of a lab coat, gloves, and safety glasses is required. This level of attire may be adjusted to more or less protective clothing after performing a **Hazard Assessment**.
c. Remove PPE prior to leaving laboratory.
d. Always wash hands after removing gloves and before leaving laboratory.
e. Do not work alone in the laboratory unless procedures are in place for doing so and appropriate supervisors have been informed. Never perform hazardous tasks while alone in the laboratory.
f. Be sure that you have met all training requirements prior to work in a laboratory.

g. Consult any relevant safety documentation prior to performing a new task or handling a new material (chemical labels, SDS, manufacturer operating manual, Standard Operating Procedures, signage near hazardous equipment, Chemical Hygiene Plan, Laboratory Biosafety Manual, etc.).
h. Clearly label all storage containers.
i. Keep all chemical containers closed unless actively in use.
j. All equipment should be inspected for defects prior to use.
k. A log may be required for the inspection, and/or operations and maintenance of certain equipment.
l. Be alert for unsafe conditions and correct them when detected.

These practices serve as the baseline for laboratory safety. Certain situations require move advanced protective measures. The following subsections will walk through how to identify these hazardous situations, select controls for those hazards, and guidance for safe operation of a laboratory.

Hazard Assessment

A hazard is something that can cause harm. Risk is the probability that a hazard will cause harm. A hazard assessment is simply a concerted effort to identify hazards present, assess the risks associated with those hazards, and select appropriate control measures to reduce those risks. A hazard assessment is an iterative process with no set end point. Hazard assessment should be revisited when any new hazards are identified either by observation, near miss, or accident and when the scope of work changes. Not revisiting the hazard assessment when the procedure or area initially assessed changes is a leading indicator for accidents.

There are several methods to perform a hazard assessment, but the first step is to identify the scope of the assessment. A single area or process will likely define the scope of the assessment. For example, when creating a Standard Operating Procedure, the scope of the hazard assessment is likely defined by the steps of the procedure to be performed and the area in which the procedure takes place.

The recommended method of hazard assessment is a Job Hazard Analysis (JHA). A JHA begins with a specific procedure to be performed. Each step is considered individually and hazards associated with each step are identified. After hazards are identified, risks associated with each hazard are assigned based on how likely the event is to occur and how harmful the hazard may be. Safety controls are then selected to reduce each risk, giving priority to the highest risks first.

For more information, examples, and templates to use in hazard assessments see the resources provided by the American Chemical Society.

Safety Controls

Safety controls are steps that can be taken to reduce the risk associated with a hazard. These steps are categorized into three or four levels of effectiveness. The most effective safety control is to remove the hazard completely by substituting it with another less hazardous material or technique. If this is not possible, then a combination of administrative controls, engineering controls, and PPE must be selected to reduce the risk to acceptable levels.

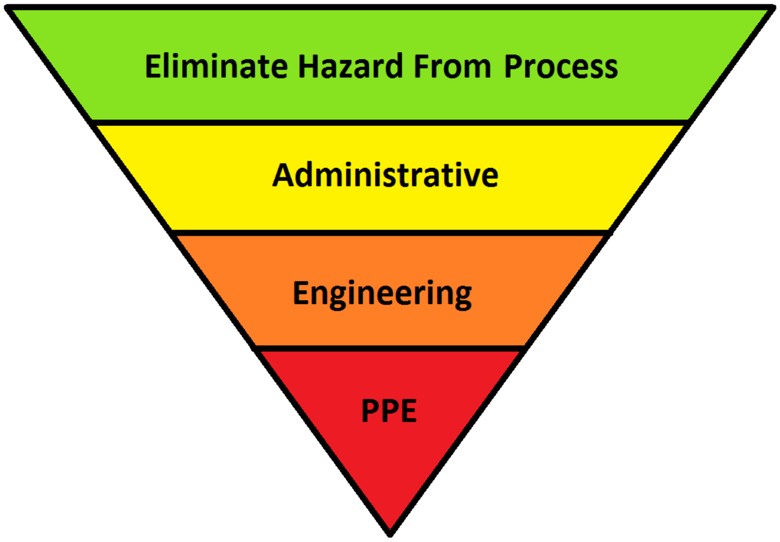


Figure 1 - Conceptual diagram of the effectiveness and applicability of the types of safety controls

Elimination/Substitution of Hazards

The most effective way to ensure control a risk is to remove hazards from your workplace all together. This method should be used whenever possible. In lieu of removing the hazard, the source of the hazard may be substituted with another material which performs the same purpose, but does not have the accompanying hazard. For example, it is often possible to substitute one solvent for another, such as substituting toluene for the more hazardous benzene.

When substituting, be sure that a new hazard is not introduced. When changing any step of a procedure, it is important to revisit the hazard assessment to identify any new hazards that may be present and to select appropriate controls.

Administrative Controls

Administrative controls consist of training, policies, and written guidance. Several documents have been created at the university level to provide general policy and guidance for safe practices in various situations. They are as follows:

Blood Borne Pathogens Program

Chemical Hygiene Program

Hazard Communication Standard Program

Laboratory Safety Manual

Laser Safety Manual

Radiation Safety Manual

Respiratory Protection Program

Safety with Chemical Carcinogens in Research and Teaching

Training

Proper training serves as a dedicated time to communicate about hazards, safe practices, emergency procedures, and to identify safety information resources. Required training components include general training administered by EHS, specific training provided by PIs or lab supervisors on the hazards present in the lab, and training required by institutional committees, such as the IACUC, IBC, or IRB. To review EHS course offerings visit the EHS training page.

a. Hazard Communication training is required for anyone using chemicals in the course of their work or research activities.
b. Hazardous Waste Awareness training is required for anyone that handles or generates a hazardous waste.
c. Radiation Safety Training (sealed and unsealed) training is required for anyone working with radioisotopes or sealed sources.
d. Laser Safety Training is required for class 3B or 4 users. Training is provided online. Contact EHS to register.
e. Laboratory Safety Training is required for all staff new to work in a laboratory setting. Contact EHS for training options.
f. Respiratory Protection Training is required for any employee using a respirator at KSU. Other requirements include registration, medical approval, and fit testing. Contact EHS.
g. Training related to an IACUC, IBC, or IRB reviewed research activities is administered through URCO.

In addition to training offered by EHS and URCO, training specific to the laboratory should be provided by the supervisor or PI. This specific training should cover:

a. An appraisal of hazardous chemicals present in the workplace including permissible exposure limits, the physical and chemical hazards, signs and symptoms of exposure, and methods to detect the release of these chemicals
b. Appraisal of other hazards present (radiation, laser, pathogen, biological materials)
b. The measures employees can take to protect themselves from those hazards
c. The location and availability of Safety Data Sheets and other reference material on the handling, storage, and disposal of hazardous chemicals present in the laboratory
d. The details of the laboratory's Chemical Hygiene Program, Hazard Communication Program, Biosafety Manual, and Standard Operating Procedures, if applicable.
e. The location and how to use and maintain safety and emergency equipment (e.g., PPE, safety showers, eye wash, fire extinguisher, spill kits, first aid kits, etc.)
f. The emergency evacuation route and emergency plans

Laboratory or Program Specific Policies

Several policies have been generated at the university level. These documents are necessarily broad and non-specific. It may be that more specific policies need to be developed in order to provide adequate guidance for the situations that arise in your laboratory.

For example, if your laboratory uses or stores hazardous chemicals you are required to have a written hazard communication plan detailing how the **Hazard Communication Standard Program** requirements are being met and a written **Chemical Hygiene Program**. If recombinant DNA or infectious material is used in your laboratory, a **Biosafety Manual** must be developed and kept on hand.

RESERVE for information on templates

Standard Operating Procedures

A standard operating procedure (SOP) is a combination of a detailed procedure and the safety controls selected during a hazard assessment. An SOP cannot be created until after a hazard assessment has been performed for the specific task and the scope of the SOP should not exceed the scope of the relevant hazard assessment(s).

Each laboratory should have available for review written SOP for activities posing potential risks to students, faculty, or staff in laboratories or shops supporting laboratory and/or research activities and for activities designated for documentation through regulation.

Reference information useful for identifying hazards and selecting safety controls is available throughout this document (see especially; **Specific Hazards** and **Laboratory Equipment**).

Contact EHS for guidance.

Engineering Controls

Engineering controls are safety controls which are built into the area or system containing the hazard. Engineering controls often take the form of a physical barrier between the worker and the hazard or increased ventilation which remove the hazard from the breathing zone of workers.

For more information see Fume Hoods and Laboratory Ventilation

General Laboratory Ventilation

Laboratory spaces should be negatively pressured relative to adjacent public spaces, such as hallways. This is to keep airborne chemicals and pathogens from leaving the laboratory environment and contaminating shared spaces. If you suspect that airborne chemicals or pathogens may be escaping your laboratory, contact EHS.

Ideally, negative pressure is achieved solely by general room supply and return air. In older spaces, a chemical hood may serve as the exhaust air for the laboratory. In this latter case, the laboratory may become positively pressured to adjacent spaces when the hood is shut off. If you see no return air ducts in your lab space this is likely the case and your hood should remain on whenever occupied or when experiments are underway.

Laboratory Chemical Hoods

All laboratories must provide an environment that is safe from fumes, vapors, dusts, and aerosolized microbes, carcinogens and radioactive materials that may be generated during an experiment. The purpose of any laboratory chemical hood (“fume hood”) is to capture the hazardous airborne material in an air stream of sufficient velocity to exhaust it safely out of the laboratory.

The chemical hood's face velocity, turbulence, and the worker movements are all important in preventing hazardous airborne material from reaching the breathing zone of the user. The face velocity is the linear air velocity at the opening or sash of the hood. The face velocity is affected by turbulence generated by the user at the opening, equipment and supplies inside the hood, drafts from doors, lab pressure differential, windows, and air vents in the laboratory - even people walking by the fume hood while it is operating. All of these factors must be managed.

The average face velocity of the fume hood with the sash positioned at the sash stop or at a height of 12-18” must be within the range of 80 to 120 ft/min.

More specifically:

a. 80-100 for nuisance dust, noxious odors and low toxic materials.
b. 100-120 for perchloric acid, carcinogens and high toxic materials.

Proper Use.

Fume hoods should be kept closed to the smallest sash opening that still allows for adequate ventilation. The sash should be kept closed except when moving materials in or out of the fume hood. To properly use a fume hood:

a. open the fume hood sash to its widest extent to place equipment or chemicals;
b. close the fume hood sash to within twelve to fourteen inches of the base to allow placement of arms for manipulation of materials; or
c. close fume hood sash to the base, slide horizontal sash to protect your face and body while allowing placement of arms for manipulation of materials.
d. The bottom baffle should be open to exhaust heavier than air vapors that tend to settle and the top baffle should be open to exhaust lighter than air vapors that tend to rise. For most general laboratory fume hoods, both baffles should be open. Keep the openings free of obstruction by apparatus or containers.
e. Do not work in a non-operating fume hood.
f. Keep all apparatus at least six inches back from the face of the hood. Placing a stripe on the bench surface is a good reminder.
g. Do not store chemicals or equipment in a fume hood.
h. Clean up any chemical spills in a fume hood when they occur.
i. Do not put your head in the hood when contaminants are being generated.
j. Do not place electrical receptacles or other spark sources inside the hood when flammable liquids or gases are present. Permanent electrical receptacles should not be placed in the hood.
k. Use an appropriate barricade if there is potential for an explosion or eruption.
l. Observe static pressure gauges, velocity monitors or other operator indicators to insure that the exhaust system is properly working. In case of failure, notify your department head.

Testing and Maintenance.

Fume hoods are tested annually by EHS. Results are posted on the fume hood as well as reported to the department head. The velocity is measured at the center of square foot sections on the face of the sash with the sash open to its full extent or to the stops, if present. In addition, smoke is used to ensure that the entire face of the fume hood is exhausting out and not into the laboratory.

When Facilities repair personnel are called:

a. Do not operate a fume hood when it is being serviced;

b. Remove any chemicals or equipment from the fume hood before maintenance personnel perform servicing;
c. Wash down the interior of the fume hood with soap and water before maintenance personnel work inside the fume hood.
d. Maintenance personnel will put on personal protective equipment such as coveralls, goggles, gloves, and respirators when servicing your fume hood; and
e. When maintenance personnel are working on the roof, you may be required to discontinue fume hood operations. If you are requested to do so, do not operate fume hoods.

Biosafety Cabinets

Biological Safety Cabinets (BSC) are special hoods equipped with High Efficiency Particulate Air (HEPA) filter systems and designed to protect personnel and the environment from biohazardous material and protect the product from contamination.

Class I - a ventilated cabinet for personal and environmental protection, with non-recirculated airflow away from the operator. This class operates similar to a fume hood, except it may or may not be connected to an exhaust duct system. May be used for work with materials requiring biosafety level 1, 2 or 3 (BSL-1, 2, or 3) containment. Protects the user and environment but not the product.

Class II - a ventilated cabinet with an inward HEPA filtered airflow that protects the user, environment and product. May be used for work with materials requiring BSL-1, 2, or 3 biosafety containment.

Class III - a totally enclosed, ventilated cabinet of gas-tight construction. Operations in the cabinet are completed through attached rubber gloves. The cabinet is kept under slightly negative air pressure. Supply air is HEPA filtered and exhaust is double HEPA filtered or a combination of HEPA filter and incineration. May be used for work with materials requiring BSL-4 biosafety containment.

Proper Use.

a. Avoid the use of flammable gases or solvents in BSCs. Care must be taken to ensure against the concentration of flammable or explosive gases or vapors.
b. Do not use open flames in BSCs.
c. Ultraviolet (UV) lamps are frequently used in BSCs for supplementary decontamination of the work area. Use of UV lamps may help maintain disinfection, but should not be relied on for the sole disinfection of the work area. Thorough surface decontamination with an appropriate disinfectant is required. The UV light must be off when working in the BSC. The window sash must be completely closed when the UV light is on.
d. BSCs must be tested and certified annually, after maintenance is performed, or after the unit is moved. EHS does not provide certification testing for BSCs, but can provide contact information for commercial certification companies in the area.
e. Thoroughly understand procedures and equipment required before beginning work.
f. Arrange for minimal disruptions in the work area while in use.
g. Turn off the UV lamp when the using the cabinet.
h. Ensure that the sash is set at its lowest position for work; this is usually marked on the sash frame.
i. Turn on BSC light and blower.
j. Check the air grills for obstruction and check pressure gauge.

k. Wash hands and arms thoroughly with germicidal soap before working in the BSC.
l. Wear proper personal protective equipment including a long sleeved laboratory coat with knit cuffs and over-the-cuff gloves, eye protection and respiratory protection, if appropriate.
m. Wipe down all interior surfaces of the BSC with 70% ethanol or other suitable disinfectant and allow to dry.
n. Load only materials required for the procedure into the BSC. Do not overload the cabinet.
o. Do not obstruct the front, side or rear air return grills.
p. Do not place large objects close together.
q. After loading the BSC, allow several minutes to purge airborne contaminants from the work area.
r. Keep all materials at least four inches inside the sash and perform all operations as far to the rear of the work area as possible.
s. Keep clean and contaminated materials segregated. Arrange materials to minimize the movement of contaminated materials into clean areas. Keep all discarded contaminated material to the rear of the cabinet.
t. Avoid moving materials or arms through the front access during use. Avoid techniques or procedures that disrupt the airflow patterns of the BSC.
u. For spill response procedures, see **Biological Spill/Release**

Laminar Flow Hood or Clean Bench

A laminar flow hood or "clean bench" is for product protection only. Do not use for work with biohazard materials, volatile chemicals, toxic materials, or radioisotopes. The flow of air is towards the operator and the velocity of air movement can aerosolize materials on the unit surface, which presents a greater inhalation potential than work on a lab bench. Learn to distinguish the difference between this and a biosafety cabinet or chemical lab hood (fume hood).

Local Ventilation

There are myriad other ways to provide localized ventilation. These devices either capture the airborne hazard at the source of generation or they provide air movement away from the operator's breathing zone. Some examples include: snorkels, canopies, vacuum systems, gas scavengers, downdraft tables, glove boxes, anaerobic chambers, and more.

EHS does not provide standardized guidance on these devices due to their variety. For testing, please contact EHS.

Gas Cabinets

Gas cabinets are required for compressed gas cylinders or containers housing poison or pyrophoric gases. Interlocks, security measures, alarms, and ventilation of these unit and/or related laboratory are required. In some cases, the requirements may be met by housing the cylinder within an approved chemical lab hood (fume hood) if administrative controls are employed and documented to address power failures that compromise controls. Contact EHS for additional guidance prior to purchasing gases that require containment.

Machine Guarding

When machinery is present in labs, the moving parts present a physical hazard that may be easily overlooked in a setting possibly laden with other types of hazards (chemical, biological, radiation, etc.). Machinery related injuries can be very severe and range from cuts to crushed hands and severed fingers or worse. For this reason, safeguards are required at all points on a machine that present a physical hazard. These include:

a. The point of operation – where the machinery performs work on the material, such as cutting, shaping, or boring.
b. Power transmission apparatus – all components of the mechanical system which transmit energy to the part of the machine performing the work, such as flywheels, pulleys, belts, connecting rods, etc.
c. Other moving parts – all parts of the machine which move while the machine is working, such as reciprocating, rotating, and transverse moving parts, as well as feed mechanisms and auxiliary parts of the machine.

The safeguards against these mechanical hazards must meet the general requirements, but can take many forms:

a. Prevent contact: The safeguard must prevent hands, arms, and any other part of a worker's body from making contact with dangerous moving parts.
b. Secure: Workers should not be able to easily remove or tamper with the safeguard, because a safeguard that can easily be made ineffective is no safeguard at all.
c. Protect from falling objects: The safeguard should ensure that no objects can fall into moving parts. A small tool which is dropped into a cycling machine could easily become a projectile that could strike and injure someone.
d. Create no new hazards: A safeguard defeats its own purpose if it creates a hazard of its own such as a shear point, a jagged edge, or an unfinished surface which can cause a laceration.
e. Create no interference: Any safeguard which impedes a worker from performing the job quickly and comfortably might soon be overridden or disregarded. Proper safeguarding can actually enhance efficiency since it can relieve the worker's apprehensions about injury.

This section has been largely adapted from OSHA's Machine Safeguards. See that manual for more information.

Personal Protective Equipment

Personal protective equipment (PPE) is the last line of defense between an individual and exposure to hazardous substances. For this reason do not rely solely upon PPE for protection from hazardous substances, but rather as a failsafe should administrative and engineering controls fail.

The minimum required attire when entering a laboratory is closed toe shoes and long pants/skirt. To perform work in an active wet laboratory, the additional attire of a lab coat, gloves, and safety glasses (or goggles as applicable) is required. This is the baseline level of PPE, however this level of attire may be adjusted to more or less protective clothing after performing a hazard assessment. This will likely be necessary for non-wet laboratories. Support operations for laboratories such as machine shops, glass shops, or other work areas should be considered when assessing department and college level PPE policies and requirements.

The hazard assessment will inform the selection of PPE based on the hazards associated with the processes and materials present. For example, when a process creates a splash risk, eye protection is necessary.

Eye protection

State law requires that every student and teacher participating in vocational, technical or industrial arts shops or laboratories must wear eye protective devices suitable to protect against the hazard. Therefore, eye protection is required in chemical, physical, or microbiological teaching and research laboratories where aerosols, splashes, sparks, dust, molten metals, injurious gases/vapors, projectiles or flying debris may be created that present an eye injury hazard. ANSI Z87.1 compliant eye protection is recommended.

- Use non-vented or protected-vent goggles for protection from aerosolized hazardous substances or minimal liquid splashes.
- Use a face shield in conjunction with eye protection when splashes to the face are possible and for protection against flying debris and contaminants to the face. Face shields come in a variety of styles, including disposable. Face shields alone are not adequate for eye protection.
- Use impact rated safety glasses with side protection or goggles when there is potential for flying debris, projectiles or damaging airborne particles. Consider the possibility of exploding vessels/glassware, centrifuge failures, and violent reactions (expect the unexpected).
- Use UV protective eyewear when UV lights are used for disinfection or other activities. Even when hood barriers are equipped with UV filtration and/or interlock protection, UV protective eye wear is recommended.
- Use appropriately filtered goggles for work with open beam lasers. Consult the **Laser Safety Manual** for additional information.
- Use a filtered shielded mask for arc welding or cutting for protection against radiant energy.

Use shielding and face/eye protection when using saws, grinders, mechanical sanding, drilling and other operations that can generate aerosols or flying debris.

Gloves

Proper gloves must be worn when working with organic solvents, corrosives, toxic materials, allergens, or pathogenic organisms. Glove type should be selected based on the hazards present. Different glove materials provide different breakthrough times for different chemicals. Specific glove material recommendations may often be found in the PPE section of a SDS. Note that powdered gloves have been banned by the FDA.

a. Inspect reusable gloves before use, wash them before removal, and replace them periodically.
b. Never re-use disposable gloves.
c. Select gloves that are the right size/fit to ensure dexterity and safety.
d. Remove gloves prior to leaving the laboratory.
e. Wash arms and hands immediately after removing gloves when working with allergens, carcinogens, pathogenic organisms, corrosive, or toxic chemicals.
f. Wash exposed skin well before leaving the laboratory.
g. If hands will be immersed in a hazardous liquid, the selection criteria may be different – consult the manufacturer.

h. Thermal protection gloves are required when:
   1. submersion in cryogenic liquids is possible (protective for short duration only)
   2. handling cryogenic systems and compressed gas/liquid piping
   3. handling heated systems or vessels
   4. transferring materials to/from hot ovens, blast furnaces, crucibles, autoclaves, etc.

Glove Material	**Application**
Butyl	A synthetic rubber material that offers the highest permeation resistance to gas and water vapors. Especially suited for use with esters and ketones.
Neoprene	A synthetic rubber material that provides excellent tensile strength and heat resistance. Neoprene is compatible with some acids and caustics. It has moderate abrasion resistance.
Nitrile	A synthetic rubber material that offers chemical and abrasion resistance, and is a very good general-duty material for gloves. Nitrile also provides protection from oils, greases, petroleum products and some acids and caustics.
PVC (polyvinyl chloride)	A synthetic thermoplastic polymer that provides excellent resistance to most acids, fats and petroleum hydrocarbons. Good abrasion resistance.
PVA™ (polyvinyl alcohol)	A water-soluble synthetic material that is highly impermeable to gases. Excellent chemical resistance to aromatic and chlorinated solvents. This glove cannot be used in water or water-based solutions.
Viton®	A fluoroelastomer material that provides exceptional chemical resistance to chlorinated and aromatic solvents. Viton is very flexible, but has minimal resistance to cuts and abrasions.
SilverShield®	A lightweight, flexible laminated material that resists permeation from a wide range of toxic and hazardous chemicals. It offers the highest level of overall chemical resistance, but has virtually no cut resistance.

Table 1 - From Grainger Chemical Protective Gloves Quick Tips #191

Clothing

Required laboratory attire includes long pants or skirts that cover the arms and legs entirely and closed-toe shoes. Avoid loose sleeves or dangling articles of clothing or adornment.

Laboratory coats, coveralls, and aprons protect the user and their clothing from spills and provide a layer that can be quickly removed when contaminated. This additional barrier is an important safety measure and also prevents continued exposures from residual contamination trapped on street clothing. Laboratory coats come in a variety of styles and can have chemical and/or flame resistant coatings applied. Laboratory clothing with special material treatment (flame retardants) must be laundered in accordance with the manufacturer's recommendations to maintain protection. Protective clothing may have service life expirations and/or a shelf life.

Procedures:

a. Use proper clothing and impermeable fabrics (as applicable) to prevent chemical and pathogenic organism exposures, avoid skin irritations and lessen the possibility of allergic reactions and sensitization.
b. Remove laboratory coats when leaving the laboratory.
c. Change laboratory coats immediately upon noticeable contamination.
d. Wear impermeable or liquid resistant aprons and/or coveralls when splashes of hazardous chemicals onto the body are possible.
e. When working with highly flammable materials, use flame retardant clothing or lab coat. Consider the flammability of clothing worn under flame retardant lab coats (cotton and natural fibers and flame resistance clothing is preferred to highly ignitable materials that melt onto the skin easier).
f. Avoid washing lab coats at home. Contact EHS for information on lab coat rental and laundering service providers.

Additional PPE may be required or specified depending on the nature of the activity, work setting and related regulations or standards.

Respiratory Protection Program

Respiratory protection may be required to prevent exposure to airborne contaminants when engineering controls (e.g., biological safety cabinets, fume hoods, laboratory ventilation, localized exhaust) prove inadequate. The KSU Respiratory Protection Program (RPP) outlines the institutional requirements for respiratory protection. A hazard assessment, medical exam, fit test, training and enrollment in the RPP are required before using a respirator. Following the procedures outlined in the RPP will minimize exposure to airborne concentrations of hazardous substances and infectious agents. Persons required to use respiratory protection, including filtering face piece respirators (dust masks), in the execution of their KSU job duties are required to be enrolled in this program through KSU Environmental Health and Safety. For more information see the Respiratory Protection Program.

Fire Safety

Laboratories often contain flammable liquids and many laboratory procedures involve heat. Some chemical reactions themselves generate heat. Due to this obvious hazard, the following guidelines are of utmost importance:

a. Interior connecting doors between laboratories should be unobstructed and unlocked (for exit) at all times.
b. Faculty and staff should be familiar with the location and use of emergency fire equipment. This includes the location of fire extinguishers, fire alarm pull stations, first aid supplies, and emergency showers. It is recommended that each department develop a list of emergency equipment and its location.

c. Environmental Health and Safety (EHS) is responsible for maintaining and checking fire alarm systems, smoke alarms, fire extinguishers and other fire suppression systems on the KSU main campus.
d. All employees should be trained how to use a fire extinguisher. Fire extinguisher demonstration and training is provided by EHS, to register for training either sign up through HRIS self-service or send an email to learning-develop-hr@k-state.edu. When sending an email, please include your name, employee ID and the course title.
e. Faculty should acquaint students in classrooms of the locations of emergency equipment, emergency exits and general evacuation or areas to await assistance for those unable to evacuate.
f. In the event of a fire, pull the fire alarm as you leave the area and call 911 to report the location of the fire. In the event of a fire alarm, all persons must proceed to the nearest exit for evacuation. Instructors should announce the location of the nearest exit at the beginning of the class each semester. All evacuees should meet in a location away from the building and out of the way of the emergency vehicles. All efforts should be made to aid physically disabled individuals to a safe location and to advise emergency rescue personnel.

Electrical Safety

Experimental setups often involve the use of several electrically powered instruments simultaneously. In order to reduce the risk of equipment and laboratory damage and personal harm, observe the following guidelines:

a. All electrical equipment and services must be grounded.
b. All electrical cords which are frayed or deteriorated must be replaced.
c. Electrical cords and instrument cables must not be located near potential heat sources, in locations where they may be subjected to wear by friction, or where they may present a shock or fire hazard.
d. Equipment electrical cords and extension cords must not be placed above ceiling tiles, through doorways or walls, or located where they will present a tripping hazard.
e. Extension cords may only be used for temporary conditions. They must not be used in place of permanent wiring. If extension cords are used, be sure the cord rating is adequate for usage and is a grounded type.
f. Electrical outlets within 6 feet of a water source should be GFCI.

Housekeeping

Laboratories should always be kept clean and organized. This helps prevent accidents, such as knocking items off of counter tops, misplacing items, spills, and additionally allows for work surfaces to be easily cleaned, disinfected, or decontaminated. Hazards such as spills are easier to identify on clean surfaces, free of clutter. Hazardous items are less likely to be misplaced. Regulatory inspectors and visitors such as funding entities and accrediting teams have positive impressions of laboratories that are tidy, clean, well-organized and adequately labeled. Recommended guidelines:

a. Keep work area and work surfaces clean and uncluttered (including hoods and glove boxes).
b. Clean up work area upon completion of a procedure and/or the end of each day.

c. Gas, air, and vacuum services should be turned off at the bench service valve when services are not in use.
d. Clean up all spills and leaks promptly. Maintain well stocked spill kits. Spill kits should contain materials appropriate to the nature of the work and chemicals used.
e. Do not use damaged glassware. Broken glassware should be discarded in closed boxes marked "broken glass", not in the regular trash receptacles. Refer to the Biohazardous/Medical Waste Management and Sharps Procedures document for additional procedures for glassware disposal.
f. Used needles and syringes, razor blades, Pasteur pipettes and other "sharps" that are NOT contaminated with biohazardous materials should be placed in a puncture-resistant container labeled:

"Sharps" or "Sharps Waste",

Non-Hazardous or Non-Medical, and

Do Not Recycle.

g. Refer to the Biohazardous/Medical Waste Management and Sharps Procedures document for additional procedures and for information on regulated, contaminated sharps management.
h. Chemicals and equipment should be clearly and correctly labeled as well as properly stored.
i. Sink traps and floor drain traps should be kept filled with water at all times to prevent escape of odors to other building areas.
j. Adequate, skid proof footstools and stepladders should be used for reaching upper shelves. Do not stand on chairs or other easily movable objects.

Sanitation

Proper sanitation goes hand-in-hand with good laboratory housekeeping. Applying cosmetics, eating, drinking, and similar actions increase the risk of contamination. Observe the following guidelines:

a. Do not store or consume food or beverages in laboratories or near chemicals.
b. Do not smoke in laboratories.
c. Do not apply cosmetics in the lab.
d. Avoid chewing gum in lab.
e. Avoid smelling and *never* taste chemicals.
f. Oral pipetting or mouth suctioning is a prohibited practice.
g. Remove gloves and wash hands prior to leaving the laboratory, except in the case of an emergency. Use a new pair of gloves upon returning to the lab.
h. Leave lab coats in the laboratory. Place soiled clothing or lab coats in a closable bag or container when transporting for laundering or proper disposal.
i. Wash exposed skin of hands and arms thoroughly before leaving the laboratory. Use soap and warm water and rub hands for at least 20 seconds. Rinse thoroughly with fingers pointing downward under water stream.

Laboratory Security

Laboratory security is an integral part of an effective laboratory safety program. Follow these procedures to ensure a secure working environment:

a. Keep laboratory doors locked when unoccupied.
b. Keep an accurate record of valuable equipment, chemicals, stocks, cultures, project materials, growth media, and those items that support project activities.
c. Notify University Police (2-6412) if materials are missing from the laboratory.
d. Inspect all packages arriving at the work area.
e. Do not leave chemicals unattended on loading docks and public access areas.
f. Report any suspicious material orders (e.g., chemicals organisms). Ensure you match invoices to orders received in the lab.
g. When research is completed for the day, ensure that chemicals and biological materials have been properly stored and secured.
h. Ask strangers (someone you do not recognize as a co-worker or support staff) for university identification. If they are not authorized to enter, ask them to leave or report their presence to management or University Police.
i. Keep high hazard materials in locked storage units whenever they are not in use. High hazard or high security materials include:
    1. Radioisotopes
    2. Carcinogens
    3. Select Agents
    4. Controlled substances and other narcotics
    5. Explosives or highly reactive materials
j. Maintain a catalog for receiving, using, and disposing of high hazard materials.

There are additional requirements and specific regulations for Select Agents.

Minors in the Lab

Minors (18 years or younger) may not work in laboratories unsupervised. Parent or guardian permission is strongly recommended for minors working in laboratory settings where inherent hazards exist. Work with (or access to) the following hazards requires documentation of parent/guardian approval:

1. Radioisotopes
2. Carcinogens
3. Select Agents
4. Controlled substances and other narcotics
5. Explosives or highly reactive materials
6. Nanoparticles (where aerosolization is possible)
7. Class 3-4 lasers
8. Live animals in the laboratory setting
9. Infectious materials, human pathogens, zoonotic agents

Pets and Assistance Animals

Pets are not permitted in academic or research laboratories. Assistance animals may only be permitted in laboratories following registration as a service animal with the Student Access Center and after EHS reviews the laboratory to determine if the animal’s presence presents a hazard or could interfere with the research activities of others. Additional entities may be consulted by EHS when considering if the service animal’s safety and welfare is jeopardized. Certain food laboratories and other settings may have additional restrictions.

See PPM 7840.100 Control of Animals on Kansas State University Property and the Student Access Center Service Animal webpage.

Safety Practices by Topic

The safety practices found herein are designed to be implemented along with the general lab safety practices previously outlined. These specific safety practices are divided by topic for ease of reference depending on the nature of the hazards present in a given area.

Chemical Safety

Chemical safety at Kansas State University is achieved by chemical hazard identification and control, careful management of chemicals, and effective hazard communication. To this end, the university implements a Chemical Hygiene Program and a Hazard Communication Program as outlined in OSHA federal regulations (29 CFR 1910.1450 and 29 CFR 1910.1200 respectively). While federal OSHA does not have jurisdiction on campus, these programs are implemented as a means of providing safe laboratory spaces and practices on campus; to meet the requirements of the Kansas Department of Labor (KDOL); to fulfill the contractual agreements with federal funding entities; and to meet the expectations of accrediting bodies.

In addition to these University level programs, each department or laboratory is required to maintain safety documents specific to their administrative area. The intent is that the Lab Safety Manual along with these written programs and laboratory level safety documents will provide comprehensive chemical safety information and meet regulatory requirements.

The sections below provide descriptions of these programs and requirements. Full written versions of these programs can be found on the EHS website.

Chemical Hygiene Program

The university maintains a Chemical Hygiene Program (CHP) that addresses general requirements for the institution. This CHP applies to all spaces on Kansas State University campuses that engage in the laboratory use of hazardous chemicals. It does not apply in laboratory uses of hazardous chemicals which present no potential for employee exposure.

The following components make up the Chemical Hygiene Plan:

a. General criteria to determine if safety controls are required and which to implement; giving particular attention to extremely hazardous chemicals (See **Hazard Assessment**)
b. **Standard Operating Procedures** for all processes involving hazardous chemicals that take place in the laboratory
c. Measures to ensure proper and adequate performance of laboratory engineering controls (fume hoods, glove boxes, biosafety cabinets, etc.)
d. Documentation of employee **Training**, which must take place upon the employee's initial assignment to a work area containing hazardous chemicals prior to assignments involving new exposure situations.
e. The circumstances under which a certain procedure requires prior approval before being performed
f. Medical consultation and examinations whenever;
    1. An employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory

    2. Environmental monitoring reveals an exposure level above the action level or PEL
    3. A chemical spill, leak, explosion or other release takes place which results in a hazardous exposure
    4. When respirator use is necessary to maintain exposure below the TLV. Every effort will be made by the Department Head to provide the necessary engineering controls (such as mechanical ventilation) to relieve the need for respirators

g. Designation of individuals responsible for implementing the CHP

Hazard Communication Standard Program

The university maintains a Hazard Communication Standard (HCS) Program as outlined in 29 CFR 1910.1200. This program includes an inventory of every hazardous chemical on campus, proper chemical labels, collections of Safety Data Sheets with Right-to-Know access, training, and a written program detailing how each portion of the Hazard Communication Program operates.

To view the university HCSP, see: *Hazard Communication Standard*

Chemical Inventories

Laboratories are required to maintain an inventory of all hazardous chemicals present in their work area on EHS Assistant. EHS Assistant is an inventory program provided by EHS for the purpose of maintaining a centralized record of all chemicals present on campus. The chemical inventory must include:

a. Full chemical name in English
b. Storage location
c. The owner of the chemical
d. The amount on hand

This information is for both safety and regulatory purposes. EHS Assistant is pre-loaded with thousands of chemicals for ease of use. When adding chemicals to your inventory, please carefully search for your chemical before adding it to the system. CAS numbers are attached to each chemical to avoid confusion caused by multiple names to identify a single chemical. Use CAS numbers to avoid duplicating entries into EHS Assistant. In addition, the amount of a chemical included in your inventory only needs to be a

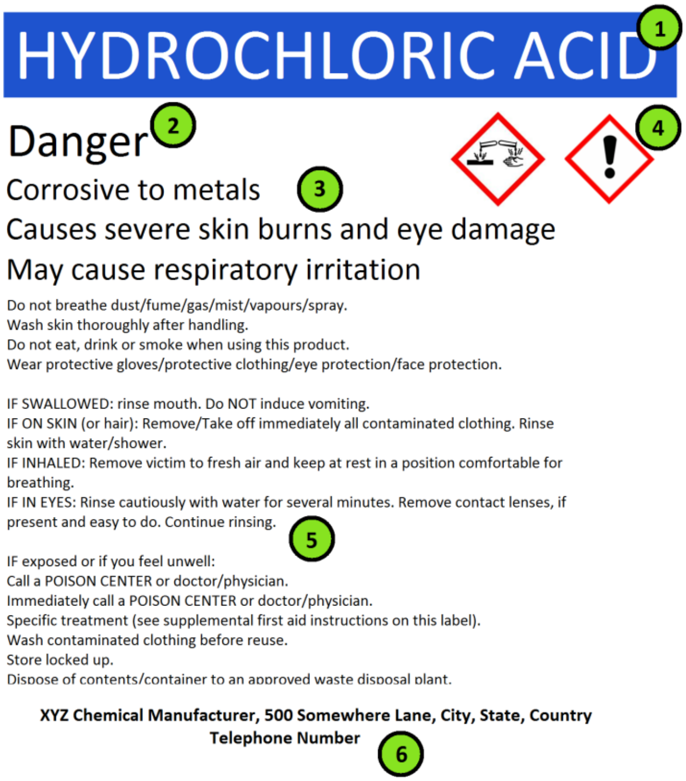
For access to the EHS Assistant program, see our webpage:

http://www.k-state.edu/safety/environmental/

Chemical Labeling

Hazardous chemicals come from manufacturers with labels containing six required fields. These fields are intended to communicate the identity of the chemical and necessary hazard information. The fields include:

1. Chemical identifier in English
2. Signal word
3. Hazard statements
4. GHS pictograms
5. Precautionary statements
6. Company contact information



HYDROCHLORIC ACID

Danger

Corrosive to metals

Causes severe skin burns and eye damage

May cause respiratory irritation

Do not breathe dust/fume/gas/mist/vapours/spray.
Wash skin thoroughly after handling.
Do not eat, drink or smoke when using this product.
Wear protective gloves/protective clothing/eye protection/face protection.

IF SWALLOWED: rinse mouth. Do NOT induce vomiting.
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

IF exposed or if you feel unwell:
Call a POISON CENTER or doctor/physician.
Immediately call a POISON CENTER or doctor/physician.
Specific treatment (see supplemental first aid instructions on this label).
Wash contaminated clothing before reuse.
Store locked up.
Dispose of contents/container to an approved waste disposal plant.

XYZ Chemical Manufacturer, 500 Somewhere Lane, City, State, Country
Telephone Number

Whenever a hazardous chemical is removed from its primary storage container to a secondary container for lab work it must be labelled. This new label must include the full chemical name in English and the hazards associate with the substance. Hazard information may be included in written language or symbols. If the hazard information is not written on the secondary container, the general method of communicating hazard information on secondary containers must be written in the laboratory Hazard Communication Program. A secondary container is exempt from these requirements under the following circumstances:

a. You are the one who transferred the chemical into the secondary container and it is in your exclusive possession, **and**
b. The chemical will be completely used up within the work shift, **and**
c. You do not leave the area.

OSHA's requirements for manufacturer labels are proscriptive, they must include the required information. OSHA requirements for laboratories, upon which KSU's requirements are based, are competency based. Containers must be labelled with the chemical name and lab workers must know the hazards associated with each hazardous substance in their workspace. If secondary containers are not labelled with this information, the laboratory is required to adequately demonstrate that lab workers know the required information.

Safety Data Sheet Requirements

Safety Data Sheets (SDS) are the simplest place to learn about the hazards associated with a chemical. Since the UN's adoption of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), SDS have begun to phase out Material Safety Data Sheets (MSDS). The new SDS contain 16 standardized sections. All SDS must contain the following sections, except for sections 12-15 which are optional:

1. Product identification
2. Hazard identification
3. Chemical composition
4. First-aid measures

5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls and Personal Protective Equipment
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

Manufacturers must provide SDS to the consumer (you) on the first shipment of a chemical order and the order following any changes made to the SDS. SDS are often available on a manufacturer’s website.

A collection of SDS for each chemical present in the workplace must be maintained. This collection of SDS may be printed in a notebook or be found online provided there are no barriers to employee access to the information. If the same chemical is purchased from multiple manufacturers, there must be an SDS for that chemical from each manufacturer in the SDS collection. The SDS should be the most current version for the product in use or in storage.

Chemical Storage

The primary objective when storing chemicals is to minimize the physical and chemical hazards associated with certain stock chemicals and with the accidental mixing of chemicals due to fire, earthquake, accidental breakage, or other laboratory accident. Assessment of these hazards must also consider the mixing of fugitive vapors from volatile compounds which can lead to destruction of containment vessels or potentially explosive conditions.

General considerations

The following guidelines are applicable to the storage of all types of chemicals:

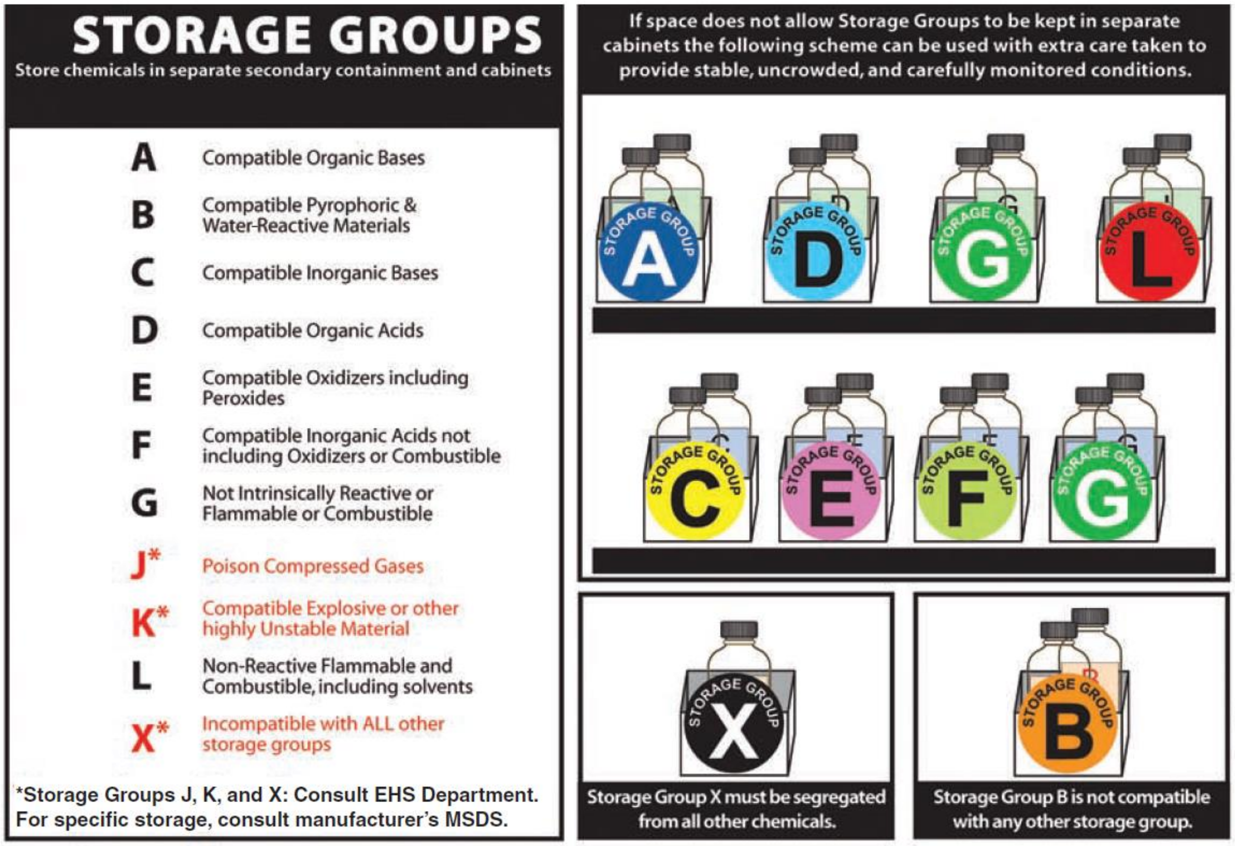
a) Chemicals should never be stored directly on the floor.
b) Keep chemicals off of work area countertops when not in immediate use.
c) Do not store chemicals in fume hoods unless required. Crowding within a fume hood results in decreased hood performance, lead to lab accidents, or may be prohibited by regulation (e.g., open volatile containers are prohibited).
d) Label all chemicals with the purchase date to maintain inventory control.
e) Store chemicals inside a closed cabinet or shelf with a lip to avoid accidental breakage.
f) Position shelves to remove tallest container in an upright position. Avoid having to tilt container to access it.
g) Store flammable liquids in approved flammable-liquid storage cabinets.
h) Store chemicals according to compatible storage groups
i) Do not store food in refrigerators or freezers used for chemical, biological or radioisotope storage. Refrigerators and freezers must be labeled "NO FOOD – CHEMICALS ONLY" or "NO

CHEMICALS - FOOD ONLY" depending on the intended purpose of the equipment. Labels are available from EHS.

Chemical storage groups

There are many systems for segregating chemicals into groups compatible for storage and this is only one of them. This system is recommended for use across KSU laboratory spaces for its conservative approach to safety and minimal laboratory expertise required by laboratory personnel to properly execute this system. The drawback of this system is that several separate chemical storage locations are required which may not be feasible in some small laboratory spaces. In these instances, other segregation systems may be used (such as Fisher Scientific’s ChemAlert color system). Contact EHS for assistance.

Ten incompatible storage groups are identified in *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards*. Ideally, these groups would each be stored in a separate cabinet, but at a minimum they must be separated by suitable secondary storage containers. In addition to the categories outlined in **Figure *2***, check SDSs for storage incompatibilities of specific chemicals. Additional incompatibilities are listed in **Appendix A: Chemical Compatibility List.**



STORAGE GROUPS

Store chemicals in separate secondary containment and cabinets

A	Compatible Organic Bases
B	Compatible Pyrophoric & Water-Reactive Materials
C	Compatible Inorganic Bases
D	Compatible Organic Acids
E	Compatible Oxidizers including Peroxides
F	Compatible Inorganic Acids not including Oxidizers or Combustible
G	Not Intrinsically Reactive or Flammable or Combustible
J*	Poison Compressed Gases
K*	Compatible Explosive or other highly Unstable Material
L	Non-Reactive Flammable and Combustible, including solvents
X*	Incompatible with ALL other storage groups

*Storage Groups J, K, and X: Consult EHS Department. For specific storage, consult manufacturer’s MSDS.

If space does not allow Storage Groups to be kept in separate cabinets the following scheme can be used with extra care taken to provide stable, uncrowded, and carefully monitored conditions.

Storage Group X must be segregated from all other chemicals.

Storage Group B is not compatible with any other storage group.

Figure 2 – Compatible storage group classification system. In addition to these categories, check manufacturers SDS for specific storage incompatibilities (From *Prudent Practices in the Laboratory,* adapted from Stanford University’s ChemTracker Storage System).

Some of these storage groups will require special storage conditions in addition to being separated from other chemicals. For information on pyrophorics, peroxides, and other highly unstable chemicals, see **Specific Hazards**.

Chemicals in Storage Group X are highly reactive, highly toxic, or some combination of the two and should be stored by themselves instead of collected in a group. Some examples include picric acid, phosphorous, sodium azide (not in solution), and sodium hydrogen sulfide.

Flammable Liquids

Flammable liquid storage is regulated by volume and the flashpoint of the chemicals. These chemicals should be stored in a flammables cabinet, or an explosion-proof or flammable-safe refrigerator at all times. No more than 5 gallons per laboratory of flammable chemicals may be stored outside of a cabinet at one time. Flammables storage cabinets must meet International Fire Code standards, including:

a. Made of flame resistant material
b. Labelled: FLAMMABLE – KEEP FIRE AWAY
c. Well fitted, self-closing doors equipped with three-point latch
d. Bottom of cabinet shall be liquid tight to a height of at least two inches

Radioactive Materials

Containers of radioactive material shall have a firmly affixed durable, clearly visible label bearing the radiation symbol and the words CAUTION (or DANGER) RADIOACTIVE MATERIAL. Labels on storage containers shall also state the quantities and kinds of radioactive materials and date of measurement. Radioactive material should be stored in a locked container within a locked room. Reasonable protection shall be provided against loss or leakage by the effects of fire or water.

Equipment used with radioactive materials such as glassware shall be kept separate from other equipment. Once used with radioisotopes, the equipment shall not be used for other work or shall not be sent for repair or glass washing area until demonstrated to be free of contamination. A storage cabinet marked with an official radiation symbol must be provided for glassware and tools used in radioisotope work.

Compressed Gases

Each tank must be properly and permanently identified when received. Never accept a cylinder on which the name of the contents is illegible. Do not rely on color codes for tank identification. Cylinder labels and/or marking must spell out the content name. Store cylinders with the content label readily visible. Use appropriate regulators and do not attempt to modify or change cylinder valves or regulators.

Only those gas cylinders in immediate use shall be located in a laboratory. Replacement cylinders and empty cylinders shall be stored in a designated area, preferably outside the building. Do not store cylinders in hallways. Transport cylinders using a proper dolly with cylinder securing apparatuses. Tightly secure threaded caps prior to moving cylinders.

All compressed gas cylinders must be secured with a chain, clamp, or strap at all times when in use, storage, or transport. Three points of contact should be made with the sides of the cylinder at all times whether in transit, storage, or use. When not in use or while in transit, regulators shall be removed and valve protection caps put in place.

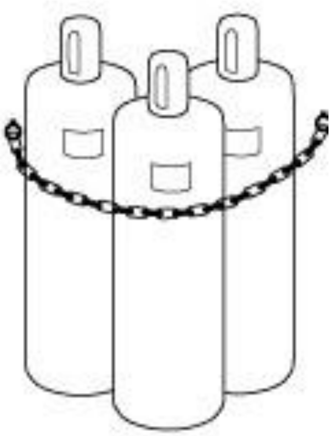


Figure 3 - example of proper three points of contact while storing gas cylinders

Use all of the contents of a cylinder whenever possible. Even though the cylinder may seem empty, continue to use recommended handling procedures for compressed gas cylinders. Return the empty cylinder to the manufacturer, if possible. Cylinders that cannot be returned and are empty or are no longer wanted are handled through the hazardous waste program.

See **Pressure Vessels.**

Peroxide Forming Chemicals

Peroxide forming chemicals have the potential to create for peroxide containing crystals under normal storage conditions. These crystals are highly reactive and may explode upon ignition by mechanical forces such as unscrewing the lid of the container. To avoid this situation, follow these guidelines:

a. All laboratories working with peroxide forming chemicals (PFC) must maintain an inventory control program for PFC to ensure these chemicals are removed from inventory as indicated, examined for signs of potential peroxides, and/or tested for peroxides.
b. Order only quantities necessary to complete an experiment and that will be used up within six months or less.
c. Purchase PFCs with added peroxide formation inhibitor, whenever possible.
d. PFCs must be appropriately labelled, including the date opened and expiration date as according to manufacturer. Expired chemicals must be promptly disposed of by EHS as hazardous waste.
e. Document on label the dates of peroxide testing and additions of inhibitors.

See **Peroxide Forming Chemicals**

Controlled Substances

Certain research activities require the use of controlled substances. Controlled substances are drugs and other substances regulated under the Controlled Substances Act to avoid illicit uses. These substances are identified in the schedules contained in the **Controlled Substances Inventory List** published by the U.S. Drug Enforcement Administration (DEA). Prior to purchasing or conducting research with controlled substances, University employees must register with the DEA and adhere to applicable Kansas Board of Pharmacy requirements. Employees with approved registrations (license) must comply with all related federal and state laws and regulations in accordance with Title 21, Code of Federal Regulations (CFR), Part 1300-1308 and the Kansas Statutes Annotated (KSA) 65-4101 through 4165; including controlled substances:

- conditions of license
- use and management
- documented disposal
- storage and inventory control
- inventory physical security requirements
- reporting and record keeping

This policy does not apply to controlled substances dispensed by a practitioner to a patient in the course of professional practice as authorized by his/her license. Clinical teaching activities must also comply with DEA and state regulations.

For further information on disposal see:

Use and Disposal of Controlled Substances Used for Research

Specially Regulated Materials

RESERVE

Shipping and Importation

RESERVE

Chemical Hazard Training

Training on the university Hazard Communication Standard Program is offered by EHS. This training includes general information, which, combined with laboratory or procedure specific training offered by PIs or other informed individuals will meet the following requirements:

a. Methods and observations to detect the presence or release of a hazardous chemical in the workplace
b. The hazards associated with the chemicals present in the workplace
c. The measures an employee can take to protect themselves from those hazards
d. The details of the HCS Program including how employees can obtain, read, and understand the relevant SDS
e. SOPs for all processes involving hazardous chemicals that take place in the laboratory

Biological Safety

Several groups oversee various aspects of biological safety on campus. These include IACUC, IBC, IRE, and others which may be found on the University Research Compliance Office website. Depending on the nature of your work you may need to register with the appropriate entity. All research and teaching activities involving microbiological agents, recombinant or synthetic nucleic acid molecules or toxins of biological origin must be registered with the Institutional Biosafety Committee (IBC) prior to project initiation. The IBC is responsible for ensuring that research conducted at KSU is in compliance with applicable regulations and guidelines, including the NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines), the Biosafety in Microbiological and Biomedical

Laboratories (BMBL), 5th Edition, and the Federal Select Agents Regulations. These form the basis for campus biosafety policies and procedures.

General Biosafety Practices

a. Maintain strict adherence to standard microbiological practices and techniques.
b. Personnel working with infectious agents or materials must be aware of potential hazards and must be trained in the practices and techniques necessary for handling such material.
c. The PI must maintain a Biological Safety Manual which identifies the hazards and safety procedures designed to minimize or eliminate risks.
d. Access to areas where infectious agents harmful to persons are used shall be limited to authorized personnel and appropriate warning signs will be posted.
e. Personnel must wash their hands after they handle viable materials and animals, after removing gloves and before leaving the laboratory.
f. All procedures must be performed carefully to minimize the creation of splashes or aerosols.
g. Work surfaces must be decontaminated at least once a day and after any spill of viable material.
h. All contaminated liquid or solid wastes or potentially infectious biological material will be autoclaved or properly disinfected prior to disposal. Materials must be transported in durable, leak-proof containers and closed for transport from the laboratory.
i. An insect and rodent control program must be in effect, if applicable.
j. Personal protective equipment (PPE) such as gloves, coats, gowns, shoe covers, boots, respirators, face shields and safety glasses must be provided by the individual's department. Use of PPE is required when working in certain animal studies, during animal necropsy, when handling pathogenic organisms, or when conducting maintenance or service in the laboratory.
k. The use of vaccines may provide an increased level of personal protection. Some work requires specific vaccines to be administered before work can begin.
l. Primary containment barriers must be provided to protect personnel and the laboratory environment from exposure to infectious agents. A biosafety cabinet (BSC) is the principal device used to provide primary containment of infectious aerosols. A sealed safety centrifuge cup or sealed tube are other examples of primary containment.
m. Secondary containment provides protection of the environment and the public external to the laboratory from exposure to biohazardous materials. Examples of secondary containment are sealed boxes for carrying primary tubes of biohazardous materials and the design of the laboratory room itself. Facility design protects personnel working inside and outside of the laboratory from biohazardous materials which may be accidentally released. The recommended secondary barrier(s) will depend on the risk of transmission of specific agents.

Biosafety Manual

A biosafety manual must be prepared when an activity involves infectious and/or recombinant DNA materials. This manual should be prepared to assist investigators, technicians, and collaborators in routine and/or emergency operation using rDNA or infectious materials. The manual should also be available to safety, and emergency response personnel in case of an incident, accident, or an emergency in a specific lab area. It should be a working document, reviewed periodically, updated as necessary, and readily accessible to all personnel working in a lab or area with infectious and/or recombinant agents. A training/familiarization sheet for all personnel working in a lab or area with infectious and/or recombinant agents should be part of the biosafety manual. A loose-leaf binder that can easily accommodate new materials is an effective option for maintaining a laboratory biosafety manual. View a sample Laboratory Biosafety Manual (DOC).

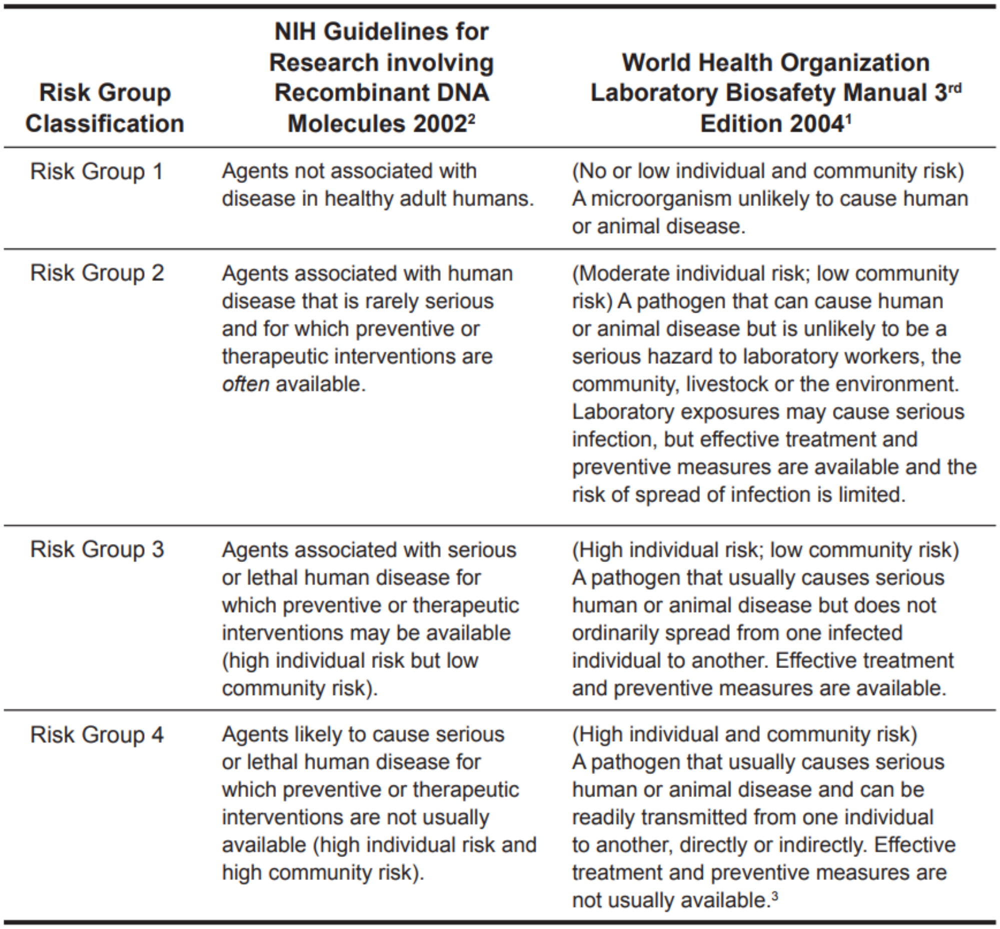
Bloodborne Pathogens

Human blood, body fluids or tissues and human cell lines must be treated as biohazardous agents to prevent the transmission of human pathogens such as Acquired Immune Deficiency Syndrome (AIDS), ARC (AIDS-related complex) syndrome, Hepatitis B and Hepatitis C to laboratory personnel. All faculty, staff and students working with human blood, body fluids or tissues, or with human cell lines must comply with the Bloodborne Pathogen Program (BBP). The BBP policy is available at: Bloodborne Pathogen Program.

Risk Groups

The hazard characteristics of a biological agent may be described as the ability to infect and cause disease, the severity of that disease, and the availability of effective preventative measures and treatments for that disease. Based on these characteristics, the World Health Organization and the National Institute of Health developed risk groups to to classify the risk level of biological agents. These risk groups are defined in the following table:

Classification of Infectious Microorganisms by Risk Group



Risk Group Classification	NIH Guidelines for Research involving Recombinant DNA Molecules 2002[2]	World Health Organization Laboratory Biosafety Manual 3rd Edition 2004[1]
Risk Group 1	Agents not associated with disease in healthy adult humans.	(No or low individual and community risk) A microorganism unlikely to cause human or animal disease.
Risk Group 2	Agents associated with human disease that is rarely serious and for which preventive or therapeutic interventions are *often* available.	(Moderate individual risk; low community risk) A pathogen that can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spread of infection is limited.
Risk Group 3	Agents associated with serious or lethal human disease for which preventive or therapeutic interventions may be available (high individual risk but low community risk).	(High individual risk; low community risk) A pathogen that usually causes serious human or animal disease but does not ordinarily spread from one infected individual to another. Effective treatment and preventive measures are available.
Risk Group 4	Agents likely to cause serious or lethal human disease for which preventive or therapeutic interventions are not usually available (high individual risk and high community risk).	(High individual and community risk) A pathogen that usually causes serious human or animal disease and can be readily transmitted from one individual to another, directly or indirectly. Effective treatment and preventive measures are not usually available.[3]

Figure 4 - from Biosafety in Microbiological and Biomedical Laboratories [BMBL]. CDC/NIH, 5th Edition, U.S. Government Printing Office, Washington, D.C

Biosafety Levels

Defined biosafety levels provide guidelines to ensure an appropriate amount of protection for laboratory users and the environment based on biological risk. Biosafety level correlates with, but is not the same as, risk group. Increasing requirements for both physical containment and procedural details come with increasing levels of protection. For more detailed information, consult the most current edition of "Biosafety in Microbiological and Biomedical Laboratories." See Appendix D for biosafety levels appropriate for work with specific agents. Each level includes the requirements of all lower levels.

Biosafety Level 1 (BSL-1)

BSL-1 facilities and practices are suitable for work involving well-characterized agents not known to consistently cause disease in immunocompetent adult humans, and present minimal potential hazard to laboratory personnel and the environment. Work is typically conducted on the open bench tops using standard microbiological practices. Special containment equipment or facility design is not required. Laboratory personnel must have specific training in the procedures conducted in the laboratory and must be supervised by a scientist with training in microbiology or a related science.

Special containment equipment or facility design is not required, but may be used as determined by appropriate risk assessment. Laboratory personnel must have specific training in the procedures conducted in the laboratory and must be supervised by a scientist with training in microbiology or a related science.BSL-1.

Biosafety Level 2 (BSL-2)

BSL-2 builds upon BSL-1. BSL-2 is suitable for work involving agents that pose moderate hazards to personnel and the environment. It differs from BSL-1 in that

a. Primary hazards to personnel working with these agents relate to accidental percutaneous or mucous membrane exposures or ingestion of infectious materials. Extreme precaution with contaminated sharps must be emphasized. BSL-2 facilities and practices are suitable for work involving agents that pose moderate hazards to personnel and the environment.
b. Laboratory personnel have specific training in handling pathogenic agents and are supervised by scientists competent in handling infectious agents and associated procedures.
c. Access to the laboratory is restricted when work is being conducted.
d. All procedures in which infectious aerosols or splashes may be created are conducted in BSCs or other primary containment equipment. Other primary barriers must be used as appropriate, such as splash shields, face protection, gowns, and gloves. Secondary barriers such as hand washing and waste decontamination facilities must be available to reduce potential environmental contamination.

Biosafety Level 3 (BSL-3)

Applicable to clinical, diagnostic, teaching, research or production facilities where work is performed with indigenous or exotic agents that may cause serious or potentially lethal disease through inhalation route exposure.

a. Infectious agents present an inhalation risk.

b. Laboratory personnel must receive specific training in handling pathogenic and potentially lethal agents, and must be supervised by scientists competent in handling infectious agents and associated procedures.
c. All procedures involving the manipulation of infectious materials must be conducted within BSCs, other physical containment devices, or by personnel wearing appropriate personal protective equipment.
d. A BSL-3 laboratory has special engineering and design features to ensure containment of airborne disease agents.

Biosafety Level 4 (BSL-4)

Currently Kansas State University has no BSL-4 facilities nor is it permitted to have any BSL-4 facilities.

BSL-4 is required for work with dangerous and exotic agents that pose a high individual risk of life-threatening disease, aerosol transmission, or related agent with unknown risk of transmission. Agents with a close or identical antigenic relationship to agents requiring BSL-4 containment must be handled at this level until sufficient data are obtained either to confirm continued work at this level, or re-designate the level.

a. Laboratory staff must have specific training in handling extremely hazardous infectious agents.
b. Laboratory staff must understand the primary and secondary containment functions of standard and special practices, containment equipment, and laboratory design characteristics.
c. All laboratory staff and supervisors must be competent in handling agents and procedures requiring BSL-4 containment.
d. Access to the laboratory is controlled by the laboratory supervisor in accordance with institutional policies.

There are two models for BSL-4 laboratories: A Cabinet Laboratory where all handling is done of agents must be performed in a Class III BSC, and a Suit Laboratory where personnel must wear a positive pressure protective suit. BSL- 4 Cabinet and Suit Laboratories have special engineering and design features to prevent microorganisms from being disseminated into the environment.

Animal Biosafety Levels

Animal Biosafety Level 1 (ABSL-1) Facilities

ABSL-1 facilities are suitable for work involving laboratory animals infected with well-characterized agents not known to consistently cause disease in immunocompetent adult humans, and that present minimal potential hazard to laboratory personnel and the environment. ABSL-1 facilities should be separated from the general traffic patterns of the building and restricted as appropriate. Special containment equipment or facility design may be required as determined by an appropriate risk assessment. Personnel must have specific training in animal facility procedures and must be supervised by an individual with adequate knowledge of potential hazards and experimental animal procedures.

Animal Biosafety Level 2 (ABSL-2) Facilities

ABSL-2 facilities and practices are suitable for work involving laboratory animals infected with agents associated with human disease and pose moderate hazards to personnel and the environment. It also addresses hazards from ingestion as well as from percutaneous and mucous membrane exposure. ABSL-2 requires that 1) access to the animal facility is restricted; 2) personnel must have specific training in animal facility procedures, the handling of infected animals and the manipulation of pathogenic agents; 3) personnel must be supervised by individuals with adequate knowledge of potential hazards, microbiological agents, animal manipulations and husbandry procedures; and 4) procedures involving the manipulation of infectious materials, or where aerosols or splashes may be created, should be conducted in BSCs or by use of other primary containment equipment. Appropriate personal protective equipment must be utilized to reduce exposure to infectious agents, animals, and contaminated equipment. Implementation of employee occupational health programs should be considered.

Animal Biosafety Level 3 (ABSL-3) Facilities

ABSL-3 involves practices suitable for work with laboratory animals infected with indigenous or exotic agents, agents that present a potential for aerosol transmission and agents causing serious or potentially lethal disease. ABSL-3 builds upon the standard practices, procedures, containment equipment, and facility requirements of ABSL-2. An ABSL-3 facility has special engineering and design features. ABSL-3 requires that 1) access to the animal facility is restricted; 2) personnel must have specific training in animal facility procedures, the handling of infected animals and the manipulation of potentially lethal agents; 3) personnel must be supervised by individuals with adequate knowledge of potential hazards, microbiological agents, animal manipulations and husbandry procedures; and 4) procedures involving the manipulation of infectious materials, or where aerosols or splashes may be created, must be conducted in BSCs or by use of other physical containment equipment. Appropriate personal protective equipment must be utilized to reduce exposure to infectious agents, animals, and contaminated equipment. Employee occupational health programs must be implemented.

When animals are subject to NIH Guidelines BL3N requirements, a double barrier shall be provided to separate male and female animals unless reproductive studies are part of the experiment or other measures are taken to avoid reproductive transmission. Reproductive incapacitation may be used. All genetically engineered neonates shall be permanently marked within 72 hours after birth, if their size permits, or their containers should be marked. In addition, transgenic animals should contain distinct and biochemically assayable DNA sequences that allow identification of transgenic animals from among non-transgenic animals.

Biosafety Level 3 Agriculture (BSL-3Ag) Facilities

BSL-3Ag containment addresses activities using agents designated as High Consequence Pathogens by the USDA when involving loose-housed animals that cannot be enclosed in primary containment caging. BSL-3Ag facilities are designed so that the room itself acts as a primary barrier to prevent release of infectious agents into the environment. Using the containment features of the standard ABSL-3 facility as a starting point, BSL-3Ag containment spaces must be designed, constructed and certified as primary containment barriers. The BSL-3Ag facility can be a separate building, but more often it is an isolated zone within a facility operating at a lower biosafety level, usually at BSL-3. This isolated zone has strictly controlled access with special physical security measures and functions on the “box within a box” principle.

Arthropod Containment Levels

Arthropod Containment Level 1 (ACL-1) Facilities

ACL-1 containment addresses activities with uninfected arthropod vectors or those infected with a non-pathogen including: arthropods that are already present in the local geographic region regardless of whether there is active vector borne disease transmission in the locale and exotic arthropods that upon escape would be inviable or become only temporarily established in areas not having active vector-borne disease transmission. The ACL-1 facilities have restricted access and are separated from the flow of general traffic. The doors are covered by plastic sheets with inward directional airflow. The area is maintained to allow detection of escaped arthropods. Work areas and primary containers are cleaned and disinfected. A pest exclusion program and mechanism of monitoring arthropod escape is in place.

Arthropod Containment Level 2 (ACL-2) Facilities

ACL-2 containment addresses activities using exotic and indigenous arthropods infected with BSL-2 agents associated with animal and/or human disease, or that are suspected of being infected with such agents. Uninfected genetically modified arthropod vectors also fall under this level provided the modification has no, or only negative effects on viability, survivorship, host range, or vector capacity. ACL-2 facilities have restricted access and are physically separated from general traffic areas by at least two self-closing doors that prevent direct escape of flying and crawling arthropods. A pest exclusion program should be in place. Mechanisms for preventing harborage and escape through drains, penetrations and other portals are considered. Illumination strategies of the facility are considered to reduce escape. Special practices are implemented for blood feeding.

Arthropod Containment Level 3 (ACL-3) Facilities

ACL-3 containment addresses practices suitable for work with potential or known vectors that are, or may be infected with, BSL-3 agents associated with human disease. Arthropods that are infected or potentially infected with BSL-3 agents may pose an additional hazard if the arthropod containment level 3 room is located in an area where the species is indigenous, or if alternative suitable vectors are present, as an escaped arthropod may introduce the pathogen into the local population. ACL-3 builds upon the practices, procedures, containment equipment, and facility requirements of ACL-2. It differs in that access is more restricted, and the microbiological containment takes a more prominent role in determining the practices and facilities. The use of sharps must be restricted. Floor drains are not recommended. HEPA filtration on both supply and exhaust air is recommended. An accurate inventory and labeling system for tracking arthropods is recommended. All work with arthropods is performed in specialized arthropod handling containers. Biosafety cabinets or appropriate primary barrier are used when infecting arthropods.

Plant Pathogens

Risk assessment and management guidelines for agriculture differ from human public health standards. Risk management for agriculture research is based on the potential economic impact of animal and plant morbidity, and mortality, and the trade implications of disease. Agricultural guidelines take this difference into account. Worker protection is important but great emphasis is placed on reducing the risk of agent escape into the environment. Containment requirements for these pathogens may also be specified in USDA permits, when required. Some plant pathogens are controlled by the Federal Select Agent Regulations.

Special federal permits may be required for importing, exporting and/or transporting human pathogen, animal pathogens, animals or animal products, plant pathogens or plant pests, and plants or plant products. Permit requirements should be verified well in advance of needing the material in question, because some permits can take 60-180 days to receive.

The USDA, APHIS, Plant Protection and Quarantine (PPQ) Unit regulates the importation into the United States, and interstate transportation and possession, of organisms and vectors of pathogenic diseases of plants. The Code of Federal Regulations, in 7 CFR, §330.200, mandates that "No person shall knowingly move any plant pest into or through the United States from any place outside thereof, or interstate, or knowingly accept delivery of any plant pest so moving unless such movement is authorized under permit under this part and is made in accordance with the conditions therein and the provisions in this part".

https://www.aphis.usda.gov/aphis/resources/permits

Experiments to genetically engineer plants by recombinant or synthetic nucleic acid molecule methods, to use such plants for other experimental purposes (e.g., response to stress), to propagate such plants, or to use plants together with microorganisms or insects containing recombinant or synthetic nucleic acid molecules, may be conducted under the containment conditions described in the NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules. The Guidelines may be found at:

https://osp.od.nih.gov/biotechnology/nih-guidelines/

Strict Animal Pathogens

The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), National Import Export Service (NIES), Organisms and Vectors (OV) Unit regulates the importation into the United States, and interstate transportation, of organisms and vectors of pathogenic diseases of livestock and poultry. The Code of Federal Regulations, in 9 CFR, §122.2 , mandates that "no organisms or vectors shall be imported into the United States or transported from one State or Territory or the District of Columbia to another State or Territory or the District of Columbia without a permit".

The same basic principles of biosafety and biocontainment can be applied to ensure that strict animal pathogens are not released into the environment. Some strict animal pathogens are controlled by the Federal Select Agent Regulations. Containment requirements for these pathogens may also be specified in USDA permits, when required.

Select Agents

The United States Department of Health and Human Services (HHS), Centers for Disease Control and Prevention (CDC) and the United States Department of Agriculture (USDA), Animal and Plant Health Inspection service (APHIS) jointly administer the Federal Select Agent Program (FSAP). The FSAP regulates the possession, use, and transfer of specifically designated agents and toxins (Select Agents) that have the potential to pose a particularly severe threat to public health and safety. The FSAP oversees these activities and registers all laboratories and other entities in the U.S. that possess, use, or transfer select agents or toxins. For details on the FSAP and a list of designated select agents go to

http://www.selectagents.gov/

HHS and USDA rules regulating the possession, use, and transfer of select agents and toxins are Code of Federal Regulations 42 CFR Part 73, 7 CFR Part 331, and 9 CFR Part 121..

All campus Select Agents (SA) activities, including the possession, storage, and use of select agents and toxins as defined by HHS and the USDA, shall only occur in the Biosecurity Research Institute (BRI) located in Pat Roberts Hall.

Laboratories that transfer or receive Select Agents must be registered with the Select Agent Program prior to transferring or obtaining Select Agents.

Each Principal Investigator, laboratory employee, room, and Select Agent used must be registered in the Select Agent Program. This can be done by contacting the Responsible Official at the Biosecurity Research Institute (BRI). The Responsible Official for Kansas State University is the Biosafety Officer at the BRI.

The regulation is very clear that these agents may only be used or stored in a registered space. Records must be maintained concerning every activity involved in working with, as well as the transferring and receiving of, Select Agents.

Proper security measures and safety practices must be followed. Questions regarding Select Agents can be directed to the KSU Responsible Official at the Biosecurity Research Institute.

This program is routinely inspected by the FSAP (CDC and USDA APHIS).

Research Involving Recombinant or Synthetic Nucleic Acid Molecules

Research with recombinant or synthetic nucleic acid molecules within the U.S. or its territories conducted at or sponsored by an institution that receives any support for research with recombinant or synthetic nucleic acid molecules from the National Institutes of Health (NIH) must comply with the most recent guidelines as published in the Federal Register. The guidelines specify practices for constructing and handling recombinant or synthetic nucleic acid molecules and organisms and viruses containing recombinant or synthetic nucleic acid molecules.

The Institutional Biosafety Committee has been established at Kansas State University in accordance with the NIH Guidelines to oversee research with recombinant or synthetic nucleic acid. All research with recombinant or synthetic nucleic acid molecules must be registered with the IBC, even if those studies are exempt from the above guidelines. Information can be obtained from the University Research Compliance Office concerning the committee.

Radiation Safety

The Radiation Safety Committee and the Radiation Safety Office are responsible for the safe use of ionizing radiation on campus. It is the policy of Kansas State University that all exposures to ionizing radiation be as low as reasonably achievable (ALARA).

Complete information concerning the procurement, storage, use, handling, and disposal of radioactive material and use of radiation producing devices can be found in the Radiation Safety Manual, which is available from EHS.

Radioactive Materials

Authorization

Authorization for the use of radioactive materials must be obtained by the faculty member responsible for the research (instructor or higher). The application form to become an Authorized Principle Investigator is available on the EHS website or through the Radiation Safety Office. The Radiation Safety Officer will meet with the potential user and present the application to the Radiation Safety Committee for final approval. The authorization will only cover the radioisotope quantities, procedures, and areas requested.

Use

Personnel working with radioactive materials should maintain strict adherence to the general laboratory safety precautions as outlined in this manual.

All laboratory personnel working with radioisotopes must be properly trained. Annual training in the use of radioisotopes is available through EHS. Other times may be arranged by contacting the Radiation Safety Officer.

If a radiation meter is kept in the laboratory, it must be registered and calibrated annually. This process is provided by EHS.

All radioisotopes must be shipped to EHS, 108 Edwards Hall. Department personnel will then deliver the shipment to the authorized laboratory.

Disposal of radioisotopes must be made through EHS. Radioactive waste is regularly picked-up from laboratories. Radioactive waste labels are available free from EHS. For pick-up, contact us through one of the following:

Phone: (785) 532-5856
E-mail: safety@ksu.edu
Web: http://www.k-state.edu/safety

Storage

Containers in which radioactive material is stored shall have a firmly affixed durable, clearly visible label bearing the radiation symbol and words CAUTION (or DANGER) RADIOACTIVE MATERIAL. Labels on storage containers shall also state the quantities and kinds of radioactive materials and date of measurement. Stored radioactive material should be kept in a locked container within a locked room. Reasonable protection shall be provided against loss or leakage by the effects of fire or water.

Equipment such as glassware used for radioactive material shall be kept separate from other equipment. Once used with radioisotopes, the equipment shall not be used for other work or shall not be sent to the repair or glass shop until demonstrated to be free of contamination. A storage cabinet marked with an official radiation symbol should be provided for glassware and tools used in radioisotope work.

Spills

Except for the most minor of spills, the Radiation Safety Office MUST be contacted. Work involving unsealed radioactive sources should occur over absorbent paper or trays to contain any potential spills. In the event of a spill outside of these protective barriers, care should be taken to not spread the contamination. This includes blotting and not wiping the spill, containing it to as small of an area as possible and closing but not leaving the area to prevent tracking the material over a wider area. Keep in mind the chemical and physical properties of the material before attempting to remove it.

Radiation Producing Devices

All radiation producing devices (particle accelerators, X-ray machines, electron microscopes, etc.) must be registered with the Radiation Safety Office. They will determine if the machines are housed and operated so that the radiation exposures are as low as reasonable achievable.

Laser Safety

The laser safety program at Kansas State University is administered by the Laser Safety Officer with oversight from the Laser Safety Committee. It is based on the *American National Standard for Safe Use of Lasers* (ANSI Z136.1-2014) and *American National Standard for Safe Use of Lasers in Research, Development and Testing* (ANSI Z136.8-2012). The purpose of this program is to protect students and employees from the hazards associated with laser systems. Laser systems are divided into the following classifications:

Class	Description	Examples
1*	Lasers considered to be incapable of producing damaging radiation levels during operation, and exempt from any control measures. May be a higher class laser embedded in a device where normal operation presents no laser hazard.	CD players Laser printers Anything where the laser is fully enclosed (embedded) and does not operate unless a barrier is in place.
1M	Lasers considered to be incapable of producing hazardous exposure conditions during normal operation unless collection optics (such as a telescope) are used.	
2	Lasers that emit in the visible portion of the spectrum (400 nm to 700 nm) and eye protection is normally afforded by the aversion response for unaided viewing.	Barcode scanners Alignment lasers Some laser pointers
2M	Lasers not known to cause damage within the aversion response time unless collection optics are used.	
3R	Lasers that are potentially hazardous under some direct and specular reflection viewing conditions if the eye is appropriately focused and stable, but the probability of injury is small.	Some laser pointers
3B**	Moderate powered lasers that may be hazardous under direct and specular reflection viewing conditions but generally are not a fire hazard, diffuse reflection hazard, nor a laser generated air contaminant (LGAC) production hazard. Controls may be required.	Light show projectors Medical lasers Research devices
4**	High powered lasers that are hazardous to view under any condition (directly or diffusely scattered) and are a potential fire, skin, and LGAC hazard. Significant controls are required.	Research and medical lasers

***Users of embedded Class 1 lasers must inform the Laser Safety Officer when maintenance is being performed on the device which will allow a beam with a classification of 3B and above to be exposed.**

****All Class 3B and 4 lasers are required to be registered with EHS**.

Users of Class 3B and 4 lasers are required to be have both comprehensive training through EHS and documented on the job training. Unless otherwise approved by the Laser Safety Officer, the procedures and design of laboratories utilizing Class 3B and 4 lasers must conform to the requirements outlined in the campus Laser Safety Manual and applicable ANSI standards.

Ultraviolet Radiation Safety

Ultraviolet (UV) radiation is a form of non-ionizing radiation that is commonly used in overhead germicidal lamps, biological safety cabinets, light boxes, transilluminators, lasers, and crosslinkers. UV radiation is just outside of the visible range, between 180 and 400 nanometers on the electromagnetic spectrum, making it a mostly invisible hazard. Exposure is not immediately felt and a user may only be aware of the hazard after the damage has already been done.

The World Health Organization divides UV radiation into three regions:

Wavelength (nm)	Region	Hazard Potential	Potential Effects of High Exposure
315-400	UV-A	Lowest	Cataracts
208-314	UV-B	Mid to High	Skin or eye burns, increased risk of skin cancer
100-280	UV-C	Highest	Skin or eye burns

Questions regarding UV radiation safety should be directed towards Environmental Health and Safety at 785-532-5856.

Safety Practices

Never allow unprotected skin or eyes to be exposed to laboratory UV radiation sources. Damage can occur within seconds. Make sure shields and interlocks are in place and operational when using transilluminators and crosslinkers. When working around a biological safety cabinet check that the UV light is off or the sash is closed. The UV light in biological safety cabinets must be off anytime the room is occupied unless the sash is closed. Labs that use UV radiation sources are responsible for training their personnel on safe ways to work around the equipment and how to minimize exposure to UV radiation.

Warning signs should be posted where UV radiation exposure may occur, either on the door to a room with UV lamps or on equipment containing a source of UV radiation. These labels should convey that there is a UV hazard present and protection and/or shielding must be used to protect the skin and eyes.

As UV lamps often get very hot, care must be taken to ensure that they are installed properly enabling proper cooling and airflow. This must be fail-safe and in such a way that solvent vapors cannot reach the lamp.

UV Personal Protection Equipment

All skin must be covered by protective apparel including arms, hands, face, and neck when there is the potential for exposure to laboratory UV radiation sources. Take care to ensure that standard laboratory clothing is worn including long pants, closed toe shoes, and a fully buttoned lab coat. Gloves are to be worn to protect the hands. Make sure there are not any gaps in coverage especially in the neck and wrist areas. Continually check while working to see if any gaps have developed.

Regular prescription eyeglasses may not block UV radiation and are not appropriate protection. Googles and face shields must be worn when there is potential for UV radiation exposure to the face and eyes. These must be stamped as conforming with ANSI Z87.1 and providing UV protection which is shown by a UV or U[#] marking.

Microwave Safety

Microwave ovens can be valuable tools in the laboratory, but it is imperative to recognize the presence of additional hazards that are not typically present when using the microwave in the home. These hazards include rapid vaporization, superheating, ignition of flammable vapors/materials, pressure buildup in sealed containers, exposure to microwave radiation from a faulty unit, electrical shock, and burns from improperly handling heated material.

NEVER USE A LABORATORY MICROWAVE TO HEAT FOOD OR DRINK FOR CONSUMPTION

Checking the following exterior elements regularly ensures that some of these hazards associated with microwave ovens are kept to a minimum:

a. **Exterior Structure:** Is the exterior structure intact? Has the unit has not been damaged or modified? Pay careful attention to seals as broken or burnt seals can be an indicator of microwave leakage.
b. **Electrical:** Is the unit is grounded using a properly rated three-pin plug and connected directly to a wall outlet? Use of power strips or extension cords is prohibited.
c. **Ventilation:** Is the area surrounding the unit clear, allowing for proper ventilation?

For safe operation:

a. Follow all directions from the manufacturer for safe usage.
b. Do not modify or defeat interlocks.
c. Use unsealed non-metal vessels. This is the prevent arcing and explosion.
d. Monitor the microwave while in operation especially when preforming the procedure for the first time or in a different unit. Material can react unexpectedly and power may differ between units.
e. Do not overfill containers. No more than 2/3 full is recommended.
f. Use proper safety equipment such as thermal gloves to remove heated items from the unit. In some cases, such as heating large quantities of materials, wearing a face shield is advised.
g. Microwaving hazardous/flammable materials or agar may require specialized equipment or procedures.

Specific Hazards

The following subsections describe the unique hazards associated with certain materials. The sections contain information on the nature of the hazard and how to safely work with the material. In general, these materials and other highly hazardous substances should be eliminated from your process or substituted with less hazardous materials whenever possible.

Prior to working with any of these substances, consult the SDS and other related safety information. It is mandatory that a hazard assessment be performed and an SOP generated for the hazardous process. The hazard assessment may or may not be in writing, but the safety controls selected as a result of that process must be included in the SOP. Additionally, some of the safety guidance within this section may not be necessary due to the detail of your specific process. Suggested safety practices may be foregone after a thorough hazard assessment is performed and or a reviewing entity has approved the process. Required safety practices are mandatory and must be implemented.

Carcinogens and highly toxic substances

Carcinogens are substances that may cause or increase growth of tumors in humans. For the purposes of the Lab Safety Manual, carcinogens are substances identified by OSHA, the International Agency for Research on Cancer (IARC), National Toxicology Program, or the American Conference of Governmental Industrial Hygienists (ACGIH) as a carcinogen or potential carcinogen.

Chemical toxicity is simply the capacity of a substance to cause harm to the body. Highly toxic substances are those with an oral LD50 < 50 mg/kg, or a lethal concentrations < 200ppm, or any chemical with unknown properties.

The risk from chemical carcinogens is greater or less depending on the quantity, the chemical properties or the intended operation. High-risk situations are those that involve the use of a highly potent chemical carcinogen, large quantities of chemical carcinogens, use of compounds with high vapor pressure or procedures that have a high potential for aerosol production or contamination. Operations such as blending or manipulation of powders are high-risk situations. In low-risk situations, the minimum safeguards are strict adherence to good laboratory practices. Personnel with medical condition, such as depressed immune response or steroid cytotoxic drug treatment, that makes them unusually susceptible to possible harmful effects of a carcinogen must be excluded from any area where accidental exposure might occur. Some carcinogens are reproductive hazards as well, meaning that they may change the DNA of sex cells or interfere with the development of the unborn child.

Carcinogens, reproductive hazards, and highly toxic substances must be handled according to the following guidelines.

Safe Handling

a) Exposure to identified carcinogens should be avoided as much as possible.
b) Use and store as little as reasonable.
c) Substitute these substances with less hazardous materials if possible.
d) Store and transport carcinogens in secondary containers
e) All work with volatile carcinogens or carcinogens in solid or powdered form shall be completed in a vented fume hood or closed system. If work is done in a vented hood, the system should remain on at all times, even when no work is being performed.
f) If work must be accomplished outside of a vented fume hood or closed system, proper respiratory protection must be worn. In order to wear respirators, the respiratory protection plan must be adhered to and lab workers must be fit tested. Contact EHS if carcinogens must be handled outside of a fume hood and for fit testing services.
g) The work area where procedures involving carcinogens are to be performed must be adequately labelled as such.
h) The work area should be covered with stainless steel trays, uncracked glass plates, dry absorbent plastic backed paper or the like. This work area should be disposed of or decontaminated after use. If additional safety precautions are deemed necessary, these should be posted at the work area as well.
i) Wash hands and arms immediately after working with these chemicals.

Cryogenics

Cryogenic materials are characterized by their extreme low temperatures. These temperatures are reached by forcing substances which have low boiling points into the liquid phase. These liquids are then stored in insulated pressure vessels.

Hazards

Cryogenic materials pose a number of hazards. The extreme low temperatures associated with cryogenic liquids and gases can cause effects similar to thermal burns when they come in contact with the skin. Unprotected skin will adhere to metals *and other types of materials* cooled to these temperatures and will cause tremendous tissue damage if torn away.

Containing boiling liquids generates very high pressures. Cryogenic containers should be handled with all the precautions of pressure vessels.

If cryogenic materials are allowed to depressurize they will rapidly expand and have the potential to displace oxygen. Such a situation may or may not be observable. A rapid expansion of a cryogenic material will likely generate a fog in the air, but if the leak occurs slowly, the fog created by the cryogenic gas may not be noticeable. In such a case, only an oxygen monitoring system can provide any warning.

Certain cryogenic materials are themselves flammable. In addition, liquefied inert gases reach temperatures capable of condensing oxygen out of the air and creating unexpected oxygen enriched atmospheres. These situations are extremely hazardous as only a slight increase in oxygen concentration can create an explosive atmosphere.

Storage and Use

a) Cryogenic liquid containers must be high pressure vessels with pressure relief valves.
b) Store pressure vessels in a dry place and check periodically for ice formation which may block pressure relief valves.
c) Keep away from ignition sources
d) Store and work with cryogenic liquids in a well ventilated place. Ensure that the ventilation leads out of the building.
e) If large volumes of cryogenic liquids are stored, an oxygen monitoring system must be installed.
f) All parts of a system using cryogenic materials must be rated for the accompanying temperatures and pressures.
g) A cryogenic system must have a pressure relief device for each segment of the system which is isolated by valves.
h) Pre-cool receiving vessels to avoid temperature shock.
i) Use tongs to place and remove items in cryogenic liquid.
j) Consider that materials may become very brittle in extreme cold. Handle all items at low temperatures carefully.

PPE

a) The eyes are very susceptible to damage from cold temperatures and should therefore be protected. Wear safety glasses and consider a face shield.
b) Close fitting gloves will provide no protection from low temperatures. Wear loose fitting thermal gloves (such as potholders) which can be easily removed if contaminated.

c) Watches, rings, or other adornments which can trap cryogenic liquids near the skin should not be worn when handling cryogenic liquids.

First aid

If contact with cryogenic material occurs, the freezing happens so quickly that the ice crystals are very small. This works in favor of the victim as the frozen cells may not rupture. The key to preventing permanent damage to the cells is to NOT rub the area. The affected area must be slowly warmed using methods which will not cause intercellular damage.

Heating Acids

RESERVE

Hydrofluoric Acid

Hydrofluoric acid (HF) is an inorganic acid that exhibits several chemical and toxicological properties which make it highly hazardous to work with. HF is not a strong acid, yet is corrosive and strongly reacts with glasses and metals. Upon contact with skin, fluoride ions quickly penetrate skin and have the capacity to cause deep tissue damage. At high concentrations symptoms will immediately occur, but at low concentrations symptoms may not be evident for hours. Without treatment, tissue damage can continue to worsen for several days. Concentrated HF also produces irritating, corrosive vapors which may cause severe health effects if inhaled.

General precautions

These precautions apply when using HF or working with chemicals or processes which may generate HF:

a. When HF is present in a laboratory, all laboratory personnel should be informed of the dangers associated with HF and appropriate emergency response procedures.
b. Only experienced personnel should handle gases or concentrated solutions of HF (>1%)
c. Never use HF when working alone or after hours.
d. Conduct operations in a properly functioning chemical fume hood with current EH&S certification.
e. In laboratories where HF is used routinely, emergency procedures and SDS should be clearly posted adjacent to the work area.
f. A HF spill kit should be located adjacent to the work area. In addition to typical spill kit materials, the kit should include calcium gluconate gel (2.5%), calcium gluconate (1% in normal, sterile, saline solution), and calcium gluconate (5% in normal, sterile, saline solution). These solutions should be replaced annually and labelled with a new expiration date.
g. All HF spills should be reported to EHS. If the spill is large or concentrated, contain the spill using HF specific absorbents if it can be done safely, grab SDS and emergency procedures, evacuate the area, and call 911. Avoid vapor exposure. Top priority is to preserve human life.
h. Avoid treating HF spills with the following: sodium or potassium carbonate, sodium of potassium hydroxide, silicon-based absorbents.

Emergency Response

The following actions should be taken when HF exposure is suspected. Dilute exposures of HF may not exhibit symptoms for several hours and in these cases treatment should still occur as swiftly as possible.

Be mindful of secondary contamination during first aid. When possible, the victims should perform first aid action on themselves. Regardless of who is providing aid, appropriate gloves should be donned. *Latex does not provide an effective barrier against HF.*

In all instances, take note of the concentration of the acid, time of exposure, means of exposure, methods of treatment, and the area and location of exposure. Provide this information to EHS and to medical personnel.

Skin Exposure.

First priority is to flush the area with water. Quickly move to and activate the emergency shower and remove all contaminated clothing and that which could trap HF. The acid should be rinsed as thoroughly and quickly as possible. If calcium gluconate gel (2.5%) is available, rinse for 5 minutes and begin to liberally and continually apply the gel. The area does not need to be dried. If not, continue to rinse for 15 minutes or until medical treatment is available.

While the victim is rinsing, someone should call 911 and inform them that someone has been exposed to HF, the location of the individual, and request an ambulance.

Once emergency personnel have been contacted and rinsing/gel application has begun, re-examine the victim for potentially overlooked sites of exposure.

Eye Exposure.

Immediately flush eyes with flowing water at an eyewash station. Hold eye lids open and away from the surface of the eyes. If sterile, 1% calcium gluconate solution is available, begin to drip continuously into the eyes within the first 5 minutes. Do not use more concentrated calcium gluconate in the eyes. If solution is not available, flush eyes for 15 minutes.

While the victim is rinsing, someone should call 911 and inform them that someone has been exposed to HF, the location of the individual, and request an ambulance. If possible, see an eye specialist. Irrigate eye during transportation.

Inhalation.

Immediately remove victim to fresh air and call 911. Keep victim warm, comfortable, and quiet. If breathing has stopped, check airway for obstruction and administer CPR. 100% oxygen should be administered as soon as possible by a trained individual and continue until medical personnel arrive. 2.5% calcium gluconate solution may be nebulized and administered to the victim. IF vapor exposure has caused burns, these should be treated the same as liquid HF exposures.

Ingestion.

Do not induce vomiting. Have the victim drink large amounts of room temperature water or milk as soon as possible. If available, Tums, Milk of Magnesia and other antacid products may be effective at neutralizing the effect of the acid. Do not administer bicarbonates as the carbon dioxide byproduct may cause additional injury.

The victim should be admitted to the hospital for treatment.

Preparation of Calcium Gluconate Gel

a) Heat a measured amount of K-Y Jelly (Johnson & Johnson) to 50-60 degrees C, typically 395 grams.
b) Add 2.5% by weight (9.9g) of reagent grade calcium gluconate slowly with good stirring until all dissolved.
c) An alternate method of adding the calcium gluconate is to add 2 grams and stir in until mostly dissolved, then add the remaining calcium gluconate (added to 35 cc of H_20) with good stirring until dissolved into the jelly.
d) Finished gel will be water-clear with many air bubbles which can be removed by allowing the bubbles to rise to the surface after standing.

Mercury

Elemental mercury is a shiny, silver-white odorless liquid that is commonly used in laboratory instruments, thermometers, batteries, and more. Mercury can be both an acute and chronic toxin and primarily affects the brain and central nervous system.

Hazards

Elemental mercury primarily poses an inhalation hazard. Absorption into the body is rapid after inhalation. Absorption rates from skin exposure and ingestion are much lower, but may still occur, especially if cuts are present. Ionic or organic forms of mercury are absorbed much more quickly through the skin.

Acute exposure to concentrated mercury vapor can affect the brain and central nervous system. In addition, this type of exposure can cause symptoms such as irritation to the lining of the mouth, airways, and lungs; increased blood pressure and heart rate; nausea, vomiting, diarrhea; skin rashes; eye irritation; and acrodynia.

Mercury is excreted from the body with a half-life of approximately one month, therefore cumulative exposure is important. Chronic exposure can lead to accumulation of mercury in the brain and kidney. This can present symptoms such as personality change, tremors, vision changes, deafness, lack of muscle coordination, loss of sensation, and memory loss.

Mercury exposure is of increased concern to pregnant women as mercury can pass the placental barrier and concentrate in the unborn child. This situation is particularly deleterious as the brain and central nervous system is still developing.

Storage and Use

a. Containers of mercury must be closed when not in use.
b. All work involving mercury should be performed over trays or pans with turned up edges to confine any spillage. Glass and plastic trays should have secondary containment incase the tray breaks.
c. Mercury spills must be cleaned up immediately. The preferred method is to suction up the elemental mercury. A special vacuum cleaner for mercury spills is available from EHS. Please call for cleanup of mercury spills. Ordinary vacuum cleaners must not be used because droplets will then be dispersed more finely throughout the laboratory and then the vacuum is contaminated with mercury.
d. Mercury monitoring can be accomplished by EHS.

e. Adequate ventilation must be provided when working with mercury. Vapors should not be re-circulated or exhausted to other laboratories or building areas.
f. Do not use mercury thermometers in ovens. The elevated temperatures will create very high mercury vapor concentrations should the thermometer break.

First aid

A single skin exposure or even ingestion of elemental mercury will likely not result in observable symptoms. Repeated or prolonged exposure by these modes is a much greater concern. If symptoms of exposure do occur, even months later, seek immediate medical attention and inform them of the mercury exposure.

Skin exposure.

Wash skin with soap and cool water for 15 minutes. If hands were exposed, be sure to scrub under fingernails.

Eye contact.

Holding the eyelids away from the eye, rinse eyes under the eyewash station for 15 minutes.

Inhalation.

If it is suspected that concentrated mercury vapor was inhaled, immediately remove to fresh air and seek medical attention.

Nanoparticles

In a laboratory context, nanoparticles are engineered materials with a characteristic length of 1-100nm. Nanoparticles are commonly present in solution or suspension, or attached to a polymer. On occasion, they may also be handled as a dry powder. Nanoparticles exhibit very different properties from larger particles of the same composition.

Hazards

The hazards associated with nanoparticles are not well characterized. Apart from a few species, the toxicity of nanoparticles are generally unknown. Until sufficient scientific evidence is present, all nanoparticles should be treated as hazardous to health and the environment. Reasonable measures should be taken to prevent human exposure and release to the environment.

a. Some nanoparticles have shown greater toxicity than larger particles of the same composition (titanium dioxide, aluminum trioxide).
b. Nanoparticles in insoluble form may be more toxic than soluble forms of the same material.
c. Particles of this size range penetrate deeply into the lungs upon inhalation and cause adverse health effects.
d. Dry powders can be highly reactive and pose a fire/explosion hazard.

Safety guidelines

The following precautions are recommended due to the largely unknown toxicity of nanoparticles.

a. Whenever possible, work with nanoparticles in solution or attached to substrates.

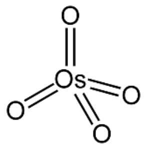
b. Work with nanoparticles in the form of a dry powder should be carried out in a fume hood, ducted BSC, or glove box. Recirculating hoods equipped with HEPA filtration (e.g., un-ducted BSC) may provide adequate ventilation, but ducted hoods are preferred.
c. Reaction vessels or furnaces containing nanoparticles should not be vented into the building. A dedicated local exhaust is preferred.
d. Dispose of nanoparticles and nanoparticle containing mixtures as a separate waste stream. Do not combine nanoparticles with other types of waste that do not contain nanoparticles. Fill out a Waste Pick-Up Request for disposal of nanoparticle containing waste streams.
e. Work areas where dry nanoparticles have been present should be wetted and wiped down with absorbent paper towels after each workday. Alternatively, disposable bench paper may be used.
f. If a spill of dry nanoparticles occurs, do not sweep or brush the dry material. If the material cannot be wetted and collected, a HEPA filtered vacuum should be used and vented through a fume hood.

PPE

a) Safety glasses and lab coats are required when working with nanoparticles.
b) Double Nitrile gloves are recommended.
c) If work with nanoparticles must occur outside of a fume hood, proper respiratory protection must be worn. Contact EHS for assistance.

Osmium Tetroxide (CAS 20816-12-0) Guidance & Procedures

OsO_4 or O_4Os
Syn: Osmic acid, perosmic oxide, osmium (VIII) oxide
Description: Colorless to pale yellow crystalline solid or mass with pungent (unpleasant), acrid, chlorine-like odor.
MW: 254.2 g/mol
Liquid above 105° F



Health and Safety Information

High acute toxicity; severe irritant of the eyes and respiratory tract; vapor can cause serious eye damage. Routes of exposure include skin & eye contact, inhalation or ingestion (if swallowed). May cause organ damage (CNS, eyes, skin, kidney). Suspect reproductive hazard. The level of health risk depends upon the dose, duration, and work being conducted.

Permissible limits

OSHA permissible exposure limit **(PEL): 0.002 mg/m3** TWA
NIOSH recommended exposure level **(REL): 0.002 mg/m3** (0.0002 ppm) TWA and
0.006 mg/m3 (0.0006 ppm) short term exposure level (STEL)
IDLH: 1 mg Os/m^3 (Based on acute inhalation toxicity data in humans. 1 mg/m^3 is suggested tolerable for 30 minutes for escape purposes)

Symptoms of Exposure

Irritation eyes, respiratory system; lacrimation (discharge of tears), visual disturbance; conjunctivitis; headache; cough, dyspnea (breathing difficulty); dermatitis

Toxicity Data

Table 2- Lethal Concentration Data

Species	Reference	LC$_{50}$	LC$_{Lo}$	Time	Adjusted 0.5-hr LC (CF)	Derived value
Rabbit	Brunot 1933	-----	1,316 mg/m^3	30 min	987 mg Os/m^3 (1.0)	99 mg Os/m^3
Rat	Shell 1961	-----	423 mg/m^3	4 hr	317 mg Os/m^3 (2.0)	32 mg Os/m^3
Mouse	Shell 1961	-----	423 mg/m^3	4 hr	317 mg Os/m^3 (2.0)	32 mg Os/m^3

Source: CDC https://www.cdc.gov/niosh/idlh/20816120.html

Physical Hazards

Corrosive (review SDS)
LEL: Noncombustible as solid
Solid is volatile. *Note: Begins to sublime below melting point & BP (boiling point: 265.5°F (129.7°C)*
Readily vaporizes from aqueous solution even at room temperature
Emits toxic fumes when heated to decomposition.

Consult the appropriate SDS for the formulation ordered and/or working solution(s) used for specific health and safety information and physical properties.

Engineering Controls

Work with osmium tetroxide must be performed inside of a certified chemical hood (fumehood). Contact KSU Environmental Health and Safety (EHS) to perform review of hood function prior to start of initial work. If work outside the hood is unavoidable, the work procedures must be reviewed and approved by in advance and will require use of respiratory protection.

- Work in lab with 100% exhaust (single pass)
- Perform work in chemical "fume" hood (pass/inspected within last 13 months). Work within hoods equipped with functioning flow indicator gauge (regardless ensure hood remains operational by checking for inward flow before daily use). The hood must be equipped with a functioning audible flow alarm. Do not disengage or alter the flow alarm. If it is not functioning or if it must be temporarily altered to routinely set up equipment, contact EHS to coordinate alterations.
    - Use in hood when preparing and handling solutions
    - Lower sash to operating height
    - Keep work surface in hood clear of unnecessary materials and equipment.
    - Ensure inlets of hood are not obstructed by glassware, equipment, etc.
    - Work six inches inside the hood. Do not block air foil.
    - Post warning sign on the fume hood indicating restricted use and list use of osmium tetroxide
    - Protect all work surfaces with plastic backed absorbent pads to containment spills. Ensure pads or debris don't block hood baffles (airflow in back of hood). Dispose of contaminated or potentially contaminated pads in bags and label and manage as hazardous waste.

DANGER

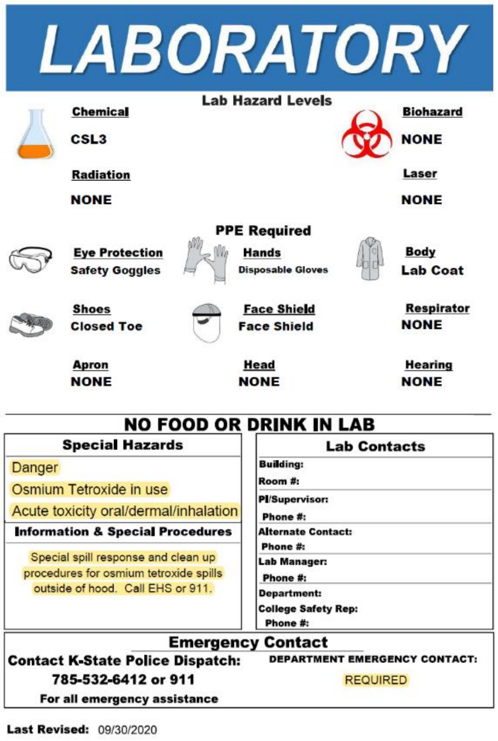
Osmium Tetroxide
in use
Oxidizing Agent
Severe Irritant
Causes Eye & Skin Damage
Toxic to Liver and Kidney
Authorized Personnel Only

Figure 5 - Sample Fume Hood Signage

    - All lab ware that has contacted osmium tetroxide must be decontaminated by rinsing or dipping in corn oil or aqueous solutions of sodium sulfide or sodium sulfite before removing from the hood.
    - Clean spills immediately. See spill response section for additional information.
    - Keep containers closed when not in use.
    - Conduct hood clean up at the end of research/project activity using the approved clean-up methods. Decontaminate/clean hood thoroughly prior to submitting work orders for hood repair.
- Ensure that the safety shower and eyewash are operational and access is unblocked.

Administrative Controls

- Provide a hard copy of the current SDS in readily accessible and visible area of the work space
- PI is responsible to train all personnel working with material, including:
    - safety controls
    - provide copy of this SOP and lab-specific SOP for osmium tetroxide
    - review the SDS and provide a current copy
    - review health hazards and symptoms of exposure
    - review emergency response procedures
    - ensure lab staff have completed Hazard Communication and Hazardous Waste Awareness training.
    - *Recommended additional trainings: Lab Safety online training and Fume Hood training* [Note: Laboratory Safety Training is required for all new lab personnel]
- List osmium tetroxide under special hazards on the KSU Lab Sign and resubmit (email) lab sign to EHS with ***current*** lab and emergency contacts. See figure 2 for an example. Use the term "Danger" in the special hazards section of the sign. Depending on volumes and concentrations in routine use, the lab sign *header* "Warning" or "Danger" may be indicated (in place of Laboratory).
- No food or drinks in lab.
- Purchase as a liquid to avoid particulate exposure of powdered form.
- Must have eye wash (inspected/run weekly) within the lab where work performed and access to vicinity emergency shower. Keep access to emergency eye wash and shower unobstructed.
- All work areas where materials is handled or stored must have plastic backed absorbent pads and/or secondary containment. Replace pads after any spill, potential spill, soiling or damage (ideally daily). Pads are recommended for lining secondary containers.
- When moving pure osmium tetroxide (e.g., to a chemical hood or other lab), do not remove it from the secondary containment during transport.
- Dispense and/or prepare the smallest amount necessary for the procedure. If a balance must be used, weighing should take place inside the labeled hood.



LABORATORY

Lab Hazard Levels

Chemical
CSL3

Biohazard
NONE

Radiation
NONE

Laser
NONE

PPE Required

Eye Protection
Safety Goggles

Hands
Disposable Gloves

Body
Lab Coat

Shoes
Closed Toe

Face Shield
Face Shield

Respirator
NONE

Apron
NONE

Head
NONE

Hearing
NONE

NO FOOD OR DRINK IN LAB

Special Hazards

Danger
Osmium Tetroxide in use
Acute toxicity oral/dermal/inhalation

Information & Special Procedures

Special spill response and clean up procedures for osmium tetroxide spills outside of hood. Call EHS or 911.

Lab Contacts

Building:
Room #:
PI/Supervisor:
Phone #:
Alternate Contact:
Phone #:
Lab Manager:
Phone #:
Department:
College Safety Rep:
Phone #:

Emergency Contact

Contact K-State Police Dispatch:
785-532-6412 or 911
For all emergency assistance

DEPARTMENT EMERGENCY CONTACT:
REQUIRED

Last Revised: 09/30/2020

Figure 6 - Sample Lab Sign w/ Hazard Info

- Report any signs or symptoms of exposure to EHS. Exposure monitoring (sampling) and medical surveillance may be required if employees present with symptoms of exposure or if vapors or dust approach reported action levels (where applicable).
- Dispose of any materials that show signs of oxidation (turn black). Place in double plastic bags and request disposal.
- Avoid contact with incompatible materials.
    - Poisonous chlorine gas formation possible with contact to hydrochloric acid.
    - Easily oxidizes organic materials
- Store in dry place in closed containers. Place these in secondary containment (sized to contain leakage). See Storage information.
- Wash hands upon removing gloves and before exiting the lab.

Personal Protective Equipment

Wear personal protective equipment (PPE) aimed at preventing *any* skin and eye contact regardless of state or concentration used. Cover any exposed skin where contact is possible.

- Lab coat (chemically resistant recommended), buttoned and sleeves rolled down, chemically-resistant wrist guards or gauntlet gloves, full length pants/skirt.
- Safety goggles (not glasses) – snug to face, face shield (with goggles) if mixing large volumes or working with pure or concentrated solutions.
- Double gloves, use gloves resistant for osmium tetroxide or per glove manufacturer recommendation for glove make/model). Use Nitrile or other approved glove material. Do not use latex. Change gloves frequently and whenever damage. Do not re-use disposable gloves.
- Closed toed shoes (e.g., leather).

a)

If work must be performed outside of a chemical hood, work procedures must be approved by EHS in advance. A NIOSH approved full-face respirator must be used. Use of a respirator requires medical clearance, training, fit-testing and enrollment in KSU Respiratory Protection Program.

- Respirator cartridge: multi-purpose chemical cartridge with P100 particulate (ex: MSA GME/P100). Must consult with KSU EHS.
- Contact EHS for selection and assessment of respiratory protection prior to purchases.

*Storage**

- Pure osmium tetroxide and concentrated solutions should be stored in a location that is secure to unauthorized access. Examples are a locked drawer or cabinet, or a refrigerator within a laboratory that is locked when authorized personnel are not present. A refrigerator containing osmium tetroxide must be labeled with a caution sign noting the presence of osmium tetroxide and its hazards.
- Store pure osmium tetroxide and its concentrated solutions in appropriate, sealed glass containers within unbreakable secondary containment (i.e., a bottle or vial within a sealed compatible plastic jar or metal can with lid). Label all containers, including secondary containment, with the chemical name and hazard warning.

*Neutralizing Osmium Tetroxide**

The following neutralization procedure should be employed when possible to reduce hazards associated with discarding osmium tetroxide:

1. Perform neutralization in a chemical hood (fume hood).
2. A 2% solution of osmium tetroxide can be fully neutralized by twice its volume of corn oil. Corn oil is preferred because of its high percentage of unsaturated bonds, but vegetable oil may be used. For every 10 mL of 2% osmium tetroxide solution, 20 mL of corn oil is required. Pour the corn oil into the osmium tetroxide solution.
3. Wait for the oil to completely turn black.
4. To test if osmium tetroxide is fully neutralized, hold a piece of filter paper soaked in corn oil over the solution. Blackening indicates that osmium tetroxide is still present and more corn oil should be added.
5. Aqueous solutions contaminated with osmium tetroxide can be fully neutralized by adding sodium sulfide or sodium sulfite to reduce osmium tetroxide to less hazardous forms.
6. Dispose of neutralized solutions as hazardous waste through KSU EHS. Follow instructions in the Disposal section below.

Disposal

Osmium-containing waste should be placed in a tightly sealed, appropriately labeled hazardous waste container.

- Do not sink dispose original product or dilutions.
- Completely fill out hazardous waste label and place on waste container or bag.
    - Liquids: Collect in leak proof, compatible container.
        - Do not use metal containers.
        - Do not place in red solvent cans.
    - Solids: Collect all excess product or contaminated media as waste, including pipette tips, gloves, ampoules and original containers.
        - Place sharps and glassware in in a rigid, hard-sided leak proof container (*do not* use sharps containers that are labeled biohazard).
        - Double bag contaminated pads, absorbents, gloves, clothing, and similar waste.
        - Empty original osmium tetroxide containers must be disposed as hazardous waste.
- Submit a Waste Pickup Request for disposal through EHS.

Emergency Response

Spill Response

Avoid breathing dust or vapors. Due to the unique nature of the spill response media, it is the responsibility of the PI to keep **appropriate spill response absorbents** in the lab.

For small spill clean-up and decontamination use corn oil, sodium sulfide, or sodium sulfite to deactivate osmium tetroxide on lab ware and on surfaces within the fume hood. Spill response materials should be kept within the laboratory (or locations designated outside of the lab and listed on special instructions on the Lab Sign) for minor spill response by lab personnel.

- Alert personnel in the immediate area.
- Isolate the area to prevent the spread of contamination.
- Don appropriate PPE (at a minimum use double gloves, buttoned lab coat, safety goggles).

- Cover the spill with **corn oil-soaked kitty litter** (or previously approved neutralizing absorbents)
- Scoop the material up and place it in a sealed plastic bag.
- Wash the area with aqueous solution of **sodium sulfite.**
- Clean the area with detergent solution.
- Remove contaminated PPE carefully and place it in waste bag/container.
- Label the waste bag/container with a completed hazardous chemical waste label and write osmium tetroxide clearly on the label. Contact EHS for waste pickup.

Only attempt clean-up of small spills (ex: 2mL), contaminated lab glassware and instruments, or manageable spills inside the chemical hood. Do not attempt clean up if not trained to do so or if it cannot be done safely. Do not perform spill response if inhalation hazard is likely.

Large Spill Response

Evacuate the room and affected areas. Do not re-enter. Prevent entry by others. Call for response.

Contact EHS for assistance and response to large spills or significant spills outside of the chemical hood. ***Do not leave a voicemail with EHS***. If you do not reach someone immediately, call KSU PD or call 911.

Contact numbers:

- Normal business hours EHS: 785-532-5856 for non-emergency incidents and guidance.
- After hours or if you are unable to reach EHS, call KSU PD 785-532-6412 and ask for EHS response.
- ***For emergencies dial 911***

Information for external and EHS responders:

Information is for pure compound

- Ionization potential: 12.60 eV
- Odor threshold: 0.0019 ppm v/v – acrid, chlorine like odor
- Readily vaporizes from aqueous solution even at room temperature
- Denser than air (8.8 relative vapor density) and water (4.9 relative water density)
- Acute dermal, oral and inhalation toxicity
- Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Some are oxidizers and may ignite combustibles (wood, paper, oil, clothing, etc.). Contact with metals may evolve flammable hydrogen gas. Containers may explode when heated.

Outdoors: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters (150 feet) for liquids and at least 25 meters (75 feet) for solids. Keep unauthorized personnel away. Stay upwind. Keep out of low areas.
Indoors: Ventilate enclosed areas. ***Do not shut off HVAC if spilled in laboratory (with 100% exhaust)***.

Excess osmium tetroxide solutions can be rendered safer by reaction with sodium sulfite to produce insoluble osmium dioxide. Ethanol will also react to produce the dioxide. Corn oil or sodium sulfide may also be used to deactivate osmium tetroxide.

In the event of a spill, mix osmium tetroxide with an absorbent material such as vermiculite, kitty litter, or dry sand (avoid raising dust). Absorbent can be mixed with corn oil.

Evacuation and emergency responder cleanup using respiratory protection may be necessary in the event of a large spill or release in a confined area and when inhalation of osmium tetroxide vapors or particles is likely. Entry to area with unknown concentrations and/or initial emergency response to assess conditions requires use of supplied air such as SCBA.

Osmium-containing waste should be placed in a tightly sealed, appropriately labeled hazardous waste container as described in the Disposal section of these procedures and disposed through KSU EHS.

Aquatic toxin. UN hazard class 6.1 PG 1, DOT label poison
UN 2471; Osmium tetroxide

Personnel Exposure

- **Skin contact**: immediately flush affected area with water and wash with soap and water. Remove contaminated clothing (do not put contaminated clothing back on). Submit a Waste Pickup request for the clothing if the contaminate cannot be safely and completely removed.
- **Eye contact**: promptly flush (rinse) with copious amounts of water for 15 minutes (lifting upper and lower lids occasionally) and obtain medical attention. Flush for 5 minutes before removing contacts (if worn), then continue rinsing. Do not use anything other than water on the eye.
- **Ingestion:** If osmium tetroxide is ingested, rinse mouth. Contact poison control for detailed instruction until medical aid administered. Provide poison control detailed information about solution (concentration, state/solution/solid, solute). Obtain medical attention immediately.
- **Inhalation:** If large amounts are inhaled, or if the person exhibits signs of exposure (without contact to skin/ingestion), move the person to fresh air and seek medical attention at once. If breathing has stopped, call 911 and perform artificial respiration (rescue breathing) using one-way valve (if available) and if trained to do so.

(sources: CDC/NIOSH, NIH/PubChem, UCLA*, Stanford)

Perchloric Acid

Perchloric acid is a strong mineral acid. Under some circumstances it may act as an oxidizer and/or present an explosion hazard. Perchloric acid fumes can also deposit into ducts over time and form explosive metallic perchlorates. In addition to explosion hazards, perchloric acid has similar corrosive properties to other strong acids and causes severe burns on contact with skin, eyes, and mucus membranes. For this reason work with perchloric acid must be carried out according to these guidelines.

General precautions

These precautions apply when using unconcentrated perchloric acid (<72%) at room temperature. When used under these conditions, perchloric acid reacts as a strong non-oxidizing acid. The following precautions should be taken when using perchloric acid under these conditions:

a. Substitute with less hazardous chemicals when appropriate. Use dilute solutions (< 60%) whenever possible.
b. Conduct operations in a properly functioning chemical fume hood with current EH&S certification. If operations are conducted frequently or in large quantities contact EH&S to determine if a specially designed fume hood dedicated to perchloric acid use is required.
c. Always use impact-resistant chemical goggles, a face shield, neoprene gloves, and a rubber apron when handling perchloric acid.
d. When using or storing even dilute perchloric acid solutions avoid contact with strong dehydrating agents (concentrated sulfuric acid, anhydrous phosphorous pentoxide, etc.). These chemicals may concentrate the perchloric acid and make it unstable.
e. Avoid contact with cellulose materials such as wood, paper and cotton. Perchloric acid may become concentrated and cause a fire or explosion.

Using perchloric acid (<72%) at elevated temperatures

When heated to temperatures above 150° C perchloric acid becomes a strong oxidizer and eventually becomes unstable. Concentrated solutions are very dangerous and can react violently with many oxidizable substances, such as paper and wood, and can detonate. Vapors may also contaminate work surfaces or ventilation equipment with perchlorate residues, which may form highly unstable compounds. These compounds may ignite or detonate under certain conditions. The following additional precautions should be followed when heating perchloric acid:

a. Perchloric acid digestions and other procedures performed at elevated temperatures must be done in a specially designed perchloric acid fume hoods. If you have been performing perchloric acid digestions in a fume hood not designed for perchloric acid, Contact EHS immediately for an evaluation of perchlorate contamination of the hood.
b. Never heat perchloric acid in an oil bath or with an open flame. Electric hot plates, electrically or steam-heated sand baths, heating mantles, or steam baths are preferred. Use explosion proof electrical equipment.
c. Avoid allowing hot perchloric acid to come into contact with any organic materials. Avoid using greases or hoses that are incompatible with perchloric acid.
d. Be sure you understand the reaction(s) that can occur when using perchloric acid. Perchloric acid may react violently with many chemicals, including acetic anhydride, alcohol, reducing agents, and many metals.
e. In wet digestions with perchloric acid, treat the sample first with nitric acid to destroy easily oxidizable matter.
f. Do not distill perchloric acid in a vacuum, because the unstable anhydride may be formed and cause a spontaneous explosion.
g. Prior to use with perchloric acid, vacuum pumps should be thoroughly flushed and refilled with Kel-F or Fluorolube.
h. Wash down perchloric acid hoods after each use, following operating instructions provided by the manufacturer of the perchloric acid hood.

i. Strongly consider using quartz apparatus which can handle temperature shock to handle perchloric acid, since it is necessary in many experiments to chill perchloric acid rapidly from the boiling point.
j. Glass-to-glass unions, lubricated with 72% perchloric acid, seal well and prevent joint freezing arising from the use of silicon lubricants. Rubber stoppers, tubes, or stopcocks are incompatible with perchloric acid.
k. When handling beakers of hot acid use properly designed tongs or other remote-handling devices.

Using anhydrous perchloric acid

Anhydrous perchloric acid (> 85% concentration) is very unstable and will usually explode when it comes in contact with organic materials. Use of anhydrous perchloric acid is prohibited.

Perchloric acid spills

CLEAN UP SPILLS OF PERCHLORIC ACID ONLY IF YOU HAVE BEEN TRAINED TO DO SO AND THE APPROPRIATE EQUIPMENT IS AVAILABLE

If you need assistance, call EHS. To clean a spill, neutralize it with soda ash (sodium carbonate) or other appropriate neutralizing agent. Soak up the neutralized spill with an inorganic based absorbent, if possible. If rags, paper towels are used, wet them and place them in a plastic bag and seal it. Do NOT use rags, paper towels, or sawdust and then put them aside to dry out, as such materials may spontaneously ignite. A second neutralization and rinsing of the wetted area is recommended. Label waste as flammable hazardous waste and submit an On-line Request for Hazardous Waste Pickup.

Storage

Perchloric acid should be stored in its original container within compatible secondary containment, preferably glass or porcelain. Secondary containment should be wiped periodically. It should be separate from organic chemicals, flammable or combustible materials, and strong dehydrating agents, but may be stored with other inorganic acids in an acid cabinet. It may also be stored in a perchloric acid fume hood. If a bottle containing perchloric acid exhibits signs of concentration, such as crystal formation or has turned dark there is a potential explosion hazard. Do NOT move the bottle, but Contact EHS for immediate assistance.

Inappropriate and Appropriate Materials

The following materials are **not recommended** for use with 72% perchloric acid: Nylon/polyamides, Dynel/modacrylic ester, Dacron/polyester, Bakelite, Lucite, vegetable-based Micarta, cellulose-based lacquers, copper/brass/bronze (which form shock sensitive salts), aluminum (dissolves), high nickel alloys (dissolve), cotton, wool, wood, and litharge (glycerin and lead oxide).

The following are suitable for use with 72% perchloric acid: Viton, tantalum, chemically pure titanium, zirconium, niobium, Hastelloy C (slight corrosion rate), PVC, Teflon, polyethylene, polypropylene, Kel-F, vinylidene fluoride, Saran, epoxy resins, glass, glass-lined steel, alumina, and Fluorolube.

Peroxide Forming Chemicals (PFC) Management

Peroxide forming chemicals (PFC) are chemicals which may react with oxygen to form peroxides. This reaction is often facilitated by light. Under normal laboratory conditions this reaction may result in an increasing concentration of peroxides in a chemical container and lead to the formation of potentially explosive peroxide crystals. These crystals may explode when subjected to mechanical shock from merely opening the container.

Peroxide forming compounds fall under one of four classes:

Class A	Spontaneously decompose and become explosive with exposure to air without concentration. • Test for peroxide formation before using or **discard 3 months after opening or at the expiration date on the container if unopened.** • If a container of a Class A peroxide is past its expiration date, or if the presence of peroxides is suspected or proven, do not attempt to open the container.
Class B	Require external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated. • Test these for peroxide formation before distillation or evaporation. • Maintain a testing program/schedule to test for peroxide formation or **discard 1 year after opening or at the expiration date on the container if unopened.**
Class C	Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock- and heat-sensitive. • **Materials should be disposed of 1 year after opening or at the expiration date on the container if unopened.**
Class D	Materials that do not fit within Group A or B or C but require special handling.

Please see **Appendix C: Peroxide Forming Chemicals Management** for a list of peroxide formers in each class.

Storage

PFCs should be stored in sealed, airtight, light resistant containers and left in the original manufacturer containers whenever possible. PFCs that have been purified of inhibitors must have inhibitors reintroduced upon storage. The addition of inhibitors should be documented. Oxygen exclusion practices should be used whenever possible (i.e. purge with inert gas).

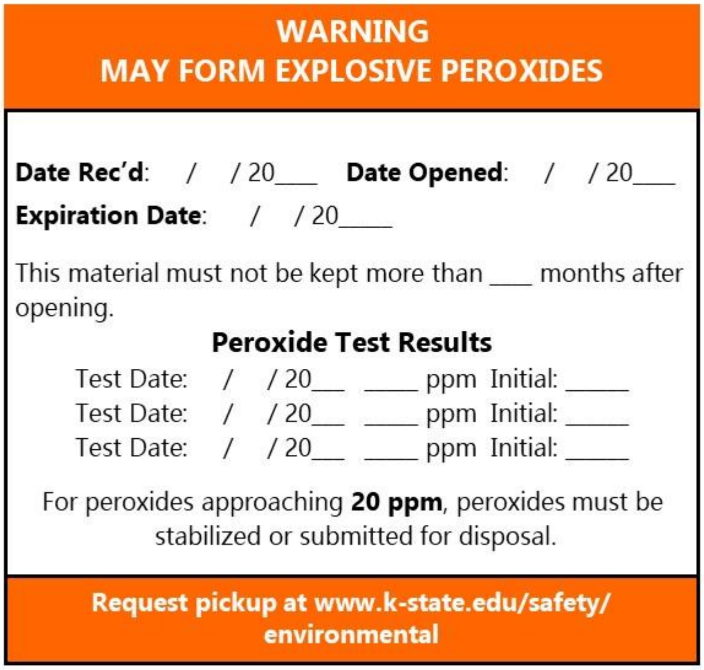
All laboratories working with PFCs must maintain an inventory in EHS Assistant to ensure these chemicals are removed from inventory before their expiration date, examined for signs of potential peroxides, and/or tested for peroxides. Laboratories should only order quantities necessary to complete an experiment and that will be used up within their shelf life. When possible, PFCs with added peroxide formation inhibitor, should be purchased.

Labelling

Label all peroxide forming chemicals with the EHS provided label. Document on the label:

- Date Received
- Date Opened
- Expiration Date, if available.
- Document the number of months the PFC must be disposed of after opening.
- If the PFC is tested for peroxides, record your initials, the date and concentration of peroxides in parts per million (ppm). When testing, if results continue to climb and start nearing 20 ppm, a Waste Pickup Request must be submitted before it reaches 20 ppm. If they are over 20 ppm it may require a costly hazardous waste disposal process.

Place this label on all PFC materials. It is available from EHS or may be printed by clicking the image below:



WARNING
MAY FORM EXPLOSIVE PEROXIDES

Date Rec'd: / / 20___ **Date Opened**: / / 20___
Expiration Date: / / 20____

This material must not be kept more than ___ months after opening.

Peroxide Test Results

Test Date: / / 20__ ____ ppm Initial: _____
Test Date: / / 20__ ____ ppm Initial: _____
Test Date: / / 20__ ____ ppm Initial: _____

For peroxides approaching **20 ppm**, peroxides must be stabilized or submitted for disposal.

Request pickup at www.k-state.edu/safety/ environmental

Peroxide Testing

Peroxide forming chemicals must be visually inspected for **increased viscosity, crystal formation, or stratification, and age before use** as these signs indicate an elevated explosion risk. It is imperative that containers exhibiting these signs not be opened as the mechanical forces could detonate the crystals. **Do NOT open or test containers of unknown origin or age, or those that have evidence of peroxide formation**. Contact EHS immediately if you discover a PFC exhibiting these signs.

Class A and Class C peroxide forming chemicals should be tested before use. All PFCs should be tested prior to concentration, i.e. distillation, evaporation. **Do not concentrate solutions that may contain peroxides.** Peroxide testing strips are available from chemical manufacturers (example: Quantofix Peroxide Test Strips [Sigma-Aldrich Part # Z249254 and Z101680]). Follow the manufacturer's instructions for using the strips/kits to ensure adequate colorimetric detection.

For peroxides concentrations of < 20 ppm, peroxides may be stabilized, or the chemicals submitted for waste disposal. **Disposal companies will not transport containers with 20 ppm or more peroxide concentration.** Stabilizing peroxides >20 ppm is not recommended in all cases due to the risk from the peroxides themselves and the risk from stabilization techniques.

Disposal

Contact EHS(785-532-5856) when you discover a suspect PFC container (presence of crystals, cloudiness, visible precipitate, discoloration, liquid stratification, or oily viscous layer) or unknown age. Do not open the container. Mark the container storage area or shelf with the words "Danger: Peroxide Hazard". Instruct others not to handle the container.

It is imperative for your safety and the safety of EHS staff and waste contractors that you provide accurate information about these materials and that you responsibly manage your inventory. Submit a waste disposal request and indicate the potential hazard if applicable.

Due to the high cost of disposal and potential risks of improperly managed PFCs, departments or PIs may be charged for handling and disposal costs for PFC that are not properly dated and managed as described herein.

Pressure Vessels

Pressure vessels are designed to withstand pressure differentials caused by compressed gases, temperature gradients, chemical reaction, etc. Under certain circumstances, pressure vessels pose an explosive hazard capable of damaging laboratory property and harming personnel.

Pressure gradients

To minimize the risk associated with pressure gradients, observe the following guidelines:

a. When working with a pressurized system, use physical barriers to protect personnel from physical injury caused by sudden failure of the system.
b. Never heat or cool a closed system not capable of withstanding the generated pressure gradient.
c. Use a pressure relief valve if system is connected to an external pressure source over 15psi.
d. Periodically inspect setup for damage or stress.

Gas cylinders

a. Only those gas cylinders in immediate use shall be located in a laboratory. Replacement cylinders and empty cylinders shall be stored in a designated area, preferably outside the building. Do not store cylinders in hallways.
b. When not in use or while in transit, regulators shall be removed and valve protection caps put in place.
c. All compressed gas cylinders must be secured with a chain, clamp, or strap at all times when in use, storage, or transport. Three points of contact should be made with the cylinder at all times whether in transit, storage, or use.
d. Each tank must be properly and permanently identified when received. Never accept a cylinder on which the name of the contents is illegible. Do not rely on color codes for tank identification.
e. Use appropriate regulators and do not attempt to modify or change cylinder valves or regulators.
f. Always use recommended handling procedures for compressed gas cylinders even though they may seem empty.
g. Return empty cylinders to the manufacturer, if possible.
h. Use all of the contents of the cylinder.
i. Cylinders that cannot be returned and are empty or are no longer wanted are handled through the hazardous waste program (see section IX). Contact EHS

Pyrophoric materials

Pyrophoric chemicals are those which will ignite spontaneously in air at 130°F (54.4°C) or below. Often, pyrophores ignite in air due to a vigorous reaction with oxygen or water vapor. Examples include organolithium compounds, silanes, and alkali metals. Due to the difficulty of keeping these compounds isolated from the air, and the potential consequences of spontaneous ignition, special administrative controls, engineering controls, PPE, and laboratory methods are required when handling them.

The following safety guidelines must be adhered to when working with pyrophores.

Storage and Use

a. Store pyrophoric chemicals under inert gas, mineral oil, or another material which will insulate the pyrophore from exposure to air or water.
b. Store the pyrophore in a separate location from other chemicals.
c. Use the smallest amount possible to achieve the desired result.
d. Use pyrophores in a fume hood sash lowered and additional safety shielding whenever practical.
e. Work should be performed within arm's reach of suitable extinguishing media. For liquids this is likely an ABC fire extinguisher. For flammable metals this is a Class D fire extinguisher.
f. Wear a fire resistant lab coat. These coats are generally blue.
g. If working in a system where explosion is possible, such as a vacuum line, face shields are required.
h. Keep spill containment equipment close at hand while working.

For detailed information on handling and use of pyrophoric material, refer to these external resources:

Sigma-Aldrich – Handling Air-Sensitive Reagents

Sigma-Aldrich – Handling Pyrophoric Reagents

University of Nottingham – Guidelines for Handling Air-sensitive Compounds

University of California San Diego – Transferring Pyrophoric Liquids

First Aid

Severe skin irritation and burns will occur if pyrophoric liquids are not removed from the skin immediately after exposure. These reagents are also highly irritating to the respiratory tract and at low vapor concentrations. If exposure occurs, rinse the affected area in the sink, eyewash station, or safety shower as appropriate. Rinsing should occur for 15-20 minutes. Afterward, immediately seek medical attention.

Reproductive Hazards

Woman who are pregnant or individuals attempting to become pregnant should be alert to the specific reproductive hazards present in the laboratory setting and employ sound laboratory sanitation practices.

Information about reproductive hazards, safety controls and reporting guidance are provided in the **Reproductive Health Hazards Section**.

Sodium Azide

Sodium Azide (NaN_3) is an inorganic compound commonly used as the gas forming agent in airbag systems. It is both highly toxic and reactive.

Hazards

Sodium azide exposure can result in headache, respiratory distress, and diarrhea. It is highly soluble in water and is quickly absorbed through the skin. The azide ion has a similar toxicity to that of cyanide (LD_{50} = 27mg/kg in rats). In aqueous solution, sodium azide hydrolyses and forms hydroazoic acid which readily volatilizes, posing an inhalation hazard at high concentrations (>5%).

Sodium azide reacts violently with many common laboratory organic compounds and metals. See your SDS for more specific information. Many of these reaction products are highly explosive.

Storage and Use

a. Handle in a working, vented fume hood and wear a lab coat, eye protection, closed toe shoes, and appropriate gloves.
b. If weighing the dry powder on a scale outside the fume hood: tare the receiving vessel with a lid in place; move vessel to fume hood and add sodium azide; close receiving vessel and return to scale to measure.
c. Avoid all contact between sodium azide and metals if possible.
d. Never dissolve in chlorinated solvents (chloroform, dichloromethane) as these solvents will react to form explosive compounds.
e. Wipe bench and walls of fume hood with soap and water after working with azides.
f. Do not allow organic azide waste to come in contact with acids. It should receive its own waste container. Organic azides will react with acids to form the highly toxic hydroazoic acid.

Laboratory Equipment

Laboratory equipment is easy to overlook when determining the hazards present in a space. They may conceal lasers, radiation sources, hazardous chemicals, biohazards, etc. Laboratory equipment must be maintained according the manufacturer’s instructions and according to the recommended schedule by those trained to do so. This training may be delivered by an experienced laboratory worker to a new worker. The following are detailed guidelines for the use and maintenance of some common laboratory equipment.

Autoclave

An autoclave uses the generation of steam to create pressure inside a sealed chamber in order to sterilized equipment, materials, or waste.

Hazards

Autoclaves generate steam/high heat, high pressure and potentially vapors that can be hazardous to operators. Risks include burns (e.g., hot surfaces, residual steam, and hot fluids scalds), hand and arm injuries (when closing doors), injuries due to explosions, and inhalation of hazardous vapors (when inappropriate materials are autoclaved). To avoid injury, personnel that operate autoclaves must be trained on the proper operation of the unit and the appropriate protective measures. Large autoclave units should have an exhaust vent above the autoclave door/opening.

Follow manufacturer’s recommendations for safe and proper operation specific to the model.

Training

All operators and the responsible person must receive training prior to starting work with autoclaves. Training is the responsibility of the department/college. Training should be reviewed or refreshed anytime operation procedures or SOPs change and if there is concern or incident indicating that review is warranted.

Training must include:

a. Review of the operation manual provided by the manufacturer
b. The specific SOPs developed for the nature of the loads and unit type,
c. Restricted materials,
d. safety practices and PPE required,
e. spill or incident response procedures,
f. documentation/log requirements,
g. proper loading and unloading,
h. failure reporting,
i. Out of service signage posting, and
j. Injury reporting and response.

Safe Practices

a. Wear Personal Protective Equipment (PPE) including a lab coat, scrubs and/or apron; heat insulating gloves that cover all hand and forearm (when handling equipment during operation); eye protection (when unloading autoclave), closed-toe footwear.
b. Do not seal containers
c. Never open the door to an autoclave if there is water running out the bottom. Clogged steam lines, equipment malfunction, or plugged drains may cause a buildup of scalding water.
d. Do not open the door until the pressure is zero and the temperature is at or below 121°C at the end of a cycle. Don’t stand directly in front of the door when opening the chamber.
e. Do not touch autoclaved material with your bare hand until sufficient time has passed to allow it to cool.
f. Avoid superheating liquids by allowing contents to sufficiently cool below the boiling point of all liquids in the autoclave. Superheating is a condition that occurs when liquids are at a temperature above their normal boiling point but do not appear to be boiling. Any disturbance of the liquid could cause some of it to violently flash to steam and spray. In situations where personnel are in a hurry to remove flasks or bottles from the autoclave, the superheated liquids may boil out of their containers or explode.

Laboratory Oven

The oven is one of the most ubiquitous laboratory instruments. Laboratory ovens are commonly used for evaporation water or residual solvents from glassware or samples prior to analysis. Some laboratory ovens can reach very high temperatures and, to do so, require high voltages. Certain samples or improperly rinsed glassware may produce hazardous atmospheres upon drying. Therefore, laboratory ovens have the potential to present physical, electrical, and chemical hazards.

Safe operation

a) It is important to know the nature of the samples being placed in the oven. It is possible to reach the melting or auto-ignition temperatures of some substances in a laboratory oven. Materials can begin softening well before reaching their melting temperature. Do not allow materials to ignite or melt in the oven. It is expensive to replace damaged or contaminated insulation.
b) Rapid changes in temperature can induce stresses in brittle material which can lead to the fracture or even explosion of containers. Whenever possible, do not rapidly quench samples at high temperature.
c) Gases produced in laboratory ovens are free to enter the atmosphere of the room. For this reason, all laboratory ovens should be placed under a fume hood.
d) Do not use an oven to evaporate volatile chemicals.
e) Do not dry glassware that was rinsed with an organic solvent without being subsequently rinsed with distilled water.
f) Do not use mercury thermometers to measure temperatures in laboratory ovens. If a mercury thermometer breaks. Immediately turn off the oven and close the door and any vents. Remove to a fume hood if not already there. Refer to the **Mercury** section of the Lab Safety Manual for additional information or Contact EHS.
g) Do not remove samples or glassware until the material has been given time to cool to near room temperature.
h) When removing samples or glassware, wear padded gloves. Note, padded gloves only provide heat detection when dry, do not use them if they become wet.
i) Take care when opening the furnace. Do not stand directly in from of the door and open it slowly to avoid coming in contact with potential spills or broken glass.

PP chapter 7

http://chemsafety.chem.oregonstate.edu/content/sop-high-temperature-box-furnace

Centrifuge

It is important to be familiar with the safe operating procedures and potential risks associated with centrifuge use in order to minimize damage to equipment, loss of samples, and personal injury.

Requirements

Any laboratory containing a centrifuge is required to do the following:

a) All personnel working in the lab must undergo documented training in the proper use of the centrifuge. This may include the user's manual, centrifuge SOP, or this document.
b) Usage and maintenance records for the centrifuge must be kept on hand.
c) Ultracentrifuges or centrifuges larger than bench scale must have a service contract and be professionally inspected/serviced regularly.

General operation

The guidelines in this section are only supplementary to the manufacturer's instructions in the user manual. Meticulously follow both sets of instructions to maximize safety of operation and the longevity of your instrument.

Before centrifugation:

a) Keep user’s manual and/or SOP near the centrifuge and consult during use.
b) Ensure maintenance schedule is up to date.
c) Consider potential hazards associated with the present centrifuge run (mechanical, chemical, biological, radiological, etc.)
d) Make sure centrifuge components are clean and dry and inspect for cracks or deformities.
e) Only use a matching set of centrifuge tubes compatible with the instrument (preferably from the same manufacturer as the instrument). The tubes must have secure lids.
f) Do not fill tubes more than ¾ full and balance them in the centrifuge.
g) Ensure components are properly seated and balanced within the centrifuge.
h) Check user’s manual for necessary speed reductions due to dense solutions or age of centrifuge.
i) Double check run speed prior to each use.
j) Ensure lid is latched closed as applicable.
k) Make sure centrifuge is running normally prior to leaving the area. Stop if unusual noise or vibrations occur.

After centrifugation:

a) Do not open the centrifuge until rotor is completely stopped.
b) Clean tubes, rotor, and other centrifuge components after use. Disinfect if applicable.
c) Consult user’s manual for detailed instructions on cleaning instrument.
d) Record run time and rotor speed.

Potential hazards

The contents of the centrifuge tubes and centrifuge itself can both pose risks to lab space and personnel.

Repetitive, high speed cycles can cause centrifuge components to fatigue and distort over time. Inadequate cleaning, poor maintenance, and incorrect operation can accelerate this process and lead to the failure of the instrument. The most dangerous type of failure is rotor failure. Expired rotors are easy to overlook, but proper maintenance and records of lifetime use can prevent these catastrophic failures.

AIHA centrifuge explosion incidents
MIT centrifuge incident

Aerosol’s can be generated whenever energy is applied to a liquid and therefore can be generated by many processes during centrifuge operation. If the aerosols are composed of hazardous chemicals or contain infectious or radioactive material, they create an increased risk of exposure to laboratory personnel. The greatest hazard is created when a centrifuge tube containing these substances breaks during centrifugation. Follow these additional steps when operating a centrifuge with a hazardous material:

a) Fill and open tubes in a chemical fume hood or biological safety cabinet.
b) Do not over fill tubes (¾ full).
c) Wipe down sealed tubes (with disinfectant if applicable) and dry.
d) After centrifuging infectious material, wait 10 min before opening tubes to avoid aerosol release or in accordance with unit manufacturer operating procedures and precautions.
e) Open tube with the opening pointed away from you.

f) Work in a chemical fume hood or biological safety cabinet when re-suspending sedimented pellets. Do not shake, but use a swirling motion. If shaking is necessary, wait 10 minutes for aerosols to settle before opening.

Accident response

The high velocities created in centrifuges can quickly spread debris and hazardous material throughout an entire laboratory if the instrument is compromised. If spills occur, follow the guidance found in the **Spill Response** section as appropriate. In addition, if infectious waste is involved, **wait at least 30 minutes for droplets to settle** before opening the centrifuge to clean up the spill.

Cell Sorters and Cytometers

Flow cytometers are automated instruments that provide quantitative measures of the properties of single cells using laser based techniques. Operators of these instruments are therefore at risk for biohazard and laser exposure.

Sample identification and handling

Hazard identification is an important step in risk analysis and informs the selection of safety protocol. For this reason it is important for the operator to have specific knowledge of the nature of the samples being handled.

j) Procedures should be developed to identify the potential biological hazards of a specimen and for containment of aerosols, waste management, and equipment maintenance.
k) Biosafety information about a sample should be collected prior to the analysis of a given sample.
l) This information should include: origin of sample (human, cultured cell lines, rodent, etc.), pathological screening information, use of viral vectors, have the infectious agents been inactivated, presence of oncogenes, presence of genetic modification, etc.
m) An appropriate BSL and associated procedure can then be implemented.

Aerosol containment

Risk of exposure to biological material primarily arises from sample handling and the potential generation of aerosols during analysis or during sample preparation. Biological specimens can contain known or unknown pathogens and therefore should be handled with care. Aerosol containment measures should be taken if a specimen is identified as infectious or potentially infectious.

n) Cytometers analyzing or sorting infectious materials or unfixed biological specimens must be placed within a BSC or other suitable containment device.
o) Only fixed materials may be sorted or analyzed in a cytometer outside of a BSC.
p) If the sample contains any genetically engineered amphotropic virus, it must be treated as infectious and BSL-2 practices must be implemented.
q) Vortexing biological specimens in open tubes is prohibited.
r) Vortexing closed tubes should take place in a BSC.
s) Samples modified using viral vectors to introduce hazardous elements into the cells may not be sorted or analyzed outside of a BSC.
t) All handling of unfixed human tissue must be done in accordance with the directions under the **Bloodborne Pathogens** section of the Laboratory Safety Manual.

Laser safety

Lasers are a common component in cytometry instruments. These components are generally protected by safety devices. A Cytometer only poses a laser hazard when these safety have been disengaged or otherwise defeated. For additional information, see **Laser Safety**.

Maintenance

Proper maintenance and record keeping is vital to insuring instruments are working properly. Engineering controls offer a high level of protection, but only when working properly. Filters require routine change outs, flow rates can change based on laboratory conditions and may need to be adjusted.

a) Efficiency of aerosol containment should be tested periodically. Records of these tests should be kept.
b) Operating manuals should be used to guide instrument maintenance and scheduling.
c) Waste effluent shall be captured in a container with concentrated bleach such that the final bleach concentration is 10%
d) Fluid lines shall be routinely decontaminated with a <10% bleach solution
e) Dispose of waste according to hazardous waste disposal guidelines.

Distillation Apparatus

Distillation apparatus are used to heat and reflux solvents in order to obtain them in high purity. The combination of flammable solvents and heat sources creates a fire hazard. Fortunately, this hazard may be easily substituted by purchasing high purity solvents or by using column purification systems. Thermal distillation should only be performed as a last resort.

The following safety precautions apply to all distillations:

a. Setup distillation apparatus in a fume hood
b. Perform distillations of flammable solvents under inert gas
c. Upon completion of a vacuum distillation, backfill the apparatus with inert gas
d. Do not leave an active distillation unattended
e. The apparatus should have an automatic high-temp shutoff whenever possible

Solvent Stills

Solvent stills are used to produce dry, oxygen free, high purity solvents. Their use involves reflux of organic solvents under inert atmosphere in the presence of a reactive metal. Additional precautions should be taken when operating:

a. Use temporary shielding to protect workers from a serious accident
b. Don hazard appropriate PPE (face shield, flame resistant lab coat, leather apron, etc.)
c. Activate still under inert atmosphere
d. Do not add drying agent, solvent, or indicator while still is hot
e. Ensure cooling equipment is in good shape and operational
f. Quench and clean still after each procedure

Push Stills

Push stills, or column purification systems, use column chromatography to remove impurities from a solvent. These apparatus use an inert pressurized atmosphere to force solvent through packed columns filled with drying media. These systems do not require heating elements, reactive metals, water cooling systems, or containment within a fume hood. Therefore they save water and electricity, free up space in a fume hood, and do not present a fire hazard.

Refrigerators and Freezers

This common piece of lab equipment is generally used for storage of reactive chemicals or biological specimens. Refrigerators and freezers can create hazardous situations if the incorrect type of unit is employed or if there is a loss of power.

Hazards

The potential hazards posed by laboratory refrigerators and freezers involve concentration of vapors, the possible presence of incompatible chemicals, and spillage. Loss of electrical power can produce extremely hazardous situations due to the concentration of vapors. Flammable or toxic vapors may be released from containers as chemicals warm up and/or certain reactive materials may decompose energetically upon warming. These concentrated vapors may leak out of the unit after concentrating within. This may pose a fire/explosion hazard or a toxicity hazard depending on the nature of the chemicals stored within.

Flammable Liquid Storage Units

Standard "domestic" refrigerators contain lights, switches, and thermostats in the refrigerated area. These features are potential ignition sources for flammable vapors. Therefore, flammable chemicals or chemical mixtures that must be kept below room temperature must be stored in refrigerators or freezers specifically designed by the manufacturer for storage of flammable liquids. Flammable liquid-approved refrigerators are designed with spark-producing parts on the outside to avoid accidental ignition.

A flammable liquid rated unit is very likely the best for your lab chemical storage needs. If flammable chemicals are never to be stored in the unit, then a domestic unit may be used for biological samples.

All materials with a flashpoint below 100° F may only be stored in an approved flammable materials storage refrigerator or freezer.

Explosion-Proof Units

Refrigerators and freezers that do not have ignition sources inside *or outside* of the unit are called explosion-proof units. These units are designed for cold storage of flammable liquids in a room that has a potentially explosive atmosphere.

Here is the difference between the two types:

- Flammable storage refrigerators and freezers have no exposed ignition sources inside the cabinet, such as lights or switches, which could ignite vapors.
- Explosion-proof or spark-proof units have no interior or exterior ignition sources. An explosion-proof refrigerator or freezer may be required in rare circumstances in hazardous locations.

Refrigerator/Freezer Labeling

Refrigerators and freezers should be labeled clearly for their intended purpose (e.g., “No Food or Drink to be Stored in this Refrigerator”, “Refrigerator For Food Only”, "NO FOOD - CHEMICAL STORAGE ONLY", "Not For Flammable Storage", etc.). It is possible that a unit may require multiple labels. All ordinary domestic refrigerators and freezers should be labeled with the phrase “No materials with a flashpoint below 100° F may be stored in this refrigerator/freezer” or “Not for flammable storage.

Refrigeration/Freezer Contents

All materials in refrigerators or freezers should be labeled with the contents, owner, date of acquisition or preparation, and nature of any potential hazard. All containers should be sealed, preferably with a cap, and placed in secondary containers or catch pans. Since refrigerators are often used for storage of large quantities of small vials and test tubes, a reference to a list outside of the refrigerator could be used. Labels and ink used to identify materials in the refrigerators should be water-resistant.

Emergency Back Up Power

Waste Management

Effective waste management is necessary to operating a safe and efficient laboratory. The following requirements are in place to minimize the risk of unanticipated chemical reactions, accidental exposure to chemical hazards, biohazardous substances, or radioactive material, and sharps related accidents due to the presence of improperly handled waste streams.

Chemical Waste

The safe use and disposal of chemicals is required of everyone. Chemicals are used in every department on the Kansas State University campus. It is the legal responsibility of each faculty, staff, and student at the University to deal with chemicals properly.

The EPA and the Kansas Department of Health and Environment (KDHE) enforce various laws which are meant to protect the environment. The EPA and KDHE encourage chemical waste minimization in every industry. The Kansas State University administration agrees with the need to reduce the quantities of hazardous waste that are generated. With this in mind, the Hazardous Waste Minimization Policy was written and is enforced (see section IX.H. below).

Penalties

The department or college that allows the improper storage or disposal of chemicals or chemical products will be held liable for any fees or penalties imposed by the EPA or the (KDHE). Any costs for waste disposal that may have been prevented by proper management or recycling may be imposed on the offending department or college by EHS.

Individuals (faculty, staff or students) who have knowledge of improper disposal of chemicals or chemical products must make the University administration aware of the situation. This can be accomplished by advising EHS, any member of the Campus Environmental Health & Safety Committee, or the KSU Maintenance and Service Employee Safety Committee. The University guarantees that no reprisal will be held against the individual.

Identifying Hazardous Waste

Hazardous waste is defined under the Resource Conservation and Recovery Act (RCRA) and the Hazardous & Solid Waste Amendments (HSWA) as any liquid, solid or gas that has no commercial value (solid waste) and has a hazardous characteristic component. These characteristics are:

a. Ignitability (flash point less than 140°F);
b. Corrosivity (pH less than or equal to 2 or greater than or equal to 12.5);
c. Reactivity (reacts with air or water to produce an explosive, flammable or toxic product); or
d. Toxicity (contains specific pesticides, heavy metals or organic solvents).

In addition to the above characteristics, chemicals that are hazardous waste also identified in the F-list, K-list, P-list and U-list, which are in the EPA and KDHE regulations. Chemicals must be handled correctly when they are to be discarded. Kansas State University is regulated as a generator of hazardous waste (EPA Generator status) and must comply with the laws governed by KDHE and the EPA. Chemicals may not be discarded down the sink drain, poured onto the ground, discharged to the atmosphere, or buried at an unpermitted site.

Hazardous Waste Minimization

Laboratories are accountable for their hazardous waste from the time it is generated until it no longer exists. The one method to ensure proper disposal is to reduce or minimize the waste produced. The EPA requires waste minimization as a method of pollution prevention. The Kansas State University administration agrees with the EPA for the need to reduce the quantities of hazardous waste generated. Management and staff at all levels must be openly and actively committed to supporting sound waste management policies and practices.

The success of the Waste Minimization Plan depends ultimately on the participation and cooperation of all laboratory workers and students. The KSU community must do everything that is within its means to reduce hazardous waste on the campus. Each campus unit is urged to use any of the following techniques to reduce hazardous waste:

a. substitution (use a less hazardous chemical)
b. small quantity purchases
c. microscale experiments
d. redistribution (use of recycled chemicals)
e. waste segregation (keep waste streams separate, for example, separate organic from aqueous or halogenated from nonhalogenated).
f. Re-use waste as is or after purification. Certain purification processes such as distillation are permitted in the laboratories. The waste from these processes should be handled as hazardous waste. For assistance, Contact EHS.

Handling and Disposal of Waste

These guidelines will enable the user to directly process and discard most materials appropriately or minimize hazardous waste:

Responsibilities

a. The person responsible for the generation of the waste or the person in charge of the materials should handle the chemical waste.
b. Use and recycle materials in their intended fashion to limit disposal problems.

c. Each laboratory should be equipped with a fume hood and the means to carry out simple neutralization reactions.
d. All chemicals must be identified with the name (not symbols, formulae, or abbreviations). This includes hazardous waste.
e. All waste containers must be marked with the words “Hazardous Waste.”
f. All containers of hazardous waste must be kept closed.
g. Hazardous waste must be kept in the room where the waste is generated.
h. Full containers of hazardous waste must be dated when full and removed from the laboratory within three (3) days of the date.
i. Empty containers should be rinsed three times and then properly discarded to a trash dumpster. Deface the label on empty containers so there is no question about hazards. Do not rinse containers that held P-listed waste. These containers are considered hazardous waste and should be managed as such.

Empty Containers

Containers or container liners that held hazardous materials are not usually regulated as hazardous waste if they are empty. A container is considered empty if: All wastes have been removed that can be removed by pouring, pumping, and aspirating, and; no more than one inch of residue remains in the container, or; no more than 3.0% by weight of the contents remain inside the container (≤110 gallons), or; no more than 0.3% by weight of the contents remain inside the container (>110 gallons).

a. Do not rinse “empty” containers that held P-listed materials or wastes. If you do, the rinsate must be collected and handled as hazardous waste.
b. Non-rinsed P-listed material containers must be turned in for hazardous waste disposal. See **Appendix D: P-Listed Chemicals**.

Acids and bases

Laboratory acids or bases should not be haphazardly discarded. Most acid and base wastes can be neutralized to a pH of 5 to 9 and washed down the sink drain with copious amounts of water.

There are many alternatives today to the use of chromic acid cleaning baths. There are many suitable non-chromate containing substitutes available on the market that are safer than and just as effective as chromic acid.

Batteries

No batteries may be discarded in the trash. Batteries will be recycled if possible by EHS. An effort will be made to return dead or weak batteries to the manufacturer or a battery recycler. If no means are found to recycle batteries, they may be discarded as hazardous waste by EHS.

Bottled gas

Gas cylinders should only be procured from dealers or manufacturers that will accept the return of empty cylinders (see section VIII. J above). This is especially important in the use of lecture size or smaller bottles. Aerosol cans are considered to be gas cylinders. Empty aerosol cans may be discarded in the trash. For assistance, call EHS.

Oil

Used oil from vehicles, machines, pumps, compressors, etc., must be turned in to EHS. Used oil may not be dumped on the ground for weed or dust control. To dispose of used oil, call EHS.

Paints

Waste petroleum-based paints or paints containing lead, silver, chromium or other toxic heavy metals must be disposed of as hazardous waste. Use latex paints rather than petroleum solvent-based paints. Use alternatives to paints containing chromates. Do not buy and store large quantities of petroleum-based paints. Use up all paints; do not leave small quantities that will require hazardous waste disposal. Liquid latex paint may not be discarded in the trash. EHS will also pick up latex paint.

Solvents

The use of organic solvents in the laboratory is very common. Laboratory personnel should consider the purchase and operation of solvent stills or high performance liquid chromatography (HPLC) solvent recyclers to reclaim used solvent.

Pesticides

Do not buy or request more pesticides than is necessary for the research. Use less toxic or less flammable pesticides if possible. Limit the amounts kept in storage to prevent disposal of out-dated pesticides. Arrange for the return of research pesticides to the manufacturer. Old or unwanted pesticides will be picked up by EHS.

Photographic waste

Silver waste from photographic development is considered hazardous waste and must not be discarded into the sink drain. For assistance, call EHS.

Mercury

Do not discard elemental mercury or glassware contaminated with mercury in the trash. Do not sprinkle sulfur on mercury spills. Contact EHS to clean up mercury spills. Mercury and mercury-contaminated materials are picked up by EHS.

Departments are encouraged to replace mercury-containing devices such as manometers, barometers, thermometers, etc., with non-mercury devices.

Laboratory chemicals

Each laboratory that uses chemicals must make an effort to reduce shelf stock wherever possible. A great deal of Kansas State's hazardous waste is from the clean out of vacated laboratories. This waste generation could have been minimized if greater care were spent in purchasing, stocking, and using chemicals.

Purchase only what is needed and maintain a current inventory of chemicals in stock. EHS expects laboratory managers to use inventories as a means to reduce waste. Buy only the quantities of chemicals needed without overstocking. Use up old chemical stock before buying new stock.

Establish a centralized chemical storage area. This would facilitate the redistribution of surplus chemicals. Buy chemicals at the established chemical storerooms on campus such as the Biology Storeroom (Ackert Hall) or the Chemistry Storeroom (King Hall).

Promptly replace deteriorated labels and containers. No chemical container may be kept in storage without an identifying label.

In-Lab Disposal Methods

Neutralization. Many laboratory chemicals can be neutralized or made nonhazardous in the laboratory and discarded into the sanitary sewer system. For instance, mineral acids may be neutralized with a base to a pH between 5 and 9. The resulting solution may then be washed down the sink drain with copious amounts of water. For additional information or help in neutralizing chemicals, call EHS. Several books have been published that suggest laboratory neutralization processes, some noted ones are:

Prudent Practices in the Laboratory

Hazardous Laboratory Chemicals Disposal Guide

Destruction of Hazardous Chemicals in the Laboratory

Waste Disposal in Academic Institutions

Evaporation. Do not dispose of chemicals by evaporation. Evaporation of solvents or other chemicals as a means of disposal is not permitted under hazardous waste regulations.

Sanitary sewer system (the sink drain). Very few chemicals may be discarded into the sanitary sewer. Only small quantities of non-flammable, low hazard, biodegradable and water-soluble materials may be disposed this way. Amounts of less than 100 g or 100 ml per day may be flushed down the drain with copious amounts of water.

Trash dumpster. Do not dispose of chemicals in the trash.

Requesting Hazardous Material Disposal

A pick-up service is provided by EHS provided the following guidelines are observed:

a. Waste material may be collected in empty compatible glass or plastic containers.
b. Waste collection containers must be marked with the words “Hazardous Waste.”
c. Waste collection containers must be marked with the date when full.
d. Waste collection containers must be kept closed except when adding waste.
e. Halogenated waste must be kept separate from non-halogenated waste.
f. Organic waste should be kept separate from inorganic waste.
g. "Defuse" or stabilize reactive waste in the laboratory when it is appropriate.
h. Keep waste materials from different processes separate, if possible.
i. Excess, off-spec, or outdated unused laboratory reagents for pick-up do not need to be labeled “Hazardous Waste” as long as there is a chemical identification label on the container.

In preparation for hazardous material pick up:

a. Collection containers for hazardous waste must be labeled with the words “Hazardous Waste,” marked with the name of the chemical contained, dated when full, and be closed to prevent spillage.
b. Non-compatible materials must be kept separated (see Appendix A).
c. Box groups of containers so that they can be carried easily by hand.

d. Label the box "PUBLIC SAFETY WASTE". Appropriate labels are available at no charge from EHS.
e. Fill out a Hazardous Waste pickup request form on the EHS webpage at www.k-state.edu/safety. The form is on the right-hand side of the page. For assistance, call EHS at 2-5856.

Training

Waste awareness training is provided by the University. One-hour classes are held monthly in the basement training room in Edwards Hall. Departments may request a seminar at their location and training is available on the EHS web page.

http://www.k-state.edu/safety

All employees are encouraged to attend this training at least once a year.

Radioactive Waste

Requirements

The RSO will pick-up and properly dispose of radioactive waste produced on campus. During the normal course of experimentation, low levels of radioactive materials may necessarily be released to the sanitary sewer. The bulk of radioactive waste material, however, should be collected for later pick-up. Instructions as to proper collection and storage of radioactive waste before pick-up are given below. If a special pickup is required, please fill out our Radioactive Waste Pickup Form.

Separate by Isotope and Type:

a. Separate solid from liquid.
b. Separate aqueous liquid from organic solvent samples.
c. Separate by isotope.
    1. 14C and 3H may be stored together.
    2. Isotopes with half-lives of 30 days or less may be stored together (32P, 51Cr, 86Rb, etc.).
    3. Other isotopes must be individually stored.

Scintillation Fluid: It is required that biodegradable, aqueous type fluors are used to count samples on liquid scintillation counters.

a. Pour used scintillation fluid from vials into collection container (i.e., gallon jug).
b. Rinse vials with water and dispose in the regular trash.

Waste Containers:

a. All containers for waste must be labeled with the radioactive sticker provided by the RSO. When the container is ready for disposal, the date and amount of isotope contained must be added.
b. All containers must remain closed except when adding waste.
c. Solid waste containers:
    1. Must be hard-sided, such as a cardboard box.
    2. Must be lined with a plastic bag.
    3. Must have a closeable lid.
d. Liquid waste containers: Do not use any container that did not originally contain liquid.
    1. Quart size or larger only.

2. Do not fill completely full. Leave at least 1" headspace for small jars and 3" headspace for larger jars.
3. Must have lid that seals securely. Be sure jar is designed to hold liquids

Pick-up:

a. Radioactive waste is picked upon the first Thursday following your source package delivery. Pick-ups are every Thursday until your inventory is zero. Contact the RSO at 2-5856 if special arrangements need to be made.
b. When the original source container is to be disposed, be sure to return the Radioisotope Receipt and Disposal Log to the RSO.
c. Waste which is not properly packaged and labeled will not be picked up.
d. If your waste is also considered hazardous as defined in the Good Laboratory Safety Practices Manual, call the Department of Environmental Health and Safety at 2-5856 to request a hazardous waste pick-up.

Biohazardous/Medical Waste

Biohazardous/Medical wastes and contaminated materials are disposed of by category. There are three categories of waste: Category 1 waste is known, assumed, or suspected of being infectious to humans, plants, or animals and could cause harm if released to the environment, Category 2 waste has the appearance of biohazardous/medical waste, but is not contaminated with regulated materials, Category 3 wastes are contaminated with hazardous chemicals or radioactive material. For more information, see Biohazardous and Sharps Waste Management Manual**.**

Waste Treatment

a. All biohazard waste/materials must be collected in red or orange biohazard bags or tubs. These containers must be kept closed.
b. Pathogenic organisms or contaminated materials must be decontaminated prior to disposing in the trash.
c. Once a biohazard waste is autoclaved/sterilized, place the red bag into a dark, sealed trash bag prior to placing it into a dumpster. This will prevent others from mistaking it as biohazardous/medical waste.
d. Materials designated as Category 1 waste must be disposed of as medical waste. This includes sharps contaminated with Category 1 waste (needles, syringes, scalpels, razors, Pasteur pipettes, etc.).
e. Sharps contaminated with Category 1 waste must be placed in puncture-resistant plastic containers that have the biohazard symbol.
f. Pathogen-containing waste must also be labeled “Infectious waste-name of the pathogen”,
g. Do not put Hazardous Waste labels on biohazard/medical waste.

Requesting Medical/Biohazardous Waste Disposal

Sharps

Sharps are items capable of puncturing, piercing, cutting, or abrading the skin. Sharps are also handled according to the same categories that apply to biohazardous medical waste: Category 1 waste is known, assumed, or suspected of being infectious to humans, plants, or animals and could cause harm if released to the environment, Category 2 waste has the appearance of biohazardous/medical waste, but is not contaminated with regulated materials, Category 3 wastes are contaminated with hazardous chemicals or radioactive material. The below requirements apply to all three categories. For detailed information on handling category 1 or 3 sharps (contaminated sharps), see Biohazardous and Sharps Waste Management Manual

Sharps must be disposed in an appropriate sharps container as soon as possible after use. Place waste in a rigid, puncture-resistant, leak-proof (on sides and bottom), labeled waste container that has a secure lid with an alternate smaller opening appropriate to the type and size of waste.

Never:

a. Place sharps in regular trash bags or waste cans
b. Reach into a sharps waste container (or other waste receptacles).
c. Place liquids, such as full syringes, in the sharps waste container.
d. Fill the container beyond the “fill” line where applicable (approved medical waste containers have a fill line). Containers **must not** be over ¾ full or at full capacity such that: 1) lids do not fit securely, 2) materials poke out from the opening, or 3) the capacity presents a puncture or contamination risk to individuals handling the container.
e. Reuse sharps waste containers
f. Place sharps in food containers or items resembling containers of food
g. Place sharps in waste containers designed for broken glass

When ready for container disposal, transport, or treatment, ensure the lid is properly secured. Follow the procedures for proper disposal management based on the nature of the sharps waste category.

Category 2 Sharps (Non-biohazardous, Uncontaminated)

Use a container that is puncture-resistant and leak-proof. Do not use red containers. Deface any existing container markings. Clear or white regular medical sharps containers may be used as long as biohazardous markings are removed or defaced. Some re-purposed plastic containers may be used to collect and store sharps that are **not contaminated** and were **not** generated in a clinic or laboratory that generates and/or handles biohazardous or other potentially infectious materials (which must be handled only as Category 1 sharps).

To use containers other than those specifically manufactured and/or sold for sharps waste, the container must be a rigid, undamaged, and be puncture resistant. Sturdy liquid laundry detergent containers are acceptable. As a guide, containers made of polypropelene (PP) or high-density polyethylene (HDPE) displaying the recycling designations numbers of 5 or 2, respectively, are generally suitable.

Any original product labeling must be completely defaced or covered with proper secondary label. These re-purposed containers are acceptable, but not recommended due to the tendency for this to be mistaken for empty reusable/recyclable materials. If this type of container is used, all original product marking should be removed and replaced with appropriate precautionary labeling to include:

a. Sharps
b. Non-Biohazardous or Non-Medical
c. Do not recycle

Glass Waste

Contaminated glass waste should be disposed of as a category 1 or 3 sharp depending on the nature of the contamination. See Biohazardous and Sharps Waste Management Manual for more information.

Dispose of glassware in a box with a lid or which can be securely closed. Do not throw glassware in regular trash cans. Broken glass or glassware waste containers are available from laboratory supply vendors. Any sturdy, undamaged corrugated box is suitable. The boxes should be lined with a 2 mil poly bag.

All containers must be clearly labeled with one of the following:

a. Laboratory Glassware
b. Lab Glassware Only
c. Broken Glass or Glass

Keep glassware for disposal separate from all other waste in the laboratory or shop. Laboratory glassware and chemical containers cannot be recycled. Chemical and reagent containers must be empty prior to disposal. All contents must be removed prior to disposal by ordinary means (e.g., draining, pouring, scooping).

Once the glassware waste container is three-quarters full, seal the top of the box with packaging and transport the closed container to the building trash dumpster. Custodial services is not required to take out laboratory or shop glassware waste.

Do not handle broken glass with your hands. Use a brush and dustpan, tongs, or forceps to pick up broken glass. Substitute plastic ware for glassware when practical in laboratories with infectious agent work.

Occupational Health and Medical Monitoring

Exposure to various hazardous agents found in the workplace poses potential health risks. Individuals with specific risks may be required to have personal exposure monitoring, preventative measures (e.g., vaccines or antigen testing), medical monitoring (medical tests, serum collection), or medical surveillance (healthcare provider review of reported symptoms and/or medical test results). These services must be provided to the employee at the expense of the employer.

Medical Surveillance

Work with certain agents may require enrollment into a specific medical surveillance program as dictated by regulatory, accreditation entity expectations, or KSU policy to ensure worker protection. This includes chemical agents known to cause occupational cancers and/or other occupational illness as defined the OSHA Laboratory Standard or as part of the EPA Worker Protection Rule.

Formaldehyde Medical Surveillance

Formaldehyde is present in various KSU clinical and laboratory settings, often in the form of formalin. When working with dilute solutions such as formalin, exposures may be safely controlled by employing good laboratory practices such as working in a chemical fume hood and/or working with small amounts, and wearing recommended PPE.

Formaldehyde is a known human carcinogen and a chemical sensitizer and allergen. Employees that are potentially exposed at or above the OSHA action level for formaldehyde, as determined by personal or area sampling, must enroll in a formaldehyde medical surveillance program. The action level is established for the protection of employees routinely exposed to higher levels of formaldehyde in the execution of their work activities. Medical surveillance consists of filling out a medical questionnaire annually that is reviewed by a licensed healthcare provider. A physical exam may also be required as determined by the healthcare provider. Contact EHS for assistance enrolling in a medical surveillance program.

In some cases, employees might experience adverse symptoms when exposed below the action level or during non-routine or casual contact to formaldehyde. In this event, medical guidance should be sought through an occupational healthcare provider.

Contact EHS for guidance and for worksite assessment.

Select Agents Medical Surveillance

Individuals working with select agents must be enrolled in the BRI medical surveillance program. Contact the BRI for assistance.

Asbestos Worker Medical Surveillance

Asbestos is a once commonly used building material which may be broken into microfibers capable of causing chronic respiratory health effects in those exposed. All remodels which may disturb asbestos containing materials must include a work order through Facilities which will lead to a check for asbestos containing material.

EHS provides oversight for all asbestos related projects for the University. This includes the Division of Facilities, the Department of Housing and Dining Services, Athletics, the KSU Union, Hale Library, the Foundation Center, and outside contractors working on campus. This service is provided at cost to Facilities with nominal charges added to all other departments. The services that are provided include bulk samples (polarized light microscopy analysis) for each job, inspection for the location of asbestos (visual) and air quality (phase contrast microscopy analysis).

For more information, see:

https://www.k-state.edu/safety/occupational/asbestos-lead/

Exposure Monitoring

If there is reason to believe that chemical exposure levels in the workplace exceed the TLV, STEL, or action level for any of the present chemicals EHS or the Department Head will initiate exposure monitoring. If this monitoring discloses employee exposure above the TLV, STEL or action level EHS and the Department Head will determine appropriate steps to mitigate this exposure, including initiating periodic monitoring.

Exposure monitoring serves as a reference when implementing exposure controls and helps to determine the effectiveness of the measures taken. Periodic monitoring may cease once exposure concentrations are shown to be below the TLV, STEL, and action level for the chemical hazards present over the course of two consecutive monitoring events that take place at least seven days apart.

Affected employees will be notified of the monitoring results. Contact EHS for monitoring. Cost for such monitoring is the responsibility of the requesting department.

Reproductive Health Hazards

If you work in a laboratory or clinic setting and you are pregnant or potentially pregnant, you may contact the KSU Department of Environmental Health and Safety (EHS) for guidance on preventing workplace exposures to reproductive hazards and to voluntarily report your pregnancy (785-532-5856). Specific reporting and controls are recommended for employees that work with radioactive isotopes.

The EHS Occupational Safety section can assist you by conducting a workplace hazard assessment to determine the nature of the potential exposures in your specific work setting and make recommendations about controls to avoid exposure. These controls can include administrative practices (e.g., this might include altering your work practices or substituting less hazardous chemicals for more hazardous materials), engineering controls (such as the use of biosafety cabinets or fume hoods), or the use of personal protective equipment (PPE). Cursory or general guidance is provided in this document, but to ensure that the nature of the controls you employ are protective for your specific circumstances, call EHS and ask to speak to an Occupational Safety representative, the Radiation Safety Officer, or the director for information and/or to schedule an assessment.

Confidentiality

You may make inquiries to EHS regarding exposures and hazards of the work setting without identifying your specific circumstances or identity. Once you have made a written ***official declaration of pregnancy***, if the conditions of your work circumstances place you or your unborn child at risk, it may be necessary to communicate with your supervisor or other department representative to make recommendations about safety.

You can discuss your concerns with an EHS Occupational Safety representative without needing to disclose your circumstances to your department. General information shared is kept confidential. However, if alterations to work are necessary for safety, your supervisor may need to be informed of your condition.

An assessment can be conducted of your work area to discern the risks present. This may be conducted without disclosing information with others in the laboratory and can be treated as a routine laboratory inspection.

Radiation Safety

Ionizing radiation is a known reproductive hazard. It has been linked to birth defects and other reproductive problems. Exposure to ionizing radiation at work could increase your chances of having reproductive problems. It is important to follow all controls and safety protocols when working with sources of ionizing radiation.

There are specific federal and state regulations and license requirements that apply to pregnant workers exposed to radiation or radioactive materials. The EHS Radiation Safety section ensure compliance to these requirements and also manages the purchase, use, and disposal of radioactive materials for Kansas State University. The program provides monitoring for personnel exposures to radioisotopes. To provide you with adequate monitoring during pregnancy, you should report your condition to the Radiation Safety Officer by completing a Declaration of Pregnancy form. Review the guidelines in the Radiation Safety Manual and fill out the declaration form. If there is potential for specific exposure, EHS Radiation Safety may issue you a fetal monitor.

Chemical Safety

There are workplace hazards that could be harmful for pregnant or breastfeeding women, or for members of the worker's household if a worker carries home contaminants from the workplace on clothes, skin, and shoes. It is important to follow all safety protocols and use appropriate PPE when working in the laboratory or clinic setting.

If you are pregnant, it is important to discuss your workplace activities and the materials you use both in the workplace and at home with your OB/GYN. Additionally, Contact EHS Occupational Safety to discuss the materials you work with and to coordinate a workplace hazard assessment as needed. A hazard assessment may also include air sampling depending on the nature of the hazards present.

Complete the University-specific Laboratory Safety training through the Vivid Learning System to learn about basic laboratory safety controls and hazards to anticipate in the laboratory.

The following is a list of potential reproductive hazards that may be present in the laboratory or research clinic setting. This list is not exhaustive. For a review of the specific chemicals in your work area, Contact EHS Occupational Safety/Industrial Hygiene. Review the Safety Data Sheets (SDS) for information about the health hazards of a specific material. If the material is a *known* reproductive hazard, this should be identified within the SDS.

Anesthetic Gases
Antineoplastic (Chemotherapy) Drugs
Chemical Disinfectants and Sterilants
    Glutaraldehyde
    Ethylene oxide
Formaldehyde (very limited evidence)
Solvents
Lead and other Heavy Metals (use in research or as radiation shielding)

Additional information on some materials used routinely within the campus settings is provided below.

Formaldehyde/Embalming Fluids/Fixatives

Limited research studies are available on the reproductive hazards to a fetus resulting from *airborne* exposures to formaldehyde. In the laboratory, ventilation and the use of fume hoods greatly reduce the potential for exposure when using proper work practices. Higher hazards exist from potential ingestion, which can occur from poor sanitation practices. Methanol/alcohol is a teratogen via ingestion.

If you work routinely with formaldehyde solutions (>4%), sampling required. Individuals with exposures at or above regulated “action” levels may be required to enroll in the EHS Formaldehyde Medical Surveillance program. Contact Occupational Safety for additional information.

Anatomy Classrooms and Work with Preserved Carcasses, Cadavers or Specimens.

Anatomy coursework is generally conducted in specially designed classrooms and on downdraft tables that exhaust chemical vapors present in embalming fluids or other fixatives. Routine sampling in these areas for formaldehyde is conducted by Occupational Safety. If you are conducting this type of work outside of these classroom settings, contact Occupational Safety for an assessment of your work area.

Respirators may be used to protect workers from airborne contaminants. Use of a respirator by employees requires enrollment in the KSU Respiratory Protection program, medical clearance, training, and fit testing. Voluntary use of respiratory protection by non-employees such as students taking anatomy courses does not require enrollment in the KSU program, but you may Contact EHS for advice, information for your physician, respirator fit testing, and training. You must check with your OB/GYN if it is safe to use a respirator during your pregnancy. In cases where the levels of formaldehyde are below the permissible exposure level, carbon impregnated masks are an alternative to a traditional respirator.

Always wear scrubs and/or lab coat when in these settings. Disposable gowns/scrubs are an option and may be disposed after each use. These clothing articles should be worn in addition to the minimum PPE described in the PPE section. Remove gowns/scrubs/lab coats upon exiting the lab/clinic/classroom and place them in a sealed bag for transport. Your department may have a program to launder your items.

Work with 4% Formalin

Unless you are making solutions in the laboratory, most work with formalin should not present a serious hazard when work is infrequent and/or for short lengths of time as long as you are following proper laboratory safety protocol, including proper hygiene and hand washing and you wear appropriate PPE. Any preparations of volatile chemicals should be performed in a properly functioning chemical fume hood.

Anesthetic Gases

Studies have found an association between exposure to anesthetic gases and reproductive problems. It is important to follow the safety protocol established for your workplace and specific work activities and use appropriate PPE. It is also important to use waste gas scavenging devices. Information about waste anesthetic gas hazards and recommended controls is available from EHS.

Infectious Agents

The following information is adopted from the Centers for Disease Control (CDC) information on reproductive health and the workplace.

Working with or exposure to certain bacteria, viruses, or other infectious agents could increase your chances of having a miscarriage, a baby with a birth defect, or other reproductive problems. Some infections can pass to an unborn baby during pregnancy and cause a miscarriage or birth defect.

Infections like seasonal influenza (the flu) and pneumonia can cause more serious illness in pregnant women (CDC).

These and other infections can pass to the unborn baby during pregnancy, or cause more severe illness to a pregnant woman:

- Chicken pox (varicella zoster virus)
- Coccidiodomycosis
- Cytomegalovirus (CMV)
- Ebola virus
- Hepatitis B virus (HBV)
- Hepatitis C virus (HCV)
- Hepatitis E virus (HEV)
- Human Immunodeficiency Virus (HIV)
- Herpes
- Influenza
- Listeria
- Malaria
- Measles
- Parvovirus B19 (Fifth disease)
- Rubella (German measles)
- Toxoplasmosis

Exposure Control

General Guidelines

Make sure your vaccines are up to date. Seasonal influenza (flu) and other illnesses can cause more serious illness in pregnant women.

a) Get your seasonal flu shot. If you are pregnant, you should get the flu shot (inactivated vaccine) and not the nasal vaccine (LAIV, live attenuated nasal vaccine).
b) Do not get the MMR (measles mumps rubella) vaccine during pregnancy. If you are a pregnant healthcare worker who is not vaccinated and not immune, do not work with rubella-infected patients. Rubella infection is dangerous for pregnant women and their babies.
c) Learn more about vaccines for pregnant women.

Wash your hands often if you are around someone who is sick.

Lab, Animal Care, Clinic

a) Report your condition (voluntary) and any changes to your work activities.
b) Complete the Bloodborne Pathogens training online
c) Follow recommended infection control guidelines (standard precautions) carefully. If you follow these guidelines, you will be generally at no higher risk of catching a harmful infection from a patient than other workers. Learn more about infection control in general healthcare settings.

d) If working with pathogens as part of an IACUC protocol, an OHSP Form 4 and 5 should be filled out and submitted to indicate a change in status. A new consultation with Via Christi Occupational Health will be triggered by those forms.
e) Complete the Laboratory Safety training. Follow safety guidelines for laboratory workers. These guidelines will help you prevent laboratory-acquired infection when followed correctly.
f) For laboratory work with concentrated cultures of pathogens, contact the EHS Occupational Safety section.
g) Ensure that you are using biosafety cabinet that is appropriate to the type of work activity and materials that you are using. Contact EHS Occupational Safety section if you are not sure.

Physical/Energy Hazards

Beyond chemicals and infectious agents, physical hazards can pose a risk to the unborn child. This includes radiation, which is covered under the Radiation Safety section. Loud noises and potentially vibrations can pose a risk. Excessive heat can also become a concern. Generally, there are few instances of these hazards in the lab or clinic setting. If you believe that you do have this type of exposure, consult with the EHS Industrial Hygiene group. They can conduct noise level readings of your area and suggestion shielding or other controls depending on the nature of the hazard.

Long or irregular work shifts, as well as lifting bending and standing for long periods can present additional risk to pregnant women. Always consult with your OB/GYN about your work and any changes to your working conditions.

Resources

CDC/National Institute for Occupational Safety and Health (NIOSH) Reproductive Health and the Workplace:

Webpage: http://www.cdc.gov/niosh/topics/repro/default.html

What you should know: http://www.cdc.gov/niosh/topics/repro/femaleHealthImpact.html

The Effects of Workplace Hazards on Female Reproductive Health:

Webpage: http://www.cdc.gov/niosh/docs/99-104/

Document: http://www.cdc.gov/niosh/docs/99-104/pdfs/99-104.pdf

Related Articles

Collins, J., et al (2001) A review of adverse pregnancy outcomes and formaldehyde exposure in human and animal studies. *Regulatory Toxicology and Pharmacology* 34, p17-34.

Respirator Medical Clearance

Employees that must wear respiratory protection in the course of their work activities must be medically approved to wear respiratory protection by a licensed healthcare provider. To verify medical approval, the employee is provided a respirator clearance form that is filled out by the employer and provided to the healthcare professional. The clearance form lists the conditions of work, anticipated exposure type, and respirator required. The healthcare provider signs the clearance form, indicating if the employee is medically cleared for respirator use and listing any applicable limitations or conditions of approved use. All KSU employees using respiratory protection in the performance of their job must have documented medical clearance. Review other requirements of the **Respiratory Protection Program**.

IACUC Occupational Health Program Enrollment

The Federal Office of Laboratory Animal Welfare (OLAW) requires all institutions conducting animal research to provide occupational health support for all of its animal researchers and staff. All occupational animal workers participate in the Occupational Health Safety Program (OHSP). This includes animal caretakers, herdsmen, student workers, researchers, graduate students, or students having contact with animals in research activities. The IACUC application form has a section where PIs list all protocol-associated personnel. This is used to identify personnel for both mandatory animal care and use training, and enrollment in the OHSP. The enrollment of other personnel not identified through the IACUC protocol process is initiated by the individual department or group (i.e., animal care staff, facility staff) engaged in animal care and use activities. Animal worker enrollment in the OHSP is also spot checked during the semiannual animal facility inspections.

The University Research Compliance Office (URCO) maintains a database of individuals participating in university research projects. This database documents participation in the animal care and use OHSP. The URCO captures names of participants in proposals upon submission, and documents their status in the animal care and use OHSP. If additional information, training, or documentation is needed, the PI is contacted for further information or action.

To initiate the enrollment process, please access the Occupational Health forms on the University Research Compliance Office website at http://www.k-state.edu/comply/iacuc/ohsp/index.html. If you should have any questions please contact the University Research Compliance Office (URCO) by phone (785) 532-3224 or email at comply@ksu.edu.

Additional medical monitoring may be required other University entities as identified in the Laboratory Safety Manual.

Hearing Conservation Plan

Long-term exposure to excessive noise leads to permanent, irreparable hearing loss. Many individuals who live and work in noise are reluctant to recognize it as a serious threat or to accept and use personal hearing protection. Noise-induced hearing loss occurs slowly over months or years making it difficult to convince those at risk to guard their sense of hearing.

The purpose of the Hearing Conservation Program is to prevent job-related, noise induced, hearing loss in University employees. Work areas of the University which test to be noise hazard areas (exceed the maximum permissible noise exposure for employees) shall enter into the Hearing Protection Program. The three-part program includes testing, training, and hearing protection.

Noise testing and hearing tests

Sound surveys will be conducted once every two years or more frequently as considered appropriate in departments considered noise hazard areas by the Industrial Hygienist. Employees who are exposed to an eight hour time-weighted-average (TWA) of 85 dBA or greater will have their hearing tested annually.

Employees exposed to a TWA of 90 dBA or greater noise exposure for eight hours must wear hearing protection.

All hearing testing will be conducted in a sound treated audiological test booth in the Kansas State University Speech and Hearing Center under the supervision of a Certified Audiologist. New employees will be tested within six months of employment. In-service training for employees shall be performed annually. These training sessions will cover the areas of basic audition, anatomy of the ear, noise and noise-induced hearing loss, and the benefits of hearing protection.

Scheduling will be coordinated with the involved department, the Department of Environmental Health & Safety and the Speech and Hearing Center.

Hearing protection

Engineering controls should be instituted to reduce noise levels to reasonable limits where practical. In all areas where noise hazards exist, warning signs should be posted at entrances or on the periphery of those areas. Hearing protection must be worn when the noise level exposure equals or exceeds a TWA 90 dBA. In addition, hearing protective equipment must be available to those exposed to noise levels between 85 and 90 dBA.

The costs for this program including testing, training and hearing protection will be provided by the affected department. The guidelines for hearing conservation can be found in the complete guidelines published by the Department of Environmental Health & Safety is available from the Department in hard copy.

Emergency Planning and Response

The priorities of the University during an emergency are the protection of the following: human lives, the lives of animals associated with the University’s mission, valuable research processes, University and personal property, and the environment. This is accomplished through effective use and coordination of University and community resources. Review the following information to ensure your laboratory is prepared for an emergency.

Emergency Plans

Emergency plans are key tools that provide guidance to the members of your laboratory during an emergency. By developing an emergency plan and training your laboratory members on how to properly implement it, you increase the chances they will be able to cope with an emergency situation and decrease the chances of injury, damage to lab equipment, and loss of research data. The most recent version of the campus emergency guide can be referenced here:

https://www.k-state.edu/police/emergency/

The University is currently in the process of revising this document. Upon completion and approval this document will be made available to the University community to assist in planning efforts. Additionally, a template emergency plan for departments and/or buildings is in development and will be released for use upon completion and approval. If you have any questions regarding emergency plans or preparedness please contact the KSU Emergency Management Coordinator at kstateem@ksu.edu

First Aid Kits

The ANSI Z308.1-2003 standard establishes minimum performance requirements for first aid kits and their contents that are intended for use in various work environments. Because each work environment is unique, it is expected that the required products will be supplemented with additional products and quantities based upon the hazards found in the particular work environment.

Kansas State University recommends that a first aid kit be located in the main office of each department and in every laboratory and shop area. Each kit and/or location shall be easily accessible and visibly marked as a place where first aid supplies are located. To ensure immediate access to first aid supplies, it is recommended that first aid kits not be locked.

First aid kits should be regularly inspected to ensure completeness, condition of contents and expiration dates to maintain compliance with this standard. Any item beyond its marked expiration date should be removed from the kit and replaced.

Minimum Required Contents (10 person kit)

a. 1 - absorbent compress (32 sq. in.)
b. 16 - adhesive bandages (1 X 3 in.)
c. 1 - adhesive tape (3/8 in. X 5 yd.)
d. 10 - individual-use antiseptic applications (0.5 g or 0.14 fl. oz. each)
e. 6 - individual-use burn treatment applications (0.9 g or 1/32 oz. each)
f. 2 pairs medical exam gloves
g. 4 - sterile pads (3 X 3 in.)
h. 1 - triangular bandage (40 X 40 X 56 in.)

Optional Recommended Contents

a. antibiotic treatment
b. battery powered flashlight
c. bandage compress
d. eye covering
e. eye wash
f. cold pack
g. roller bandage

It is a good idea to customize the first aid kit to suit the specific hazards of your workplace. You can identify additional items by asking your employees what they need and also by looking over past accident reports. Additional items might include:

a. various bandage and compress sizes,
b. antiseptic wipes,
c. disposable tweezers,
d. scissors,
e. calamine lotion,
f. hydrocortisone cream,
g. disposable thermometers,
h. mouth barrier devices for rescue breathing, or

i. other items that would be helpful in your workplace.

Oral medications such as analgesics (pain reliever/fever reducer), cold remedies, antihistamines and others should not be included in first aid kits.

Spill Response

Faculty and staff must be familiar with the hazardous materials and hazardous situations that exist in their laboratory. New employees must be trained in the use of hazardous materials and situations within the first few weeks on the job. Each laboratory must develop and maintain a list of hazardous materials such as, “acetone, 4 liters, 237 King Hall.”

Faculty and staff working in laboratories should make themselves familiar with the location and use of emergency chemical spill equipment. This includes the location of chemical spill kits, personal protective equipment and first aid supplies.

Chemical Spill Release

Small Spills

Small spills involve low volumes of less hazardous chemicals (e.g., not highly flammable or highly volatile toxic materials). These spills should be cleaned up by lab personnel or other staff that have received required training (i.e., Hazard Communication, Hazardous Waste Awareness, and on-the-job department training related to hazardous materials used in the lab), have appropriate PPE, and have sufficient information about the material spilled (e.g., Safety Data Sheet).

Spill kits should contain, at a minimum, the following:

a. Protective clothing.
b. Chemical absorbent material.
c. Acid/base neutralization chemicals.
d. Polypropylene squeegee.
e. Drain stopper (or absorbent sock to place around drain).
f. Polypropylene pan and broom.
g. Tongs (for handling broken glass)
h. Mercury sorb/amalgam for labs using mercury or mercury containing instruments and thermometers.
i. Barricade or caution signs.

Small spill response procedures:

1. Put on appropriate PPE.
2. Contain the spill; protect any floor drains or exterior storm drains.
3. Pick up broken glass with tongs or a dustpan and hand broom.
4. Use absorbents to neutralize/clean up the spill.
5. Place neutralized material/saturated absorbents in a trash bag or other container that will contain fluid.
6. Place and fill out a hazardous waste label for the container.
7. Notify EHS of the spill by calling 785-532-5856.
8. Fill out a pickup request for the container at www.ksu.edu/safety.

Large Spills

Spills or releases of highly hazardous material, such as toxic or flammable gas, air or water reactive chemicals, explosive chemicals, etc., should not be cleaned up by laboratory personnel. When a highly hazardous material is spilled, call 911 for University Police (alt: 785-532-6412).

Large spill response procedure:

1. Evacuate the laboratory, leaving fume hoods on and opening their sashes and closing all doors and windows.
2. Alert all personnel in adjoining rooms to leave the area.
3. Call 911.
4. All affected personnel should meet at a safe location and await emergency response personnel. Those who have been exposed to chemicals will be evaluated by Emergency Medical Technicians from the local hospital.
5. While waiting for emergency response, retrieve a copy of all relevant SDSs.
6. Notify the laboratory PI.
7. Provide all requested information to the Fire Department and EHS personnel, such as the name of the chemical that was spilled/released and quantity.

Biological Spill/Release

The primary concerns in biological spill cleanup are to prevent further contamination and exposure to the hazardous material. The general procedure for spill cleanup is to protect yourself, contain the spill and secure the area, disinfect the spill, clean up debris, dispose of the material, and clean yourself up.

The components of a biological spill kit are as follows:

a. Disinfectant solution appropriate to the material handled in lab (10% bleach, 70% ethanol, etc.)
b. Mechanical device for handling debris
c. Absorbent material
d. Biohazard bags

Biological Spills in BSL-1 Labs

The hazards associated with BSL-1 materials are minimal. Cleanup procedures are necessary, however, to prevent further contamination.

1. Notify laboratory personnel in the area and restrict access to the spill area to prevent further contamination.
2. Get the Spill Kit and put on the appropriate personal protective equipment (PPE): lab coat, eye protection, and gloves.
3. Place a paper towel or some other absorbent paper product over the spill.
4. Spray the paper towel or other absorbent with a fresh 10% bleach and water solution or equivalent.
5. Allow the absorbent material and sterilization compound to set on the spill for five to fifteen minutes, depending on the size of the spill.
6. During the five to fifteen minute sterilization period, prepare the red biohazard bag by opening the bag and folding it down from the top so that a wide opening is created and contamination of the outside bag surfaces during filling is prevented.

7. When the five to fifteen minute sterilization time is up, put the soaked towels or absorbent material in the biohazard bag. If broken glass or sharps are present use a mechanical device to handle the contaminated material. Wipe up any remaining spill residue with clean paper towels and place them in the biohazard bag.
8. Clean the spill area again with the fresh 10% bleach and water solution or equivalent, placing the paper towels in the biohazard bag when finished.
9. Remove gloves, taking care not to touch the outside surfaces of the gloves with your bare hands, then place them in the biohazard bag.
10. Wash hands, thoroughly.
11. Dispose of the waste as biohazard waste.

Biological Spills in BSL-2 Labs

The primary hazards associated with working in BSL-2 laboratories are accidental percutaneous or mucous membrane exposures, or ingestion of infectious material. A spill increases the risk of these hazards by potential introducing broken glass, aerosols, and challenges to containing the material. If you need help to clean up the spill, call EHS at 785-532-5856. BSL-2 cleanup procedures are the same as BSL-1 procedures except for the following:

1. Take special care when handling sharps.
2. If aerosols may have been generated by the spill or if the spill is found within a centrifuge, all personnel should leave the area or the centrifuge should be closed immediately. Wait 30 minutes for the aerosols to dissipate before proceeding in clean up.

Biological Spills in BSL3 Labs

RESERVE

Radioactive Spill/Release

Except for the most minor of spills, the Radiation Safety Office MUST be contacted. Work involving unsealed radioactive sources should occur over absorbent paper or trays to contain any potential spills. In the event of a spill outside of these protective barriers, care should be taken to not spread the contamination. This includes blotting and not wiping the spill, containing it to as small of an area as possible and closing but not leaving the area to prevent tracking the material over a wider area. Keep in mind the chemical and physical properties of the material before attempting to remove it.

Emergency Equipment

Emergency Showers and Eye Washes

Suitable facilities for quick drenching or flushing of the body and eyes must be provided near the work area for emergency use where eyes or body of any person may be exposed to injurious, corrosive materials. These facilities must be installed such that:

a. The shower and/or eyewash must be located within 10 seconds of unobstructed travel from site of corrosive material use.
b. Operating chains or bars must be freely accessible so the shower can be used in the event of an emergency.

c. The area beneath and in front of each safety shower and eyewash station must be kept clear and unobstructed at all times.
d. Immediate and extended (15 minutes), continuous flow must be available to laboratory users.
e. Eye wash bottles for immediate eye rinsing have shelf lives and must be maintained. These units do not meet the extended flow requirement for a laboratory, but may be used as a supplement to permanent eyewash stations
f. Permanent installations must also be maintained. Eye and face wash stations must be flushed by laboratory users on a weekly basis by allowing the water to flow for approximately 3 minutes to remove stagnant water from the pipes. Maintain a record to verify weekly checks.
g. Emergency showers should be tested twice a year (preferably at the beginning of the Spring and Fall semesters) by laboratory personnel to ensure safe operation when needed in the event of an emergency.
h. New installations must allow for hands free continuous operation. Check with EHS for guidance on ANSI standard expectations for new installations.

For more information, see Emergency Shower Testing Initiative

Fire Extinguishers

Fire extinguishers are placed in or near laboratories depending on the degree of fire hazard.

Fire extinguishers are installed, inspected and maintained per NFPA 10, please Contact EHS if an additional extinguisher is needed or an existing extinguisher needs to be relocated.

Campus standard fire extinguishers are 10# ABC, if special agent extinguishers are required please Contact EHS for assistance.

Laboratories that require Class D (flammable solids) fire extinguishers, should consult with EHS. Class D fire extinguishers must be purchased by the using laboratory and special training is required. EHS will provide inspections and maintain records. Fire extinguisher demonstration and training is provided by EHS, to register for training either sign up through HRIS self-service or send an email to learning-develop-hr@k-state.edu. When sending an email, please include your name, employee ID and the course title.

Exits and Egress

It is highly important that exits and egress pathways are clearly identifiable and useable in the case of an emergency. Never move or conceal exit signage. This includes overhead signs and egress route posters. Exits and egress paths must be kept clear of obstructions and usable at all times. This includes keeping furniture, lab equipment, carts, boxes, and trash away from exit doors and out of the egress paths. Keeping fire and smoke separation doors closed prevents egress corridors and stairwells from being filled with smoke during a fire situation. In addition, never alter exit door mechanisms or otherwise render the door unusable.

Contact EHS to identify egress areas and emergency exits.

Evacuation

It is each person’s responsibility to acquaint themselves with locations of emergency equipment, emergency exits and general evacuation routes of each building they occupy. If during an emergency situation evacuation is not a possibility a sheltering in place strategy should be considered.

Things to remember if sheltering in place:

a. Stay in a location that can be protected from the hazard and easily located by emergency first responders (stairwells, rooms with exterior windows, etc..)
b. Protect yourself from the hazard (close all openings where smoke or odors may enter a room, open windows for fresh air, check doors for heat prior to opening, etc,..)
c. Notify first responders of your location (call, text, put a sign in or hang a piece of clothing, sheet or other article out an exterior window).

Fire

Planning

The KSU fire safety website provides guidance on a variety of fire safety topics:

https://www.k-state.edu/safety/fire/safetycodes/evacuation.html

Faculty and staff should be familiar with the location and use of emergency fire equipment. This includes the location of fire extinguishers, fire alarm pull stations, first aid supplies, fire blankets and emergency showers. It is recommended that each department develop a list of emergency equipment and its location.

Those who will need egress assistance should register with HR and with KSU Police. Registration information is available on the fire safety webpage above.

EHS is responsible for maintaining and checking fire alarm systems, smoke alarms, fire extinguishers and other fire suppression systems on the KSU main campus.

All employees should be trained how to use a fire extinguisher. Training is available for employees and students through EHS. Sign up for fire extinguisher training through HRIS Self Service or call 2-5856.

Faculty should acquaint students in classrooms of the locations of emergency equipment, emergency exits and general evacuation or areas to await assistance for those unable to evacuate.

Fire Response

In the event of a fire, pull the fire alarm as you leave the area and call 911 to report the location of the fire. Fire alarms are not all connected to the Manhattan Fire Department. In the event of a fire alarm, all persons must proceed to the nearest exit for evacuation. Instructors should announce the location of the nearest exit at the beginning of the class each semester. All evacuees should meet in a location away from the building and out of the way of the emergency vehicles. All efforts should be made to aid physically disabled individuals to a safe location and to advise emergency rescue personnel.

Weather Emergency

Tornado and Inclement Weather

All building occupants should know where to go in case of a tornado or severe weather. In the event of a tornado, sirens will sound outdoors a steady three-minute blast when there is need to take cover. Sirens are intended to alert personnel outside the building. For those inside buildings, an alert will be sent to personnel in every building via the telephone. People can also receive severe weather alerts by signing up for KSU Alerts via KSU Connect (https://connect.k-state.edu/). Each department head should prepare a plan on how personnel will be advised of the weather emergency.

Observe the following safety guidelines:

a. Get and stay indoors during the storm.
b. Go to the interior hallways on the lowest level of the building or storm shelter if designated for the building by signage.
c. Stay away from windows, doors, outside walls and protect your head.
d. Listen for improved weather conditions through KSU Alerts, weather networks/apps, local radio or television station.

The University Fire Marshal has placed tornado refuge signs near each building exit. By order of the State Fire Marshal (K.A.R. 22-18-2), these signs must be posted and must not be removed. For questions or replacement sign(s), call 2-5856.

After the severe weather emergency has passed, faculty or staff should notify the proper emergency personnel of any damages or injuries by calling 911. All university related injuries or illnesses must be reported through Accidental Injury Forms, located in the departmental office, as per the Policy and Procedures Manual.

Flooding

The KSU campus is on high ground relative to the rest of Manhattan, therefore serious flooding is unlikely. In the event of a flood, the KSU Alerts system will provide additional information. If advised to do so, evacuate immediately. Do not drive onto a flooded roadway or through flowing water. For more information reference *Flash Flood Safety* from the National Oceanic and Atmospheric Administration.

Power Outage

In the event of a power outage, laboratory instruments and engineering controls may no longer provide the level of protection they did while being powered. Two examples of this behavior are fume hoods and laboratory refrigerators and freezers. Fume hoods may not receive emergency power and will cease drawing vapors away from the laboratory. Refrigerators and freezers containing volatile chemicals will eventually increase in temperature, potentially creating a hazardous environment inside the body of the instrument.

Take the following precautions when the power is off:

a. Shut down experiments and processes involving hazardous chemicals.
b. If equipment failures create hazardous conditions, notify EHS immediately.
c. Fume hoods
    1. Stop operations emitting hazardous vapors, fumes, or infectious agents
    2. Cap open containers
    3. Close the safety sash

    4. Check for adequate airflow once power returns.
- d. Refrigerators and freezers
    1. Transfer volatile chemicals from cold rooms and unpowered units to an operational refrigerator or freezer.
    2. Transfer dry ice to refrigerators and freezers to keep materials cold. Do not use dry ice in walk-in coolers or confined spaces.
    3. Do not open units until transferring material or adding dry ice. An unopened unit may stay cold for several hours.
    4. Once power returns, keep doors on units closed until working temperatures have been restored.

https://blink.ucsd.edu/safety/research-lab/laboratory/power-failure.html#3.-When-the-power-returns

Injury Response and Reporting

Work-related incidents/injuries/illness/accidents should be reported through the electronic Incident Reporting System within 3 days of the incident. Paper forms are no longer accepted to report worker incidents. For injuries requiring immediate or urgent care, seek medical assistance/care via the nearest and most appropriate healthcare facility and report the injury after or have the supervisor report the incident.

For assistance with the electronic Incident Reporting System, please contact your department HR Liaison or HCS Benefits office. Find information related to workers compensation on the HCS website.

Incidents involving students and individuals who are not university employees may also be reported through the Incident Reporting System portal. Questions or concerns may be directed to EHS at safety@ksu.edu for incidents not related to employment. Students are strongly encouraged to report injuries occurring on campus through the Incident Reporting System. Providing information about student campus injuries helps the university respond to safety concerns and perhaps avoid future incidents.

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Appendices

Appendix A: Chemical Compatibility List – List of chemicals which should not be mixed or stored near each other

Do not contact:	With:
Alkali Metals	Water, carbon dioxide, calcium, potassium, carbon tetrachloride, sodium, and other chlorinated hydrocarbons
Acetic Acid	Chromic acid, nitric acid, hydroxyl containing compounds, ethylene glycol, perchloric acid, peroxides, and permanganates
Acetone	Concentrated sulfuric and nitric acid mixtures
Acetylene	Copper (tubing), fluorine, chlorine, iodine, silver, mercury, and their salts
Ammonium Nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, and finely divided organics or combustibles
Anhydrous Ammonia	Mercury, halogens, calcium hypochlorite, and hydrogen fluoride
Aniline	Nitric acid, hydrogen peroxide
Bromine	Ammonia, acetylene, butadiene, butane, hydrogen, sodium carbide, turpentine, and finely divided metals
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organics or combustibles, and carbon
Chromic Acid	Acetic acid, naphthalene, camphor, alcohol, glycerol, turpentine, and other flammable liquids
Chlorine	Ammonia, acetylene, butadiene, benzene and other petroleum fractions, hydrogen, sodium carbide, turpentine, and finely divided powdered metals
Cyanides	Acids
Hydrogen Sulfide	Nitric acid, oxidizing gases
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, and sodium peroxide
Iodine	Ammonia, acetylene, butadiene, benzene and other petroleum fractions, hydrogen, sodium carbide, turpentine, and finely divided powdered metals
Mercury	Acetylene, fulminic acid, and hydrogen
Nitric Acid	Acetic, chromic and hydrocyanic acids, aniline, carbon, hydrogen sulfide, flammable liquids or gases, and substances which are readily nitrated

Oxygen	Oils, grease, hydrogen, flammable liquids, solids or gases
Oxalic Acid	Silver and mercury
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, and other organic materials
Phosphorous Pentoxide	Water
Potassium Permanganate	Glycerol, ethylene glycol, benzaldehyde, and sulfuric acid
Sodium Peroxide	Any oxidizable substances, e.g., methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethylacetate, and furfural
Sulfuric Acid	Chlorates, perchlorates, permanganates, and water

Appendix B: Chemical Carcinogen List – List of carcinogens found in Safety with Chemical Carcinogens in Research and Teaching Manual

Appendix C: Peroxide Forming Chemicals Management – List of Peroxide forming chemicals and expiration dates based on class

Appendix D: P-Listed Chemicals – Chemicals found in OSHA's P-list for hazardous chemical wastes

Appendix A: Chemical Compatibility List

Do not contact:	With:
Alkali Metals	Water, carbon dioxide, calcium, potassium, carbon tetrachloride, sodium, and other chlorinated hydrocarbons
Acetic Acid	Chromic acid, nitric acid, hydroxyl containing compounds, ethylene glycol, perchloric acid, peroxides, and permanganates
Acetone	Concentrated sulfuric and nitric acid mixtures
Acetylene	Copper (tubing), fluorine, chlorine, iodine, silver, mercury, and their salts
Ammonium Nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, and finely divided organics or combustibles
Anhydrous Ammonia	Mercury, halogens, calcium hypochlorite, and hydrogen fluoride
Aniline	Nitric acid, hydrogen peroxide
Bromine	Ammonia, acetylene, butadiene, butane, hydrogen, sodium carbide, turpentine, and finely divided metals
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organics or combustibles, and carbon
Chromic Acid	Acetic acid, naphthalene, camphor, alcohol, glycerol, turpentine, and other flammable liquids
Chlorine	Ammonia, acetylene, butadiene, benzene and other petroleum fractions, hydrogen, sodium carbide, turpentine, and finely divided powdered metals
Cyanides	Acids
Hydrogen Sulfide	Nitric acid, oxidizing gases
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, and sodium peroxide
Iodine	Ammonia, acetylene, butadiene, benzene and other petroleum fractions, hydrogen, sodium carbide, turpentine, and finely divided powdered metals
Mercury	Acetylene, fulminic acid, and hydrogen
Nitric Acid	Acetic, chromic and hydrocyanic acids, aniline, carbon, hydrogen sulfide, flammable liquids or gases, and substances which are readily nitrated
Oxygen	Oils, grease, hydrogen, flammable liquids, solids or gases
Oxalic Acid	Silver and mercury
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, and other organic materials

Phosphorous Pentoxide	Water
Potassium Permanganate	Glycerol, ethylene glycol, benzaldehyde, and sulfuric acid
Sodium Peroxide	Any oxidizable substances, e.g., methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethylacetate, and furfural
Sulfuric Acid	Chlorates, perchlorates, permanganates, and water

Appendix B: Chemical Carcinogen List

Examples of chemical carcinogens, potential carcinogens and tumor promoters as listed in the Safety with Chemical Carcinogens in Research and Teaching Manual.

- N acetoxy 2 acetamidofluorene
- N acetoxy 2 acetamidostilbene
- N acetoxy 4 acetamidobiphenyl
- N acetoxy N acetamidophenanthrene
- 2 acetylaminofluorene
- acrylonitrile
- actinomycin D
- adriamycin
- aflatoxins
- aldrin
- alkanes (certain long chain ones)
- allyl methylsulfonate
- alpha,alpha dichloromethyl methyl ether
- anthralin
- 2 aminoanthraquinone
- 4 aminobiphenyl
- 1 amino 2 methylanthraquinone
- amitrole
- o anisidine
- o anisidine hydrochloride
- aramite
- arsenic and certain arsenic compounds
- asbestos
- auramine (technical grade)
- azathioprine
- benz[a]anthracene
- 3,3' dichlorobenzidine and its salts
- dieldrin
- dienestrol
- diepoxybutane
- 1,2,4,7 diepoxyhexane
- 1,2,4,5 diepoxypentane
- di(2,3 epoxypropyl) ether (DGE)
- di(2 ethylhexyl)phthalate
- diethylstilbestrol (DES)
- diethyl sulfate
- dihydroteleocidin B
- 3,3' dimethoxybenzidine
- 4 dimethylaminoazobenzene
- dimethylcarbamoyl chloride
- 1,1' dimethyl hydrazine
- dimethyl sulfate
- 1,4 dioxane
- direct black 38, technical
- direct blue 6, technical
- direct brown 95, technical
- epichlorohydrin
- 1,2 epoxybutyronitrile
- estradiol 17B
- estrone
- ethinylestradiol
- ethylene dibromide (EDB)
- 5 nitro o anisidine
- N (4 nitro)benzoyloxypiperadine
- 4 nitrobiphenyl
- nitrofen
- nitrogen mustard
- 2 nitropropane
- 4 nitroquinoline N oxide
- N nitrosodimethylamine
- N nitrosodi n butylamine
- N nitrosodiethanolamine
- N nitrosodiethylamine
- N nitrosodimethylamine
- p nitrosodiphenylamine
- N nitrosodi n propylamine
- N nitroso n ethylurea
- N nitroso n methylurea
- N nitrosomethylvinylamine
- N nitrosomorpholine
- N nitrosonornicotine
- N nitrosopiperidine
- N nitrosopyrrolidine
- N nitrososarcosine
- norethisterone
- oxymetholone
- pentachloronitrobenzene
- phenactin

benzene
benzidine and benzidine based dyes
benzo[c]chrysene
benzo[b]fluoranthene
benzo[j]fluoranthene
benzo[k]fluoranthene
benzo[g,h,I]perylene
benzo[O]phenanthrene
benzo[a]pyrene
benzotrichloride
benzoyl peroxide
beryllium and certain beryllium compounds
N,N bis(2 chloroethyl) 2 naphthylamine
bischloroethyl nitrosourea (BCNU)
bischloromethyl ether (BCME)
7 bromomethylbenz[a]anthracene
3 bromopropionic acid
1,3 butadiene
1,4 butanediol dimethane sulfonate
N butyl N nitrosourethane
cadmium and certain cadmium compounds
carbon black
carbon tetrachloride
carrageenan (degraded)
chlorambucil
chloramphenicol

ethylene dichloride (EDC)
ethyleneimine
ethylene oxide
ethylene thiourea
ethyl methanesulfonate
1 ethyl 1 nitrosourea
euphorbia lattices (certain ones)
fatty acids and fatty acid methyl esters (certain ones)
1 fluoro 2,4 dinitrobenzene
formaldehyde
2 (2 furyl) 3 (5 nitro 2 furyl) acrylamide
glycidaldehyde
gyromitrin
hexachlorobenzene
hexachlorobutadiene
hexachloroethane
hexamethyl phosphoramide
hydrazine
hydrazine sulfate
hydrazobenzene
hexachlorobutadiene
hexachloroethane
N hydroxy 2 aminoaphthalene
beta hydroxy 1 ethylaziridine
ICR 170
indeno[1,2,3 cd]pyrene

phenazopyridine
phenazopyridine hydrochloride
phenolic compounds (certain ones)
phenoxyacetic acid herbicides
N phenyl beta naphthylamine
phenylhydrazine
phenytoin
phorbol 12,13 dibenzoate
phorbol 12,13 didecanoate
polybrominated biphenyls (PBB)
polychlorinated biphenyls (PCB)
procarbazine
procarbazine hydrochloride
progesterone
propane sultone
beta propiolactone
propyleneimine
propylthiouracil
reserpine
12 O retinoylphorbol 13 acetate
saccharin
safrole
selenium sulfide
sodium lauryl sulfate
soots, tars, and mineral oils
sterigmatocystin

chloroacetone
1 (2 chloroethyl) 3 cyclohexyl 1 nitrosourea (CCNU)
chloroethylene oxide
chloroform
chloromethyl methyl ether (technical grade)
chlorophenols
chloroprene
chromium and certain chromium compounds
chrysarobin
chrysene
cisplatin
citrus oils
coal gasification
coal liquefaction
coal tar products
coal tar pitch volatiles
coke oven emissions
coke production
conjugated estrogens
p cresidine
croton oil
cupferron
cycasin
iodoacetic acid
iron dextran complex
kepone (chlordecone)
lead acetate
lead phosphate
lindane and other hexachlorocyclohexane isomers
malonaldehyde
melphalan
mestranol
7 methylbenz[a]anthracene
methyl bromide
methyl chloride
3 methylcholanthrene
5 methylchrysene
11 methylcyclopenta[a]phenanthren 17 one
4,4' methylenebis(2 chloroaniline) (MOCA)
4,4' methylenebis(n,n dimethyl) benzenamine
4,4' methylene dianiline
methyl hydrazine
methyl iodide
methyl methanesulfonate
N methyl N' nitro N nitrosoguanidine
4 O methyl tetradecanoylphorbol 13 acetate
streptozotocin
sulfallate
teleocidin
2,3,7,8 tetrachlorodibenzo p dioxin (TCDD)
1,1,2,2 tetrachloroethane
tetrachloroethylene
2,3,4,5 tetrachloronitrobenzene
2,3,4,6 tetrachloronitrobenzene
2,3,5,6 tetrachloronitrobenzene
12 O tetradecanoylphorbol 13 acetate
thioactamide
thiourea
thorium dioxide
tobacco extracts and condensates
o tolidine
o toluidine
o toluidine hydrochloride
p toluidine
toxaphene
trenimone
treosulphan
1,1,3 trichloroethane
2,4,6 trichlorophenol

cyclophosphamide
dacarbazine
DDT
2,4 diaminoanisole and its salts
2,4 diaminotoluene
dibenz[a,h]acridine
dibenz[a,j]acridine
dibenz[a,h]anthracene
7H dibenzo[c,g]carbazole
dibenzo[a,j]anthracenen
dibenzo[a,c]naphthacene
dibenzo[a,e]pyrene
dibenzo[a,h]pyrene
dibenzo[a,i]pyrene
dibenzo[a,l]pyrene
1,2 dibrom 3 chloropropane (DBCP)
N (4 methoxy)benzoyloxypiperadine
N methyl N' nitro N nitrosoguanidine
metronidazole
mezerein
michler's ketone
mineral oils
mirex
mitomycin C
mustard gas
alpha naphthylamine
beta naphthylamine
nickel carbonyl
nickel and certain nickel compounds
nickel sulfide roasting, fume and dust
nitrilotriacetic acid
trichlroethylene
triethylenemelamine
tris(aziridinyl) p benzoquinone
tris(aziridinyl)phosphine sulfide
tris(2,3 dibromopropyl)phosphate
tryptophane P1
tryptophane P2
Tween 60
uracil mustard
urethane
vinyl bromide
vinyl carbamate
vinyl chloride
vinyl cyclohexene dioxide
vinyl fluoride
vinylidene chloride
vinylidene fluoride monomer

Appendix C: Peroxide Forming Chemicals Management

Class A - Severe Peroxide Hazard

Spontaneously decompose and become explosive with exposure to air without concentration. Test for peroxide formation before using or discard 3 months after opening or at the expiration date on the container if unopened. If a container of a Class A peroxide is past its expiration date, or if the presence of peroxides is suspected or proven, do not attempt to open the container.

Chemical Name	CAS Number
Butadiene (liquid monomer)	106-99-0
Chloroprene (liquid monomer)	126-99-8
Divinyl ether	109-93-3
Isopropyl ether	108-20-3
Potassium amide	17242-52-3
Potassium metal	7440-09-7
Sodium amide (sodamide)	7782-92-5
Tetrafluoroethylene (liquid monomer)	116-14-3
Vinylidene chloride	75-35-4

Class B - Concentration Hazard

Require external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated. Test these for peroxide formation before distillation or evaporation. Maintain a testing program/schedule to test for peroxide formation or discard 1 year after opening or at the expiration date on the container if unopened.

Chemical Name	CAS Number
Acetal	105-57-7
Acetaldehyde	75-07-0
Benzyl alcohol	100-51-6
2-Butanol	78-92-2
Cumene	98-82-8
Cyclohexanol	108-93-0
2-Cyclohexen-1-ol	822-67-3

Cyclohexene	110-83-8
Decahydronaphthalene (decalin)	91-17-8
Diacetylene (butadine, gas)	460-12-8
Dicyclopentadiene	77-73-6
Diethyl ether (ether)	60-29-7
Diethylene glycol dimethyl ether (diglyme)	111-96-6
Dioxanes	N/A
Ethylene glycol ether acetates (glyme)	110-71-4
Furan	100-00-9
4-Heptanol	589-55-9
2-Hexanol	626-93-7
Methyl cyclopentane	96-37-7
Methyl isobutyl ketone	108-10-1
3-Methyl-1-butanol	123-51-3
4-Methyl-2-pentanol	108-11-2
Methylacetylene (gas)	74-99-7
Other secondary alcohols	N/A
2-Pentanol	6032-29-7
4-Penten-1-ol	821-09-0
1-Phenylethanol	98-85-1
2-Phenylethanol	60-12-8
Tetrahydrofuran (THF)	109-99-9
Tetrahydronaphthalene (tetralin)	119-64-2
Vinyl ethers	N/A

Class C - Shock and Heat Sensitive

Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock- and heat-sensitive. Materials should be disposed of 1 year after opening or at the expiration date on the container if unopened.

Chemical Name	CAS Number
Acrylic acid	79-10-7
Acrylonitrile	107-13-1
Butadiene (gas)	106-99-0
Chlorobutadiene	184963-09-5
Chloroprene	126-99-8
Chlorotrifluoroethylene (gas)	79-38-9
Methyl methacrylate	80-62-6
Styrene	100-42-5
Tetrafluoroethylene (gas)	116-14-3
Vinyl acetate	108-05-4
Vinyl chloride (gas)	75-01-4
Vinyl pyridine	100-69-6; 100-43-6
Vinylacetylene (gas)	689-97-4
Vinyldiene chloride	75-35-4

Class D

Materials that do not fit within Group A or B, but require special handling.

Chemical Name	CAS Number
Acrolein	107-02-8
Allyl ether	557-40-4
Allyl ethyl ether	557-31-3
Allyl phenyl ether	1746-13-0
n-Amyl ether	693-65-2
p-(n-Amyloxy)benzoyl chloride	36823-84-4
Benzyl ether	103-50-4
Benzyl ethyl ether	539-30-0
Benzyl methyl ether	538-86-3

Benzyl n-butyl ether	588-67-0; 3459-80-1
Benzyl-1-napthyl ether	613-62-7
Bis(2-(methoxyethoxy)ethyl) ether	143-24-8
1,2-Bis(2-chloroethoxyl)ethane	112-26-5
Bis(2-chloroethyl) ether	111-44-4
Bis(2-ethoxyethyl) adipate	109-44-4
Bis(2-ethoxyethyl)ether	112-36-7
Bis(2-methoxyethyl) carbonate	626-84-6
Bis(2-methoxyethyl) ether	119-96-6
Bis(2-methoxyethyl) phthalate	117-82-8
Bis(2-methoxymethyl) adipate	109-44-4
Bis(2-n-butoxyethyl) phthalate	117-83-9
Bis(2-phenoxyethyl) ether	622-87-7
Bis(4-chlorobutyl) ether	6334-96-9
Bis(chloromethyl) ether	542-88-1
2-Bromomethyl ethyl ether	13057-17-5
beta-Bromophenetole	596-10-6
o-Bromophenetole	593-19-7
p-Bromophenetole	588-96-5
3-Bromopropyl phenyl ether	588-63-6
tert-Butyl methyl ether	1634-04-4
n-Butyl phenyl ether	1126-79-0
n-Butyl vinyl ether	111-34-2
Chloroacetaldehyde diethylacetal	107-20-0; 107-30-2
2-Chlorobutadiene	126-99-8
1-(2-Chloroethoxy)-2-phenoxyethane	2243-44-9
Chloroethylene	75-01-4
Chloromethyl methyl ether	107-30-2

beta-Chlorophenetole	614-72-2
o-Chlorophenetole	143-24-8
p-Chlorophenetole	622-61-7
Cyclooctene	931-88-4; 931-87-3
Cyclopropyl methyl ether	540-47-6
p-Di-n-butoxybenzene	75942-37-9
Di-n-propoxymethane	505-84-0
Di(1-propynl) ether	111-43-4
Di(2-propynl) ether	
Diallyl ether	557-40-4
p-Dibenzyloxybenzene	621-91-0
1,2-Dibenzyloxyethane	622-22-0
1,2-Dichloroethyl ethyl ether	623-46-1
2,4-Dichlorophenetole	5392-86-9
Diethoxybenzene (m-,o-,p-)	2168-54-9
1,2-Diethoxyethane	629-14-1
Diethoxymethane	462-95-3
2,2-Diethoxypropane	126-84-1
Diethyl acetal	105-57-7
Diethyl ethoxymethylenemalonate	87-13-8
Diethyl fumarate	623-91-6
Diethylketene	96-22-0
1,1-Dimethoxyethane	534-15-6
Dimethoxymethane	109-87-5
1,2-Epoxy-3-isopropoxypropane	4016-14-2
1,2-Epoxy-3-phenoxypropane	122-60-1
1-Ethoxy-2-propyne	
p-Ethoxyacetophenone	1676-63-7

1-(2-Ethoxyethoxy)ethyl acetate	
2-Ethoxyethyl acetate	111-15-9
(2-Ethoxyethyl)-a-benzoyl benzoate	604-63-7
1-Ethoxynaphthalene	5328-01-8; 75440-80-1
o,p-Ethoxyphenyl isocyanate	5395-71-1
3-Ethoxypropionitrile	2141-62-0
Ethyl vinyl ether	109-92-2
Ethyl-b-ethoxypropionate	763-69-9
2-Ethylacrylaldehyde oxime	99705-27-8
2-Ethylbutanol	97-95-0
Ethylene glycol monomethyl ether	109-86-4
2-Ethylhexanal	123-05-7
4,5-Hexadien-2-yn-1-ol	2749-79-3
2,5-Hexadiyn-1-ol	28255-99-4
n-Hexyl ether	112-58-3
o.p-Iodophenetole	
Isoamyl benzyl ether	109-53-5
Isoamyl ether	544-01-4
Isobutyl vinyl ether	109-53-5
Isophorone	78-59-1
b-Isopropoxypropionitrile	110-47-4
Isopropyl-2,4,5-trichlorophenoxy acetate	93-78-7
3-Methoxy-1-butyl acetate	4435-53-4
Methoxy-1,3,5,7-cyclooctatetraene	
2-Methoxyethanol	32718-54-0; 109-86-4
3-Methoxyethyl acetate	
2-Methoxyethyl vinyl ether	111-96-6
b-Methoxypropionitrile	110-67-8

n-Methylphenetole	202-507-4
2-Methyltetrahydrofuran	96-47-9
m-Nitrophenetole	
1-Octene	173994-67-7; 25377-83-7; 111-66-0
Oxybis(2-ethyl acetate)	628-68-2
Oxybis(2-ethyl benzoate)	56-35-9
b,b-Oxydipropionitrile	
1-Pentene	25377-72-4; 109-67-1
Phenoxyacetyl chloride	211-862-4
a-Phenoxypropionyl chloride	122-35-0
Phenyl-o-propyl ether	
p-Phenylphenetone	
n-Propyl ether	111-43-7
n-Propyl isopropyl ether	627-08-7
Sodium 8-11-14-eicosatetraenoate	
Sodium ethoxyacetylide	73506-39-5
1,1,2,3-Tetrachloro-1,3-butadiene	921-09-5
Tetrahydropyran	142-68-7
Triethylene glycol diacetate	111-21-7
Triethylene glycol dipropionate	n/a
1,3,3-Trimethoxypropene	17576-35-1
4-Vinyl cyclohexene	100-40-3
Vinylene carbonate	872-36-6

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Acknowledgement:

KSU Environmental Health and Safety acknowledges the assistance of the UC Santa Cruz Office of Environmental Health & Safety, whose webpage (https://ehs.ucsc.edu/lab-safety-manual/index.html) has served as useful resources.

Appendix D: P-Listed Chemicals

P-listed hazardous wastes include:

a) residue remaining in a container or inner liner that held one of these chemicals,
b) discarded commercial chemical products, manufacturing chemical intermediates,
c) off-specification commercial chemical products or manufacturing chemical intermediates, and
d) spill residues or debris resulting from spill cleanup of one of these chemicals.

The list is in alphabetical order by material name. Each listed hazardous waste is assigned a hazardous waste code which precedes the name of the waste.

Hazardous waste No.	**Chemical abstracts No.**	**Substance**
P023	107–20–0	Acetaldehyde, chloro-
P002	591–08–2	Acetamide, N-(aminothioxomethyl)-
P057	640–19–7	Acetamide, 2-fluoro-
P058	62–74–8	Acetic acid, fluoro-, sodium salt
P002	591–08–2	1-Acetyl-2-thiourea
P003	107–02–8	Acrolein
P070	116–06–3	Aldicarb
P203	1646–88–4	Aldicarb sulfone.
P004	309–00–2	Aldrin
P005	107–18–6	Allyl alcohol
P006	20859–73–8	Aluminum phosphide (R,T)
P007	2763–96–4	5-(Aminomethyl)-3-isoxazolol
P008	504–24–5	4-Aminopyridine
P009	131–74–8	Ammonium picrate (R)
P119	7803–55–6	Ammonium vanadate
P099	506–61–6	Argentate(1-), bis(cyano-C)-, potassium
P010	7778–39–4	Arsenic acid H_3AsO_4
P012	1327–53–3	Arsenic oxide As_2O_3
P011	1303–28–2	Arsenic oxide As_2O_5

P011	1303–28–2	Arsenic pentoxide
P012	1327–53–3	Arsenic trioxide
P038	692–42–2	Arsine, diethyl-
P036	696–28–6	Arsonous dichloride, phenyl-
P054	151–56–4	Aziridine
P067	75–55–8	Aziridine, 2-methyl-
P013	542–62–1	Barium cyanide
P024	106–47–8	Benzenamine, 4-chloro-
P077	100–01–6	Benzenamine, 4-nitro-
P028	100–44–7	Benzene, (chloromethyl)-
P042	51–43–4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-
P046	122–09–8	Benzeneethanamine, alpha,alpha-dimethyl-
P014	108–98–5	Benzenethiol
P127	1563–66–2	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.
P188	57–64–7	Benzoic acid, 2-hydroxy-, compd. with (3aS-cis)-1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo[2,3-b]indol-5-yl methylcarbamate ester (1:1).
P001	[1]81–81–2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%
P028	100–44–7	Benzyl chloride
P015	7440–41–7	Beryllium powder
P017	598–31–2	Bromoacetone
P018	357–57–3	Brucine
P045	39196–18–4	2-Butanone, 3,3-dimethyl-1-(methylthio)-, O-[(methylamino)carbonyl] oxime
P021	592–01–8	Calcium cyanide
P021	592–01–8	Calcium cyanide $Ca(CN)_2$

P189	55285–14–8	Carbamic acid, [(dibutylamino)- thio]methyl-, 2,3-dihydro-2,2-dimethyl- 7-benzofuranyl ester.
P191	644–64–4	Carbamic acid, dimethyl-, 1-[(dimethyl-amino)carbonyl]- 5-methyl-1H-pyrazol-3-yl ester.
P192	119–38–0	Carbamic acid, dimethyl-, 3-methyl-1- (1-methylethyl)-1H- pyrazol-5-yl ester.
P190	1129–41–5	Carbamic acid, methyl-, 3-methylphenyl ester.
P127	1563–66–2	Carbofuran.
P022	75–15–0	Carbon disulfide
P095	75–44–5	Carbonic dichloride
P189	55285–14–8	Carbosulfan.
P023	107–20–0	Chloroacetaldehyde
P024	106–47–8	p-Chloroaniline
P026	5344–82–1	1-(o-Chlorophenyl)thiourea
P027	542–76–7	3-Chloropropionitrile
P029	544–92–3	Copper cyanide
P029	544–92–3	Copper cyanide Cu(CN)
P202	64–00–6	m-Cumenyl methylcarbamate.
P030		Cyanides (soluble cyanide salts), not otherwise specified
P031	460–19–5	Cyanogen
P033	506–77–4	Cyanogen chloride
P033	506–77–4	Cyanogen chloride (CN)Cl
P034	131–89–5	2-Cyclohexyl-4,6-dinitrophenol
P016	542–88–1	Dichloromethyl ether
P036	696–28–6	Dichlorophenylarsine
P037	60–57–1	Dieldrin
P038	692–42–2	Diethylarsine
P041	311–45–5	Diethyl-p-nitrophenyl phosphate

P040	297–97–2	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	55–91–4	Diisopropylfluorophosphate (DFP)
P004	309–00–2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a,-hexahydro-, (1alpha,4alpha,4abeta,5alpha,8alpha,8abeta)-
P060	465–73–6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abeta,5beta,8beta,8abeta)-
P037	60–57–1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta, 7aalpha)-
P051	[1]72–20–8	2,7:3,6-Dimethanonaphth [2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta, 7aalpha)-, & metabolites
P044	60–51–5	Dimethoate
P046	122–09–8	alpha,alpha-Dimethylphenethylamine
P191	644–64–4	Dimetilan.
P047	[1]534–52–1	4,6-Dinitro-o-cresol, & salts
P048	51–28–5	2,4-Dinitrophenol
P020	88–85–7	Dinoseb
P085	152–16–9	Diphosphoramide, octamethyl-
P111	107–49–3	Diphosphoric acid, tetraethyl ester
P039	298–04–4	Disulfoton
P049	541–53–7	Dithiobiuret
P185	26419–73–8	1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O- [(methylamino)-carbonyl]oxime.
P050	115–29–7	Endosulfan

P088	145–73–3	Endothall
P051	72–20–8	Endrin
P051	72–20–8	Endrin, & metabolites
P042	51–43–4	Epinephrine
P031	460–19–5	Ethanedinitrile
P194	23135–22–0	Ethanimidothioic acid, 2-(dimethylamino)-N-[[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester.
P066	16752–77–5	Ethanimidothioic acid, N-[[(methylamino)carbonyl]oxy]-, methyl ester
P101	107–12–0	Ethyl cyanide
P054	151–56–4	Ethyleneimine
P097	52–85–7	Famphur
P056	7782–41–4	Fluorine
P057	640–19–7	Fluoroacetamide
P058	62–74–8	Fluoroacetic acid, sodium salt
P198	23422–53–9	Formetanate hydrochloride.
P197	17702–57–7	Formparanate.
P065	628–86–4	Fulminic acid, mercury(2+) salt (R,T)
P059	76–44–8	Heptachlor
P062	757–58–4	Hexaethyl tetraphosphate
P116	79–19–6	Hydrazinecarbothioamide
P068	60–34–4	Hydrazine, methyl-
P063	74–90–8	Hydrocyanic acid
P063	74–90–8	Hydrogen cyanide
P096	7803–51–2	Hydrogen phosphide
P060	465–73–6	Isodrin
P192	119–38–0	Isolan.

P202	64–00–6	3-Isopropylphenyl N-methylcarbamate.
P007	2763–96–4	3(2H)-Isoxazolone, 5-(aminomethyl)-
P196	15339–36–3	Manganese, bis(dimethylcarbamodithioato-S,S′)-,
P196	15339–36–3	Manganese dimethyldithiocarbamate.
P092	62–38–4	Mercury, (acetato-O)phenyl-
P065	628–86–4	Mercury fulminate (R,T)
P082	62–75–9	Methanamine, N-methyl-N-nitroso-
P064	624–83–9	Methane, isocyanato-
P016	542–88–1	Methane, oxybis[chloro-
P112	509–14–8	Methane, tetranitro- (R)
P118	75–70–7	Methanethiol, trichloro-
P198	23422–53–9	Methanimidamide, N,N-dimethyl-N′-[3-[[(methylamino)-carbonyl]oxy]phenyl]-, monohydrochloride.
P197	17702–57–7	Methanimidamide, N,N-dimethyl-N′-[2-methyl-4-[[(methylamino)carbonyl]oxy]phenyl]-
P050	115–29–7	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
P059	76–44–8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P199	2032–65–7	Methiocarb.
P066	16752–77–5	Methomyl
P068	60–34–4	Methyl hydrazine
P064	624–83–9	Methyl isocyanate
P069	75–86–5	2-Methyllactonitrile
P071	298–00–0	Methyl parathion
P190	1129–41–5	Metolcarb.
P128	315–8–4	Mexacarbate.

P072	86–88–4	alpha-Naphthylthiourea
P073	13463–39–3	Nickel carbonyl
P073	13463–39–3	Nickel carbonyl $Ni(CO)_4$, (T-4)-
P074	557–19–7	Nickel cyanide
P074	557–19–7	Nickel cyanide $Ni(CN)_2$
P075	[1]54–11–5	Nicotine, & salts
P076	10102–43–9	Nitric oxide
P077	100–01–6	p-Nitroaniline
P078	10102–44–0	Nitrogen dioxide
P076	10102–43–9	Nitrogen oxide NO
P078	10102–44–0	Nitrogen oxide NO_2
P081	55–63–0	Nitroglycerine (R)
P082	62–75–9	N-Nitrosodimethylamine
P084	4549–40–0	N-Nitrosomethylvinylamine
P085	152–16–9	Octamethylpyrophosphoramide
P087	20816–12–0	Osmium oxide OsO_4, (T-4)-
P087	20816–12–0	Osmium tetroxide
P088	145–73–3	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
P194	23135–22–0	Oxamyl.
P089	56–38–2	Parathion
P034	131–89–5	Phenol, 2-cyclohexyl-4,6-dinitro-
P048	51–28–5	Phenol, 2,4-dinitro-
P047	[1]534–52–1	Phenol, 2-methyl-4,6-dinitro-, & salts
P020	88–85–7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
P009	131–74–8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P128	315–18–4	Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester).
P199	2032–65–7	Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate

P202	64–00–6	Phenol, 3-(1-methylethyl)-, methyl carbamate.
P201	2631–37–0	Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate.
P092	62–38–4	Phenylmercury acetate
P093	103–85–5	Phenylthiourea
P094	298–02–2	Phorate
P095	75–44–5	Phosgene
P096	7803–51–2	Phosphine
P041	311–45–5	Phosphoric acid, diethyl 4-nitrophenyl ester
P039	298–04–4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
P094	298–02–2	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
P044	60–51–5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
P043	55–91–4	Phosphorofluoridic acid, bis(1-methylethyl) ester
P089	56–38–2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P040	297–97–2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P097	52–85–7	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P071	298–00–0	Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester
P204	57–47–6	Physostigmine.
P188	57–64–7	Physostigmine salicylate.
P110	78–00–2	Plumbane, tetraethyl-
P098	151–50–8	Potassium cyanide
P098	151–50–8	Potassium cyanide K(CN)
P099	506–61–6	Potassium silver cyanide

P201	2631–37–0	Promecarb
P070	116–06–3	Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
P203	1646–88–4	Propanal, 2-methyl-2-(methyl-sulfonyl)-, O-[(methylamino)carbonyl] oxime.
P101	107–12–0	Propanenitrile
P027	542–76–7	Propanenitrile, 3-chloro-
P069	75–86–5	Propanenitrile, 2-hydroxy-2-methyl-
P081	55–63–0	1,2,3-Propanetriol, trinitrate (R)
P017	598–31–2	2-Propanone, 1-bromo-
P102	107–19–7	Propargyl alcohol
P003	107–02–8	2-Propenal
P005	107–18–6	2-Propen-1-ol
P067	75–55–8	1,2-Propylenimine
P102	107–19–7	2-Propyn-1-ol
P008	504–24–5	4-Pyridinamine
P075	[1]54–11–5	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts
P204	57–47–6	Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethyl-, methylcarbamate (ester), (3aS-cis)-.
P114	12039–52–0	Selenious acid, dithallium(1+) salt
P103	630–10–4	Selenourea
P104	506–64–9	Silver cyanide
P104	506–64–9	Silver cyanide Ag(CN)
P105	26628–22–8	Sodium azide
P106	143–33–9	Sodium cyanide
P106	143–33–9	Sodium cyanide Na(CN)
P108	[1]57–24–9	Strychnidin-10-one, & salts

P018	357–57–3	Strychnidin-10-one, 2,3-dimethoxy-
P108	[1]57–24–9	Strychnine, & salts
P115	7446–18–6	Sulfuric acid, dithallium(1+) salt
P109	3689–24–5	Tetraethyldithiopyrophosphate
P110	78–00–2	Tetraethyl lead
P111	107–49–3	Tetraethyl pyrophosphate
P112	509–14–8	Tetranitromethane (R)
P062	757–58–4	Tetraphosphoric acid, hexaethyl ester
P113	1314–32–5	Thallic oxide
P113	1314–32–5	Thallium oxide Tl_2O_3
P114	12039–52–0	Thallium(I) selenite
P115	7446–18–6	Thallium(I) sulfate
P109	3689–24–5	Thiodiphosphoric acid, tetraethyl ester
P045	39196–18–4	Thiofanox
P049	541–53–7	Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$
P014	108–98–5	Thiophenol
P116	79–19–6	Thiosemicarbazide
P026	5344–82–1	Thiourea, (2-chlorophenyl)-
P072	86–88–4	Thiourea, 1-naphthalenyl-
P093	103–85–5	Thiourea, phenyl-
P185	26419–73–8	Tirpate.
P123	8001–35–2	Toxaphene
P118	75–70–7	Trichloromethanethiol
P119	7803–55–6	Vanadic acid, ammonium salt
P120	1314–62–1	Vanadium oxide V_2O_5
P120	1314–62–1	Vanadium pentoxide
P084	4549–40–0	Vinylamine, N-methyl-N-nitroso-

P001	[1]81–81–2	Warfarin, & salts, when present at concentrations greater than 0.3%
P205	137–30–4	Zinc, bis(dimethylcarbamodithioato-S,S')-,
P121	557–21–1	Zinc cyanide
P121	557–21–1	Zinc cyanide $Zn(CN)_2$
P122	1314–84–7	Zinc phosphide Zn_3P_2, when present at concentrations greater than 10% (R,T)
P205	137–30-4	Ziram