University of Kentucky

Model
Chemical Hygiene Plan

Reviewed and approved
Chemical Safety Committee
September 2020

University of Kentucky

CHEMICAL HYGIENE PLAN

For

_____
Principal Investigator/Laboratory Supervisor
(Chemical Hygiene Officer)

_____
Department

_____
Room and Building

_____ _____
Campus Phone *After-hours Emergencies Phone*

Location of laboratories (specify all rooms in which hazardous materials are stored).

_____

_____

Authorized Personnel

Laboratory personnel: List all employees and students that use hazardous materials under your jurisdiction. Also indicate Laboratory Supervisor, if applicable, and his/her after-hours emergency telephone number.

Name	Status (e.g. research asst., student)
_____	_____
_____	_____
_____	_____
_____	_____

Name	Status (e.g. research asst., student)
_____	_____
_____	_____
_____	_____
_____	_____

_____ _ _____

Signature of Principal Investigator/Laboratory Supervisor (Chemical Hygiene Officer) *Date*

_____
Annual Revision Date

_____
Annual Revision Date

_____
Annual Revision Date

_____
Annual Revision Date

NOTE: Maintain the original copy of this form in the Laboratory Chemical Hygiene Plan binder.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

Purpose

The purpose of this model Chemical Hygiene Plan is to define work practices and procedures to help ensure that Laboratory Workers at the University of Kentucky are protected from health and safety hazards associated with the hazardous chemicals with which they work.

Background

The Chemical Hygiene Plan is part of the University's compliance with the regulations promulgated on January 31,1990 by the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) and adopted by Kentucky OSH. This standard entitled "Occupational Exposures to Hazardous Chemicals in Laboratories" is hereafter referred to as the Lab Standard. See Appendix I for information on obtaining or viewing a copy of the Lab Standard.

Overview

By OSHA regulations the Chemical Hygiene Plan must include:

- Standard Operating Procedures
- Criteria to determine and implement specific control measures, such as engineering controls and personal protective equipment
- An ongoing program to ensure that laboratory chemical hoods and other engineering controls are functioning properly
- Information and training requirements
- Circumstances under which a particular laboratory function will require "prior approval"
- Provisions for medical consultation and medical exams
- Designation of the Principal Investigator/Laboratory Supervisor as the Chemical Hygiene Officer
- Additional precautions for work with select carcinogens, reproductive toxins, and extremely toxic substances
- This model Chemical Hygiene Plan (referred to as the Plan throughout this document) will be reviewed annually by the institutional Chemical Hygiene Officer and/or the Chemical Safety Committee. Each laboratory's Chemical Hygiene Plan must be **reviewed annually** by the laboratory's

Chemical Hygiene Officer and the "revised date" must be listed on the Plan. [For discussion of Institutional Chemical Hygiene Officer and Chemical Hygiene Officer see Chapter 9].

- All Laboratory Workers, prior to the commencement of lab duties, must read this Chemical Hygiene Plan. In addition to the Plan, the Laboratory Workers must be familiar with and adhere to prudent laboratory safety guidelines developed by their Laboratory Supervisor, UK requirements and other relevant regulatory requirements (e.g. Radiation Safety).

- A written record stating that each Laboratory Worker has reviewed the Chemical Hygiene Plan and related health and safety policies and guides must be kept by the CHO and available for review upon inspection. (See Form I for an example of a training record form.)

Definitions

Hazardous Chemical - OSHA has defined a hazardous chemical as "a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees".

Laboratory - OSHA defines a laboratory as "a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis."

Lab workers - are employees. OSHA defines an employee as "an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments." An example of a Laboratory Worker would be a University teaching assistant, research assistant or faculty member instructing an academic lab. OSHA would not consider students in an academic laboratory as employees. However, as a matter of university policy, the principles outlined in this Chemical Hygiene Plan will apply to students in our laboratories. Also included, will be visiting professors and volunteers that might be working in the lab. Thus, Laboratory Supervisors must ensure that these groups that are in their laboratories are adequately instructed in relation to safe laboratory procedures.

Minors in Research Laboratories or Animal Facilities

Students under the age of 18, not enrolled as a University of Kentucky student, who wishes to do research in a lab must follow the Minors in Research Lab Policy and accompanying forms. The policy can be found at the following website https://ehs.uky.edu/docs/pdf/ohs_minors_in_labs_0001.pdf.

Assistance

If there is any question about where the Lab Standard applies and whom it covers, the Occupational Health and Safety Department, upon request, will make this determination. The University of Kentucky office of Environmental Health and Safety has professionals in several disciplines (e.g. Radiation Safety; Environmental Management; Fire Marshal; Occupational Health/Industrial Hygiene & Safety) that can be consulted related to laboratory safety. See Appendix II for an organizational chart.

CHAPTER 2

RESPONSIBILITIES

Background

The University of Kentucky is committed to providing a safe and healthful environment for all persons associated with the institution. The University intends to be a role model for the Commonwealth in its environmental stewardship, health protection and safety standards and its compliance with all laws and regulations relating to the environment, health, and safety. Management, faculty, staff, and students are asked to support these goals in all university activities and the University administration will provide the necessary resources to achieve these goals.

A vast array of educational activities and research utilizing hazardous materials is conducted at the university that requires cooperation of all parties involved to ensure that such activities are conducted safely with regard to workers, students, the community, and the environment. The following outlines specific responsibilities associated with laboratory safety and this Chemical Hygiene Plan.

Faculty and Staff in charge of supervising laboratories (referred to as Laboratory Supervisors throughout document) have the following responsibilities for implementing the Chemical Hygiene Plan:

- Inform and train employees concerning chemical safety as required by this Plan. Retain training records and all documentation
- Implement and enforce rules and standards of this plan concerning health and safety for laboratories under the supervisor's jurisdiction and restrict access to the laboratory (see Authorized Access in Chapter 3 "Standard Operating Procedures")
- Serve as the "Chemical Hygiene Officer" for his/her laboratories
- Ensure compliance of Laboratory Workers with this Plan
- Ensure the availability and enforce the proper use of appropriate personal protective equipment and relevant health and safety reference materials
- Remain cognizant of chemicals stored and used in labs and their associated hazards
- Reconcile the laboratory’s chemical inventory, annually (see Appendix IV for sample inventory form)

- Conduct internal inspections of labs for health and safety concerns and maintain an inspection log of inspection findings (see Appendix III for a sample self-inspection form. Also visit the website for the example table of laboratory violations https://ehs.uky.edu/ohs/inspections.php.

- Request assistance from Environmental Health and Safety, as needed

- Request allocation of funds from superiors for health and safety improvements as needed, or budget into research grant proposals

Laboratory Worker responsibilities regarding implementation of the Chemical Hygiene Plan:

- Follow all health and safety standards and rules

- Report all hazardous conditions to the Laboratory Supervisor

- Wear or use prescribed protective equipment

- Report any suspected job-related injuries or illnesses to the Laboratory Supervisor and seek treatment immediately

- Refrain from the operation of any equipment or instrumentation without proper instruction and authorization

- Remain aware of the hazards of the chemicals in the lab and how to handle hazardous chemicals safely

- Request information and training when unsure how to handle a hazardous chemical or procedure

Deans, Directors, and Heads of Academic and Administrative Units have the primary responsibility for the health and safety of their staff and students. Specific responsibilities regarding the implementation of the Chemical Hygiene Plan include:

- Collaborate with faculty and staff to adapt the Model Chemical Hygiene Plan to include lab-specific guidelines and to develop strategies to implement the Plan.

- Consider the idea of developing departmental-wide laboratory safety training programs, committees, and shared use facilities.

- Make budget arrangements for health and safety improvements. It is the responsibility of these respective individuals to request the necessary monies in the budget process

Environmental Health and Safety Department responsibilities include the following:

- Appoint an Institutional Chemical Hygiene Officer who will routinely review the model Chemical Hygiene Plan and suggest modifications as needed
- Provide technical assistance to Laboratory Supervisors and workers concerning appropriate storage, handling, and disposal of hazardous chemicals
- Provide general laboratory safety training upon request
- Conduct exposure assessments and laboratory inspections upon request and on a routine basis
- Provide technical assistance concerning personal protective equipment and laboratory safety equipment; and
- Remain current on rules and regulations concerning chemicals used on campus.

CHAPTER 3

STANDARD OPERATING PROCEDURES

Purpose
The Lab Standard requires operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals. This Plan represents a minimum set of guidelines for UK laboratories handling hazardous chemicals.

Background
The Lab Standard is intentionally vague about SOPs. Individual administrative units, laboratories or research groups are required to develop more detailed procedures as the situation arises. These procedures must be written, added to the laboratory's Chemical Hygiene Plan, and made available to Laboratory Workers. To assist in the development of SOPs Form IV can be used. Acceptable lab safety references such as those listed in the OSHA Lab Standard may be adopted in whole or may be useful in developing additional procedures. In all situations, individual faculty or staff will be responsible for enforcing adequate safety and hygiene measures in laboratories they supervise. If necessary, additional assistance from Environmental Health and Safety is available.

Hierarchy of Defense
To protect workers from exposure to hazardous chemicals there is a hierarchy of defense. At the top of the hierarchy are engineering controls. Engineering controls consist of general room ventilation and most notably in laboratories, fume hoods. The second is work practice/administrative controls and finally, personal protective equipment (PPE). It is imperative that all lab personnel know what PPE is appropriate for all operations in the lab, what work practices are to be followed and then to understand how the engineering controls work.

The following standard operating procedures apply to all labs at the University. Your lab may require additional requirements as determined by a hazard evaluation.

Personal Protective Equipment

Attire Proper attire must be worn in the laboratory. All lab personnel must be wearing a lab coat when there is active work being done with hazardous materials such as biologicals, chemicals, radiologicals and physical hazards. Legs and feet must be covered, i.e. no open toed shoes. Legs must be covered to at least ankle length. Nylon hoses and tights are not considered appropriate attire. Loose clothing and long hair must be confined. Additionally, to enter the lab, eye protection must be worn. This includes all laboratory personnel as well as visitors. PPE must be left in the laboratories and not worn in public areas.

Modification to this attire policy can be requested by contacting Occupational Health and Safety at 257-1376.

Eye Protection It is University of Kentucky policy that any University personnel including Students, Faculty, Staff and visitors shall wear appropriate safety glasses at all times when work is being conducted in the lab with hazardous materials as determined by the Assessment Chart and Hazardous Waste Identification Chart Index. The wearing of **contact lenses** in labs has been a controversial issue. Most research has shown there is no greater risk when wearing contact lenses. Contact your optometrist or ophthalmologist for additional questions.

Face Shields Full-face shields must be worn when conducting a procedure where splashing of corrosive or injurious material is a potential. Face shields must be worn when working with >4 liters of corrosive liquid. Full-face shields with bottom caps to protect under the chin are preferred due to the tendency to raise the chin when a splash occurs.

Footwear All footwear must cover the entire foot, be slip resistant and be made of impermeable material (e.g. leather). Perforated shoes do not provide adequate protection against spilled materials.

Gloves Most laboratories will require more than one type of glove material. Latex examination gloves are not meant to provide protection from chemicals and should not be used in labs for this purpose. Nitrile is a good all-purpose glove material and has less of an issue for allergic reactions. Appendix IV offers some generic information for glove selection. Your glove supplier can also provide information. When working with highly hazardous chemicals that can be absorbed through the skin, specific glove testing information should be obtained from the manufacturer. Written information needs to be provided to all lab workers preferably in the form of an SOP, Form IV. Occupational Health and Safety (257-2924) can provide additional assistance in appropriate selection.

Gloves shall not be worn in halls or public areas. When samples are transferred through general use areas, a secondary container is recommended. If a sample must be carried by hand, glove one hand to hold a protected sample. The ungloved hand shall be used to open doors or push elevator buttons. In the lab be aware of using common equipment with gloved hands such as computers and phones.

Lab Coats and Aprons The primary purpose of a lab coat is to protect against splashes and spills. A lab coat shall be nonflammable, where necessary. A lab coat should fit properly and should be easily removed. Lab coats shall be buttoned when in use. Lab coats shall be clean. If a coat becomes

contaminated remove immediately. Lab coats shall never be taken home to be laundered. A lab coat can be laundered in a work-related on-site washer and dryer. Also, a laundry service, typically handled by the department, can be used. Contact your supervisor if you have questions.

If working with flammable materials, such as pyrophorics, a flame-resistant lab coat is required.

Rubber coated aprons may be needed for work with corrosive chemicals, depending on the specific tasks to be done.

The chart below can help establish the appropriate lab coat needed in the lab.

Task	**Material Needed**
General Lab Work	100% Cotton Lab coat
>4 Liters of Corrosive Material	Rubber Coated apron
Pyrophoric Materials	Flame resistant lab coat

Respiratory Protection The use of some substances may require respirators. See Chapter 4 for a discussion of "Controlling Chemical Exposures". Any use of respiratory protection in the lab requires prior approval from OHS. Please contact the Institutional Chemical Hygiene Officer.

HAZARD ASSESSMENT AND PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS FOR GENERAL LABORATORY OPERATIONS

Hazard	Personal Protective Equipment Required		
	Eye	**Face**	**Hand/Skin/ Body**
Any laboratory use of chemicals	Safety glasses always		Lab coat
Use of corrosive chemicals, strong oxidizing agents, carcinogens, mutagens, etc.	Chemical splash goggles	Full face shield and goggles (for work with >4 liters of corrosive liquids)	Resistant gloves (See Appendix VI for chemical resistance of common glove materials) Impervious lab coat, coveralls, apron, protective suit (for work with >4 liters corrosive liquids)
Temperature extremes	Safety glasses always		Insulated gloves for handling ovens, furnaces, cryogenic baths, and other devices over 100° C or below -1° C
Sharp objects (broken glass, insertion of tubes or rods into stoppers)	Safety glasses always		Heavy cloth barrier or leather gloves

Work Practice and Administrative Controls

Authorized Access The laboratory supervisor must restrict access to laboratories. If the lab is not attended the entry door should be locked. Children (under age 17) are not allowed in laboratories except as authorized by the laboratory supervisor for an officially sanctioned activity (e.g. class or open house). Pets are also prohibited from laboratories.

Broken Glassware Broken glassware cannot be disposed of in the regular garbage. It should be placed in a box with a plastic liner so that no shards can present a hazard when disposing of the entire container. Do not overfill the container; keep it under 30 pounds.

Chemical Handling Encourage the use of poly coated bottles or use bottle carriers for transporting chemicals that are in regular glass containers. Close caps securely and avoid storing chemical containers in hard to reach areas. Pour chemicals carefully, and never add water to concentrated acid. Metal containers and non-conductive containers (e.g., glass or plastic) holding more than five gallons must be grounded when transferring flammable liquids.

Chemical Inventory An annual updated chemical inventory is required for all laboratories on campus. The University is using the Chematix Chemical Management Software system. Please see Form II for more information. For questions please notify Robert Thomas 257-4016.

Chemical Spills and Accident Response As a matter of policy, University personnel should handle their own small spills and releases. For emergency situations i.e., large spills and leaks, evacuate and call 911 (Campus Police) from a safe location. See Chapter 11, Planning for Emergencies for more information.

Chemical Storage A chemical is considered to be in storage when the chemical is not in active use. A chemical in storage should be stored in appropriate container such as a glass or plastic container with a secure tight-fitting lid. Round bottom flasks are not considered proper storage containers. Parafilm and aluminum foil are not considered to be secure lids.

Chemicals should be stored by compatibility, not simply by alphabetical arrangement. Oxidizers should be separated from organics, air/water reactives must be kept dry and cyanides should be stored away from acids. (See Appendix V for examples of incompatible chemicals).

> **Flammable liquids** including hazardous waste shall be limited to 10 gallons per 100 ft^2. Half that amount must be in a flammable storage cabinet. Please review fact sheet at https://ehs.uky.edu/fire/flstpol1.html.

Cold Storage of flammables in a refrigerator are prohibited unless it is approved for such storage. Such refrigerators are designed not to spark inside the refrigerator. If refrigerated storage is needed, choose either a flammable safe or explosion proof refrigerator. More information about the different types of refrigerators can be found at the following web page, https://ehs.uky.edu/docs/pdf/ohs_refrigerators.pdf.

Peroxide forming chemicals shall be labeled when received and opened, then disposed of by the manufacturer's recommendation or within a specified time as discussed here: https://www.as.uky.edu/sites/default/files/Peroxide%20Former%20Guideline_0.pdf .

Containers Check the integrity of containers and if damaged or leaking, transfer to an acceptable container or call Environmental Management for assistance (323-6280). For disposal, complete an E-Trax waste pickup request and submit to Environmental Management. Observe chemical compatibility; for example, hydrofluoric acid must not be stored in glass and some oxidizers should not be stored in plastic containers.

Cylinder Handling and Storage: https://ehs.uky.edu/ohs/cgc2.html

General Transport of Cylinders

- Transport cylinders by hand truck, do not roll, drag, or slide cylinder
- Secure cylinder to hand cart
- Move cylinders with valve caps in place
- Move extremely toxic chemicals (e.g. hydrogen sulfide, chlorine, and arsine) during off hours if possible

General Storage of Cylinders

- Secure cylinders to a wall or immovable object always
- Secure cylinders upright, with either a valve cap or gauge on the cylinder
- Store cylinders in a well-ventilated area
- Separate empty and full cylinders
- Secure cylinders according to compatibilities

General Use of Cylinders

- Match regulator with the cylinder
- Use the appropriate tubing
- Use appropriate PPE when needed

Other Considerations

- Contact manufacture for information on use and compatible materials
- Cylinders must be added to UK's chemical inventory system, Chematix: https://etrax.chematix.com/Chematix/more details on page 112)

- For storage and use of flammable gasses, contact the Fire Marshal, 257-6326.

Disposal of Waste It is important to segregate waste. To request pickup of hazardous, biohazardous or chemical waste, call Environmental Management at 323-6280 or complete an E-Trax waste pickup request (https://etrax.chematix.com/Chematix/). Disposal of all laboratory waste must follow the procedures specified by Environmental Management: https://ehs.uky.edu/env/waste_management.php. To request pickup of radioactive wastes, contact Radiation Safety at 323-6780.

The Hazardous Waste Contingency Plan is a useful reference guide regarding Hazardous Waste Contingency Plan areas that accumulate hazardous waste (Satellite Accumulation Areas (SAA's). This plan also outlines Emergency Action Plans (BEAP) involving hazardous waste: https://ehs.uky.edu/env/media/contingency-plan-quick-reference-guide.pdf.

Door View Panel Laboratory door view panel should not be covered.

Electrical Policy Extension cords shall not be used as permanent wiring. Only Underwriters Laboratory (UL) listed surge protectors that are ground and have a built-in 15-amp circuit may be used. For more information regarding UK's Electrical Policy: https://ehs.uky.edu/fire/electrical.html.

.

Equipment Use proper equipment that is in good condition. For example, never use chipped or cracked glassware. Never modify electrical equipment outside of the manufacturer's specification. Use flammables with only approved equipment such as blenders. Flammables that require cooler temperatures for storage should be put in specific refrigerators/freezers. One is referred to as flammable safe and has no exposed ignition sources inside the cabinet, such as lights or switches that could ignite vapors. These are less expensive than the explosion-proof refrigerators/freezers and would be adequate in most lab applications. The other type of refrigerator/freezer is referred to as explosion-proof. This type may be required in rare circumstances for hazardous locations. Explosion-proof or spark-proof units have no interior or exterior ignition sources and are considerably more expensive. For more information on selection of a flammable safe or explosion proof refrigerator, refer to the Cold Storage section on the previous page.

Food, Drink, Cosmetics Eating, drinking and the application of cosmetics (including lip balm) are forbidden in areas where hazardous chemicals, biohazards and radioactive materials are used. These activities must be in designated, well defined non-chemical areas that are separated from the lab area by physical barriers such as partitions or filing cabinets. A line on the floor will not

be considered adequate separation. Consumables must not be placed in the same refrigerator as chemicals, biohazards, or radioactive material.

Glass Tubing When inserting tubing into stoppers, lubricating tubing as well as wearing gloves or wrapping in a thick cloth will help to protect hands from being cut in the event of the tubing slipping and breaking.

Hazardous Materials Hazardous materials should not be used on open laboratory benches.

Headphones/Earphones These listening devices are acceptable as long as the volume is not too loud. The wearer of these devices must have the volume low enough so that they are able to carry out a normal conversation. Normal laboratory operations as well as alarms, (fume hood, fire, etc.) should be heard when the listening devices are in use.

Horseplay Practical jokes or other inappropriate and unprofessional behavior in the laboratory setting is forbidden. Avoid distracting or startling any other workers.

Housekeeping Exits, aisles and safety equipment must NOT be obstructed in any way with equipment, furniture, etc. No items can be stored in the corridors. For questions related to the use of corridors, exits, or other Fire Marshal issues, contact the Fire Marshal's office (257-6326).

Labeling All chemical containers must be labeled. All labels must be legible, in English and include chemical/product name (chemical formulas alone are not acceptable) and relevant hazards. Labels on incoming containers must not be removed or defaced. Peroxide forming chemicals shall be labeled when received and opened, then disposed of by the manufacturer's recommendation, or within a specified time as discussed here: https://www.as.uky.edu/sites/default/files/Peroxide%20Former%20Guideline_0.pdf.

Waste chemical containers must be clearly marked as "Hazardous Waste" indicating the specific name of the waste chemical(s), rough percentage(s), and hazard class (e.g., flammables, oxidizers, carcinogen, etc.). Contact OHS or Environmental Management for hazardous waste labels. Do not date waste containers until they are full and ready for pickup.

Reaction intermediates should be labeled. These chemicals shall be assumed as hazardous and subject to the Chemical Hygiene Plan. To ensure compliance, label the container with as much information as possible such as parent compounds, any potential hazards and health effects.

LABORATORY DOOR SIGNAGE Each laboratory door must be legibly marked with the following information:

1. Room number
2. Department
3. Laboratory Supervisor's name
4. Emergency contacts, including names, office location, and office and emergency telephone numbers
5. Special hazards/instructions (e.g. location of large quantities of flammables or the presence of a "local alarm" system)

Form III has an example of the standard laboratory signage which can be created online here: https://ehs.uky.edu/apps/lab_sign/.

If you have the recommended door signs that allow inserts, the following link is a template for those systems:
https://ehs.uky.edu/docs/pdf/bio_s_lab_signage_0001.pdf

Mercaptans To avoid false reporting of natural gas leaks, the Physical Plant department should be contacted when mercaptans are used in a laboratory in such a manner that persons outside of the laboratory could smell the mercaptan and suspect a natural gas leak in the building. Please review the fact sheet at https://ehs.uky.edu/docs/pdf/ohs_mercaptans.pdf If a natural gas leak occurs, the building should be evacuated, and the proper authorities should be notified. For more information about the emergency response procedures for natural gas, please view the following website: https://ehs.uky.edu/fire/natgas.html.

Mouth Pipetting Mouth pipetting is forbidden.

No Smoking This policy exists throughout the University and applies in all laboratories.

Open Flames on Benchtop Whenever possible, open flames should be replaced by electrical heating. Prior approval is needed if open flames are to be used in the laboratory.

Open Lab Designs When working in an open lab design, such as the Biomedical Biological Sciences Research Building (BBSRB), noise should be kept to a minimum. Be aware that neighbors cannot simply close the lab door to reduce the noise. Sound attenuating devices should be used for noise producing bench top equipment, such as sonicators.

Pregnant Laboratory Workers If a worker is pregnant or is planning to become pregnant, (OHS) can provide guidance for working with reproductive toxins. More information can be found at the following website:
https://ehs.uky.edu/ohs/pregnant.php.

Perchloric Acid Contact OHS at 257-3242 for prior approval before initiating work with perchloric acid heated above ambient temperature or above 72% concentrations. It will give off vapors that can condense and form explosive perchlorates. Hence, when heating perchloric acid above ambient temperature, a specifically designed and dedicated perchloric acid Laboratory chemical hood with a wash down system or a local scrubbing or trapping system must be used.

Personal Hygiene Hands should be washed frequently throughout the day, before leaving the lab, after contact with any hazardous material, and before eating, drinking, smoking, and applying make-up or lip balm.

Personal Use of Chemicals Laboratory workers are not allowed to remove chemicals from the lab for personal use.

Piranha Solution Contact OHS at 257-3242 for prior approval before initiating work with Piranha Solution. Waste containers for Piranha Solution must be closed with a vented cap. Caps can be obtained from Environmental Management.

Pyrophoric/Water Reactive Chemicals
Special precautions need to be made when working with these compounds. A written standard operating procedure (SOP) must be done when any of these chemicals are used in the laboratory.

Recapping of Needles Recapping of hypodermic needles is prohibited in the laboratory. If recapping is required, contact OHS for prior approval.

Unattended Experiments Frequently, laboratory operations are carried out continuously or overnight. For experiments involving hazardous operations, it is essential to plan for interruptions in utility services such as electricity, water, and inert gas. Operations are to be safe and plans made to avoid hazards in case of failure. If necessary, arrangements for routine inspection of the operation can be made and, in all cases, the laboratory lights should be left on and an appropriate sign posted on the door.

Vacuum pumps and vacuum lines Exhaust from vacuums shall be vented through the fume hood or equipped with local exhaust. Vacuum lines leading from an experimental procedure shall always be equipped with traps to prevent contamination of vacuum equipment or house lines. Traps shall be evaluated for appropriateness and special safety precautions instituted if needed.

- **Particulates:** determine size range being generated and choose capable filtration
- **Aqueous non-volatile:** in most cases a filter flask at room temperature will prevent liquids from contaminating a vacuum source

- **Solvent or other volatile liquids:** choose a cold trap that is large enough and cold enough to condense vapors plus a filter flask large enough to hold all possible liquids that could be aspirated. Avoid using liquid nitrogen if possible. Liquid nitrogen should only be used in sealed or evacuated equipment and with extreme caution. Liquid oxygen can form if proper procedures are not followed. For most applications, a slurry of dry ice and isopropanol or ethanol can be used.
- **Corrosive, highly reactive or toxic gases:** a sorbent canister or scrubber shall be used that can trap the contaminant.

Waste Anesthetic Gas (WAG) Make sure that proper procedures are followed when using vaporizers and scavenging systems during animal surgeries. A fact sheet regarding safe use of Isoflurane can be found here: https://research.uga.edu/docs/policies/compliance/oacu/UGA-IACUC-Isoflurane-Guidelines.pdf.

Working Alone When working with acutely hazardous materials, it is advisable to have a second person present, or at a minimum, maintain surveillance via telephone contact.

Engineering Controls

Laboratory Chemical Hood and Other Engineering Controls See Chapter 5, "Laboratory Chemical Hoods and Other Engineering Controls."

Safety Shower/Eyewashes Safety showers and/or eyewashes are required in labs where corrosive chemicals are used. PPD is charged with testing the eyewashes and shower units. A log of those checks can be obtained by contacting PPD.

Laboratory personnel should be familiar with using an eyewash or safety shower. Training for proper use can be found at the following website: https://ehs.uky.edu/classes/classes_ohs_0001.php#emergency_eyewash.

If operations in the lab require safety procedures greater than what is outlined above, please insert or reference the location of lab specific SOPs here. For the SOP template consult Form IV.

CHAPTER 4

CONTROLLING CHEMICAL EXPOSURES

The Lab Standard requires the employer to determine and implement control measures to reduce employee exposure to hazardous chemicals; particular attention must be given to the selection of control measures for chemicals that are known to be extremely hazardous. There are three major routes of entry for a chemical to enter the body: inhalation, absorption, and ingestion. Three types of controls for prevention of these various routes of entry include engineering controls, personal protective equipment, and administrative controls. Each route of entry can be controlled in several ways, as explained below.

Inhalation Hazards

Inhalation of chemicals is the most common route of entry. To avoid inhalation exposures, hazard reduction methods such as substituting a less volatile or a less toxic chemical or substituting a liquid or solid chemical for a gaseous one is the best means of control. If substitution is not practical, engineering controls such as ventilation should be used to lessen the chance of exposure. The use of well-functioning local exhaust ventilation such as laboratory chemical hoods, biological safety cabinets, vented glove boxes and other local exhaust systems is often required to minimize exposure to hazardous chemicals. Dilution ventilation may be used to reduce exposure to nonhazardous nuisance odors. For extremely toxic chemicals such as those classified as poisonous gases by State or Federal agencies (e.g., arsine, phosgene), the use of closed systems, vented gas cabinets, fail-safe scrubbing, detection or other stricter controls may be required and would require prior approval.

If both substitution and engineering controls are unavailable, the use of personal protective equipment may be required to reduce inhalation exposures. Respiratory protection from dust masks to self-contained breathing apparatus may be utilized to this end. If laboratory employees wear respirators, requirements of the OSHA Respirator Standard (1910.134) must be met and a written respirator program must be implemented. A respiratory program can be developed at https://ehs.uky.edu/ohs/respgate.php. This Standard requires training on the proper use of respirators; medical surveillance to ensure the user can wear a respirator, and fit testing to ensure that the respirator fits properly. A lab worker or his/her supervisor should contact the Occupational Health and Safety Department (257-3827) if respiratory protection is to be utilized to control exposures to hazardous chemicals.

In addition, the following principles should be utilized to reduce the risk of exposure to hazardous chemicals:

- Minimization of exposure time for individual employees

- Restricted access to an area where a hazardous chemical is used; and
- Proper signage on lab doors to indicate special hazards within.

Skin/Eye Contact Hazards

To reduce the risk of a chemical entering the body via skin and eye contact, use engineering controls such as substitution and appropriate ventilation as described above in **Inhalation Hazards**. The more obvious means of preventing skin and eye contact is the wearing of personal protective equipment such as eye protection, face shields, gloves, appropriate clothing (long pants) and shoes, lab aprons, lab coats, and other protective equipment as appropriate to the hazard. Since the chemical resistivity of the different types of protective equipment varies significantly, the lab supervisor should consult Appendix IV or other references to ascertain that the protective equipment material is resistant to the chemical being protected against. Safety showers/eye wash equipment is required where corrosive chemicals are used. Such equipment should be prominently labeled and not obstructed.

Ingestion Hazards

Ingestion of chemicals is the least common route of entry into the body. However a Laboratory Worker can easily ingest chemicals into the body via contaminated hands if they are not washed prior to eating, smoking or sticking part of the hand, or a writing tool that has been in contaminated hands, into the mouth. Some controls for preventing this route of exposure include engineering controls like isolating the hazardous substance so minimal contact is required (e.g., use glove box). Also, administrative controls such as forbidding mouth pipetting, encouraging good personal hygiene and designating a well-marked nonchemical area where eating, drinking and the application of cosmetics is permitted. And finally, personal protective equipment such as the wearing of gloves can reduce this type of exposure.

Exposure Assessment

At the request of faculty, staff or students, exposure evaluations may be conducted by OHS. Records of exposure evaluations will be kept in the Occupational Health and Safety Department and provided to the department and affected employees and any other appropriate authorities at the University. The following is a list of chemicals that require initial monitoring to determine exposures:

- Asbestos
- Vinyl chloride

- Inorganic arsenic
- Lead
- Cadmium
- Benzene
- Cotton dust
- 1,2-Dibromo-3-chloropropane
- Acrylonitrile
- Ethylene oxide
- Formaldehyde
- Methylenedianiline
- 1,3-Butadiene
- Methylene chloride

If you are using these chemicals in a process outside a fume hood, please contact OHS at 257-2924.

CHAPTER 5

LABORATORY CHEMICAL HOODS AND OTHER ENGINEERING CONTROLS

Laboratory chemical hood Face Velocities

All Laboratory chemical hoods at University of Kentucky facilities should have face velocities between 80-120 feet per minute (fpm) with the sash at a "working height" (approximately 12 inches). As a rule, Laboratory chemical hoods should not be operated with the sash fully open and should have the sash closed when not being used. The office of Occupational Health and Safety (OHS) will conduct an annual Laboratory chemical hood inspection and certification program for all Laboratory chemical hoods at the university. Laboratory chemical hoods with face velocities within the 80-150 fpm range may be used without restriction and will be marked with a Laboratory chemical hood sticker showing face velocity at a height designated with an arrow. The face velocity range from 120 to 150 fpm does not significantly increase the safety of the user but does pose a large energy cost. That is why UK tries to keep face velocities below 120 fpm.

Hoods Needing Repairs

Laboratory chemical hoods with face velocities below 60 fpm or above 150 linear fpm must be marked with a sign indicating that the hood may not be used for chemical manipulations. A work order to repair these hoods should be processed as soon as possible. For UKMC this can be done online or by contacting the MCPPD at 323-6281. For Lexington Campus, contact your building administrator and/or operator. Once the hood has been repaired, OHS will need to be contacted to reevaluate the hood's performance.

Safe Work Practices for Laboratory Chemical Hoods

A Laboratory chemical hood cannot provide complete safety against all events that may occur in the hood, especially for toxic airborne contaminants with an exposure limit in the low part per billion range. For ordinary exposures, however, a properly designed hood in a properly ventilated room can provide adequate protection. Nevertheless, certain work practices are necessary for the hood to perform efficiently. The following work practices are required; more stringent practices may be necessary in some circumstances. From The American Conference of Governmental Industrial Hygienists in their text: "Industrial Ventilation: A Manual of Recommended Practices:"

1. All operations that may generate air contaminants at levels above the exposure limit must be conducted inside a hood.

2. Keep all apparatus at least 6 inches back from the face of the hood. A stripe on the bench surface is a good reminder.

3. Do not put your head in the hood when contaminants are being generated.

4. Do not use the hood as a waste disposal mechanism except for very small quantities of volatile materials.

5. Excessive storage of chemicals or any apparatus in the hood will impair the performance of the laboratory chemical hood. Store flammable chemicals in an approved flammable storage safety cabinet. Store corrosive chemicals in a corrosive storage cabinet.

6. Be sure that the switch is in the "on" position whenever the hood is in use and test hood often for airflow (for example using a Kim wipe).

7. Using hazardous solids (powders) in the hood may not be appropriate.

8. Keep the slots in the hood baffles free of obstruction by apparatus or containers.

9. Minimize foot traffic past the face of the hood.

10. Keep laboratory doors and windows closed (exception: some laboratories are designed for the lab doors to be open).

11. Do not remove hood sash or panels except when necessary for apparatus set-up. Replace sash or panels before operating.

12. Do not place electrical receptacles or other spark sources inside the hood when flammable liquids or gases are present. No permanent electrical receptacles are permitted in the hood.

13. Use an appropriate barricade if there is a chance of explosion or eruption.

14. If hood sash is supposed to be partially closed for operation, the hood should be so labeled, and the appropriate closure point clearly indicated.

15. Where perchloric acid is heated above ambient temperature, vapors may condense within the exhaust system to form explosive perchlorates. In such instances, specially designed Laboratory chemical hood exhaust systems must be utilized. These systems will have dedicated exhausts and a water washdown system and may be used for perchloric acid digestions only.

16. All Laboratory chemical hoods should have spill protection lips (at the front of hood and for cup sinks located in the hood).

For more information about types of fumes hoods and their function, please take the Chemical Fume Hood training class online: https://ehs.uky.edu/classes/classes_ohs_0001.php#chemical_fume_hood.

Any questions or requests for assistance in evaluation of Laboratory chemical hoods may be directed to OHS (257-2924).

Most fume hoods on campus now are equipped with flow monitors. These monitors are designed to give the user a guide for the proper function of the face velocity of the fume hood.

CHAPTER 6

EMPLOYEE INFORMATION AND TRAINING

Background

All individuals who work in laboratories who may be exposed to hazardous chemicals must be apprised of the hazards present in their work area. THIS INFORMATION AND TRAINING AS OUTLINED BELOW MUST BE PROVIDED BEFORE INITIAL ASSIGNMENT AND BEFORE NEW EXPOSURE SITUATIONS. Equipment necessary for the safe handling of hazardous substances must also be provided. IT IS THE RESPONSIBILITY OF THE PRINCIPAL INVESTIGATOR TO ENSURE THAT ALL LABORATORY WORKERS HAVE BEEN PROPERLY TRAINED.

Responsibilities

Occupational Health and Safety Department personnel provide mandatory UK Chemical Hygiene Plan/ Laboratory Safety classes quarterly as well as an online version. Information on training can be found on our web page at https://ehs.uky.edu/classes/classes_ohs_0001.php#chemical_hygiene. This class informs lab workers and principal investigators of the *general* UK Lab Safety policies and defines the roles and responsibilities of all people in the lab. This training is required only once. Additionally, the Chemical Hygiene Plan Annual Refresher training is provided online or by request. This training is a shorter version of the Chemical Hygiene Plan/Laboratory Safety class. It highlights any new requirements or regulations. It will also focus on different laboratory safety topics. It is required annually after the Chemical Hygiene Plan training is taken initially.

However, training specific for the lab where an employee is assigned is the responsibility of that employee's supervisor. Lab Specific training should be done initially and then again if the following conditions have changed.

- **A new process, piece of equipment or chemical is introduced into the laboratory**
- **A new process, piece of equipment or chemical is added to an existing procedure**
- **A scale up of a procedure, such as increasing from 5 milligrams to 5 grams**
- **Remodel of the laboratory**

Laboratory workers must be informed of the location and availability of the following:

- "Occupational Exposures to Hazardous Chemicals in Laboratories" (the OSHA Lab Standard - See Appendix I)
- This Chemical Hygiene Plan

- Reference materials on chemical safety (including safety data sheets)

- Permissible Exposure Limits (PELs) for OSHA regulated substances, or if there is no applicable OSHA standard, the recommended exposure limits or Threshold Limit Values (TLVs) may be provided. Contact OHS at 257-2924.

- Signs and symptoms associated with exposure to the hazardous chemicals found in the lab.

Training

Laboratory Worker training must include:

- Detection methods that may be used to detect the presence or release of a hazardous chemical. Examples of detection methods include visual appearance, odor, detector papers, and an understanding of chemical monitoring devices

- Physical and health hazards of the chemicals

- Hazardous waste training

- The work practices, personal protective equipment, and emergency procedures to be used to ensure that employees may protect themselves from overexposure to hazardous chemicals

- Medical consultations and examinations

The manufacturer's Safety Data Sheets (SDS) will generally contain much of the above information needed to comply with the information and training requirements of the OSHA Lab Standard. Laboratory Supervisors and employees should understand the relevant SDS and/or other comparable literature on the hazardous chemicals that are used or stored in their laboratory. The employee's supervisor must provide additional training for specific lab hazards such as….

THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELING OF CHEMICALS (GHS).

The GHS is a common coherent approach to defining and classifying hazards and communicating information on labels and safety data sheets. Its target audience includes workers, consumers, transport workers and emergency responders. It provides the underlying infrastructure for the establishment of international, comprehensive chemical safety programs.

The benefits to workers and members of the public include:

- Improved safety for workers and others through consistent and simplified communications on chemical hazards and practices to follow for safe handling and use.
- Greater awareness of hazards, resulting in safer use of chemicals in the workplace and at home.

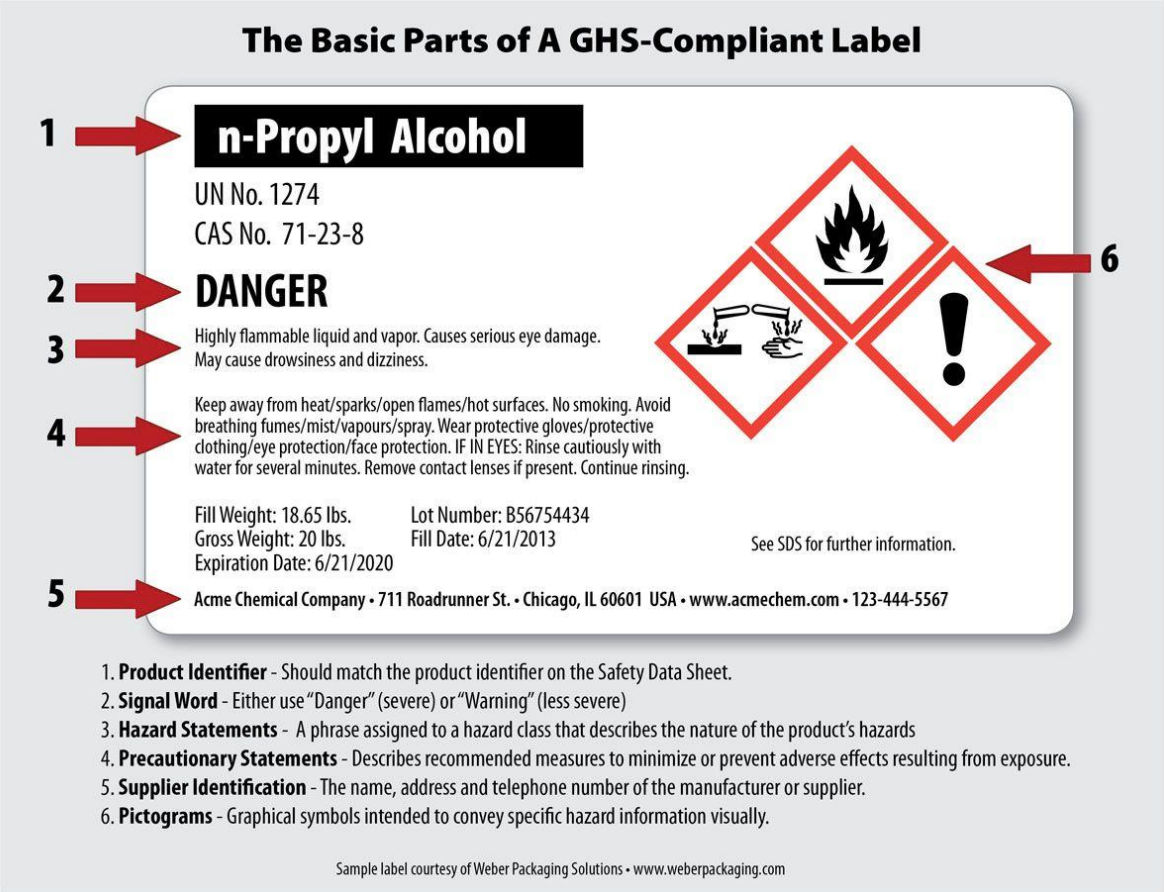
GHS Requirements:

- State the health, physical and environmental hazard criteria for substances and mixtures
- Communicate information on labels including harmonized pictograms, hazard statements, and signals words
- Material Safety Data Sheets (MSDS) are now standardized 16-section documents that all companies must adhere to and renamed, Safety Data Sheets (SDS)

GHS Label Elements:

- Symbols (hazard pictograms): convey health, physical and environmental hazard information, assigned to a GHS hazard class and category.
- Signal Words: “Danger” or “Warning” are used to emphasize and indicate the relative level of severity of the hazard, assigned to a hazard class and category.
- Hazard Statements: Standard phrases assigned to a hazard class and category that describe the nature of the hazard.

The symbols, signal words, and hazard statements have all been standardized and assigned to specific hazard categories and classes, as appropriate. This approach makes it easier for countries to implement the system and should make it easier for companies to comply with regulations based on the GHS. Below is an example of GHS chemical label:



More information about the Globally Harmonized System of Classification and Labeling of Chemicals is available at the following link:
https://www.osha.gov/dsg/hazcom/global.html
Detailed information regarding definitions of the Precautionary Statement P-Codes and Hazard Codes can be found here:
https://pubchem.ncbi.nlm.nih.gov/ghs/

Symbols/Pictograms

The GHS symbols have been incorporated into pictograms for use on the GHS label. Pictograms include the harmonized hazard symbols plus other graphic elements, such as borders, background patterns or colors which are intended to convey specific information.

GHS Pictograms and Hazard Classes

- Oxidizers

- Flammables
- Self Reactives
- Pyrophorics
- Self-Heating
- Emits Flammable Gas
- Organic Peroxides

- Explosives
- Self Reactives
- Organic Peroxides

- Acute toxicity (fatal or toxic)

- Corrosive to Metals
- Eye Damage
- Skin Corrosion/Burns

- Gases Under Pressure

- Carcinogen
- Respiratory Sensitizer
- Reproductive Toxicity
- Target Organ Toxicity
- Mutagenicity
- Aspiration Toxicity

- Environmental Toxicity (Non-Mandatory)

- Irritant (skin and eye)
- Dermal Sensitizer
- Acute toxicity (harmful)
- Narcotic Effects
- Respiratory Tract Irritant
- Hazardous to Ozone Layer (Non-Mandatory)

Shipping Dangerous Goods

Federal law requires that personnel who ship dangerous goods receive an Initial DOT/IATA Training Course upon hire, and a refresher training every two years for air transportation, and every three years for ground transportation. A dangerous good includes but is not limited to the following: aerosol sprays, butane, car batteries, dry ice, gasoline, lithium batteries, liquid nitrogen, paint, chemicals, poisons and infectious substances.

It is the shipper's responsibility to ensure that appropriate training has been completed and that only trained personnel prepare dangerous goods for shipment and sign the shipping documents.

All dangerous goods shipping documents must be maintained for a minimum of 3 years and must be readily retrievable.

For information on the initial training, please contact Environmental Management at 323-6280. The refresher training can be found online at https://ehs.uky.edu/env/shipping.php.

Monthly Fire Extinguisher Visual Inspection Checklist

The University of Kentucky's Division of Environmental Health and Safety has created a new policy to ensure the fire extinguishers in the laboratory are in good working order.

The policy requires the following parts of a fire extinguisher to be visually inspected monthly:

1. Pressure gauge needle is inside the green zone
2. The handle, gauge, and cylinder are free of damage
3. The tamper seal is present and intact
4. The pull pin is present and not bent
5. The annual inspection tag is up to date.

If the fire extinguisher has a deficiency, please notify the University of Kentucky's Fire Marshal at:859-257-8590.

In addition to the visual inspection, please maintain an unobstructed area within three feet of the fire extinguisher. Never conceal the fire extinguisher behind equipment nor furniture or hang items such as a lab coat on the extinguisher.

U.S. Drug Enforcement Administration (DEA): Controlled Substances

Researchers engaged in activities utilizing Controlled Substances are required to register directly with the DEA. The DEA defines Controlled Substances as drugs or chemicals that have the potential to be addictive or habit-forming. These substances are divided into 5 schedules (I-V) based on their potential to be habit-forming and medicinal usefulness. More information can be reviewed at https://www.deadiversion.usdoj.gov/schedules/.

Basic Requirements for PI Ordering Controlled Substances

Inventory (29 CFR 1304.11)

- A complete and accurate recorded inventory of all stocks of controlled substances must be established on the date you first engage in the manufacture, distribution, or dispensing of controlled substances.
- A new recorded inventory must be initiated at least every two years.

Security (29 CFR 1301.71 thru 74)

- Schedule I and II controlled substances must be stored in a “double lock” drug safe or a lockbox that is securely fastened with a security cord within a locked, substantially constructed cabinet.
- Schedules III, IV, and V are stored in a securely locked, substantially constructed drawer or cabinet.
- If there is a theft or loss of Controlled Substances, notify the DEA Field Division Office in your area, by submitting Form 106 within one business day of discovery of such loss or theft.
- Controlled Substances should never be given to non-registrants without proper designation from the DEA.
- Areas where controlled substances are stored shall be accessible only to an absolute minimum number of specifically authorized personnel. Furthermore, when it is necessary for employee maintenance personnel, nonemployee maintenance personnel, business guests, or visitors to be present in or pass through controlled substances storage areas, the registrant shall provide for adequate observation of the area by an employee specifically authorized in writing.

Disposal

- For disposal coordination, contact Environmental Management at 323-6280.

CHAPTER 7

PRIOR APPROVAL

The responsibility for approval of the acquisition and use of toxic chemical agents rests with the Laboratory Supervisor. Some materials including toxic compressed gases, radioactive materials, and certain recombinant DNA and biohazards require prior internal (University of Kentucky) or external approval at various levels. If there are questions concerning the need for approvals, appropriate Environmental Health and Safety departments (e.g. Radiation Safety, Biosafety, etc.) should be consulted. Below is a list of some of the chemicals and procedures requiring prior approval.

1. Respiratory protection
2. Minors in the lab
3. 13 Carcinogens
    - 4-Nitrobiphenyl,
    - alpha-Naphthylamine
    - Methyl Chloromethyl ether
    - 3.3'-Dichlorobenzidine and its salts
    - Bis-Chloromethyl ether
    - beta-Naphthylamine
    - Benzidine
    - 4-Aminodiphenyl
    - Ethyleneimine
    - beta-Propiolactone
    - 2-acetylaminofluorene
    - 4-Dimehtylaminoazo-benzene
    - N-Nitrosodimethylamine
4. Perchloric acid heated or concentration > 72%
5. Piranha Solution
6. Pyrophorics
7. Acute Toxins
8. Nanomaterials

CHAPTER 8

MEDICAL CONSULTATION

As part of an Occupational Health Program, an opportunity for Laboratory Workers to receive medical consultation must be provided under the following circumstances:

- If an employee develops any symptoms thought to arise from chemical exposure
- After an event such as a major spill, leak or explosion which may have resulted in an exposure
- The laboratory specific or Institutional Chemical Hygiene Officer identifies an over exposure as the result of an evaluation

Employees or student workers receiving pay that require medical evaluation should follow the same procedure as reporting an accident.

Primary Reporting Procedure

Employee accidents, injuries, or illnesses should be reported immediately by the employee's supervisor. Student workers receiving pay other than scholarships, fellowships, student loans, or grants are generally considered employees. Any employee accident, injury, or illness must be reported by the supervisor to UK Workers' Comp Care by calling 1-800-440-6285. This information can be accessed on the web at: https://ehs.uky.edu/ohs/accident.php

Secondary Reporting Procedure

Unsafe working conditions, near-miss accidents or accidents that did not result in a hospital visit should be reported internally using the University's Accident Injury Report found here: https://ehs.uky.edu/apps/incident/.

All UK HealthCare incidents should be reported at

Note: Any medical examination required by this Plan must be provided without cost to the employee, without loss of pay and at a reasonable time and place. Records of any medical examination will be maintained at the medical facility providing service or with appropriate medical personnel at the University.

CHAPTER 9

CHEMICAL HYGIENE OFFICER

The Laboratory Supervisor shall serve as the "Chemical Hygiene Officer" for her/his laboratories. The designated Chemical Hygiene Officer has the primary responsibility for safety and health within her/his laboratories. The Chemical Hygiene Officer is also responsible for conducting an annual review of the Chemical Hygiene Plan(s) that apply to his/her laboratories.

The Laboratory Safety Specialist of the Occupational Health and Safety Department is designated as the “Institutional Chemical Hygiene Officer” for the University of Kentucky. The Institutional Chemical Hygiene Officer is responsible for coordinating an annual review of the Model Chemical Hygiene Plan and serving as a resource to the individual laboratory Chemical Hygiene Officers.

CHAPTER 10

SPECIAL PROVISIONS FOR SELECT CARCINOGENS, REPRODUCTIVE TOXINS AND ACUTELY TOXIC CHEMICALS

The Lab Standard (1910.1450(e)(3)(viii)) requires additional employee protection when working with particularly hazardous substances. UK has developed a Standard Operating Procedure (SOP) template to document the required provisions. "Select Carcinogens," (see Appendix VII for a list of select carcinogens) reproductive toxins, engineered nanomaterials and substances which have a high degree of acute toxicity meet the requirements for an SOP. If the SDS of the chemical/mixture of interest meets one of the criteria, pictograms, GHS class, and/or category listed below in an SOP must be developed for that chemical. If the SDS does not contain information specific to the desired concentration to be used, an SOP is required for mixtures of >10%. If acute toxicity information (ATE) is unavailable, the chemical or mixture should be assumed highly toxic and an SOP must be developed. The following provisions must be included in an SOP before work begins:

1. Establishment of a designated area
2. Use of containment devices such as chemical fume hoods or glove boxes
3. Procedures for safe removal of contaminated waste; and
4. Decontamination procedures.

Criteria	Pictogram	GHS (Class, Hazard Category, Route)
Carcinogen		Carcinogenicity, Category 1A or 1B
Reproductive toxicant		Reproductive Toxicity, Category 1A or 1B
Mutagen		Category 1A or 1B)
Respiratory sensitizer		Respiratory Sensitization, Category 1A
Highly acute toxicant		Acute toxicity, Category 1 or 2, Inhalation or Dermal Acute toxicity, Category 1, Oral Specific Target Organ Toxicity - Single Exposure, Category 1 Skin Sensitizer, Category 1A
Corrosive		Skin/Eye Corrosion Category 1(A,B,C) Corrosive to metals Category 1

Reactive		Oxidizing Liquids, Category 1 Oxidizing Solids, Category 1
Explosive/Unstable		Explosives, Divisions 1.1, 1.2 or 1.3 Unstable explosive Organic peroxides Type A and B Desensitized explosives Category 1 or 2 Self Reactives Type A and B
Flammable		Flammable gas Category 1A Pyrophoric gas Chemically unstable gas Pyrophoric Liquid Category 1 Pyrophoric solid Water Reactives Category 1 or 2 Self Reactives Type C – F Self-heating substances, Category 1
		In contact with water liberates toxic gas

*This information is taken from The United Nations Economic Commission for Europe (UNECE) Globally Harmonized System for Classification and Labeling (GHS).

In addition to the general safety guidelines mentioned in the first section and throughout the CHP, special precautions are needed when handling mutagens, carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity. A minimum set of guidelines that should be followed is listed below. The lab supervisor should ensure that these and other precautions designed to minimize the risk of exposure are taken.

- Quantities of these chemicals used and stored in the laboratory must be minimized, as should their concentrations in solution or mixtures.

- Work with mutagens, carcinogens, reproductive toxins and acutely toxic chemicals must be performed within a certified functioning chemical fume hood, biological safety cabinet, ventilated glove box, sealed system, or other system designed to minimize exposure to these substances. (The exhaust air from the ventilation systems may require scrubbing, or other treatment, before being released into the atmosphere.) In all cases, work with these types of chemicals must be done in such a manner that the OSHA permissible exposure limits (PELs) or similar standards are not exceeded.

- Certain chemicals are known or suspected to harm fetuses or the reproductive health of adults. Some examples of reproductive toxins are: anesthetic gases, arsenic and certain arsenic compounds, benzene, cadmium and certain cadmium compounds, carbon disulfide, ethylene glycol monomethyl and ethyl ethers, ethylene oxide, lead compounds, mercury

compounds, toluene, vinyl chloride, xylene, and formamide. The first trimester of pregnancy is a period of high susceptibility. Often a woman does not know that she is pregnant during this period. Individuals of childbearing potential are warned to be especially cautious when working with such reproductive toxins. These individuals must use appropriate protective apparel (especially gloves) to prevent skin contact.

- Pregnant women and women intending to become pregnant should seek advice from knowledgeable sources before working with substances that are suspected to be reproductive toxins. These sources include the Laboratory Supervisor, Safety Data Sheets, the UK Environmental Health and Safety office. Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

- Compressed gas cylinders that contain acutely toxic chemicals such as arsine, chlorine, and nitrogen dioxide must be kept in well-ventilated areas.

- The ventilation efficiency of the designated laboratory chemical hood, glove box or gas cabinet and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances should be evaluated periodically by the laboratory personnel at intervals determined by the Laboratory Supervisor. The interval of evaluating systems may vary from weekly to annually depending upon the frequency of usage, quantities employed and level of hazard.

- Each laboratory utilizing these substances must designate an area for this purpose and must sign or mark this area with an appropriate hazard warning. The designated area may be an entire laboratory (bio-safety level three or four require that the ENTIRE laboratory be designated), an area of the laboratory or a device such as a Laboratory chemical hood or glove box. The designated area should be marked with a **DANGER, specific agent, AUTHORIZED PERSONNEL ONLY** or comparable warning sign.

- All laboratory workers who work in a laboratory which has an area designated for use with mutagens, carcinogens, reproductive toxins and acutely toxic chemicals must be trained about the deleterious effects of these substances as well as signs and symptoms of exposure, whether or not they actually work with the substance themselves. Training to ensure the safe handling and storage of these substances is required for those who use these materials. This training is the responsibility of the Laboratory Supervisor and must be done prior to the use of any of these materials.

- Laboratory Workers working with these chemicals must have access to appropriate protective equipment and clothing (available at no expense to

the workers) and must be trained on how to properly utilize the safety equipment. For example, when working with highly toxic gases, it is often recommended that the workers be trained by Environmental Management to use a self-contained breathing apparatus.

- Detection equipment may be required in laboratories where chemicals (especially poisonous gases) with a high degree of acute toxicity are utilized.

- For special disposal information, call Environmental Management (323-6280).

- The designated working area must be thoroughly and appropriately decontaminated and cleaned at regular intervals determined by the Laboratory Supervisor. The interval may be as short as one day or as long as six months depending upon the frequency of usage and level of hazard.

- Special precautions to avoid release and exposure of highly toxic chemicals, mutagens, carcinogens, and reproductive toxins must be utilized. For instance, volatile substances should be kept cool and contained. Gases should have properly functioning valves, check valves, regulators, containment that can withstand pressure buildup, and appropriate piping. Dispersive solids should be kept in closed containers, used in places with minimum air currents, and appropriate contact materials should be used to avoid static charging.

SAFETY INVOLVING ENGINEERED NANOMATERIALS

Auditing

UK Occupational Health and Safety (OHS) is collecting data on engineered nanomaterial. A database with material, procedure, and exposure information has been developed. This list is an attempt to consolidate and profile engineered nanomaterials in use at UK.

Nanomaterials are natural, incidental or manufactured materials containing particles, in an unbound state, as an aggregate, or as an agglomerate and where, for 50% or more of the particles in the number size distribution, one or more external dimensions ranges in size from 1nm-100nm.

Hazard Assessment

UK OHS will perform a hazard assessment on all operations identified as having engineered nanomaterials. Written procedures will be used, and operations will be monitored for airborne emissions. A TSI Ultrafine Particle Counter will be utilized to demonstrate containment or potential point source emissions. In all cases, a specific exposure control plan for the work will be developed and followed in the lab.

Exposure Control Plan

UK has developed guidelines for research involving nanomaterials. These guidelines closely follow NIOSH's suggested exposure control procedures.

Controlling exposures for nanomaterials is much the same as for any particulate. Since the toxicological data are somewhat limited, controls may be more stringent than they would be for a similar material in the non-nano size range. The following is a general description of what considerations will be made for processes and lab specific plans.

A. Engineering Controls - the first line of defense in protection from exposures.

    1. Closed systems – A closed system is one in which pipes, glassware, and chambers seal the material from the user.

    2. Fume Hoods -The most common type of engineering control to be utilized at UK will be fume hoods. In general, UK labs performing research utilizing engineered nanomaterials in solid/powder form will be performed in designated fume hoods. Fume hoods will also be used for processes that have the potential to aerosolize engineered nanomaterials that are in solution.

    3. Clean Benches or Laminar Flow Hoods - Some processes and labs will utilize clean bench systems that are equipped with HEPA filtered air to provide both product and worker protection. Hoods that do not provide worker protections will not be used when manipulating dry/powder engineered nanomaterials.

4. Each process will be evaluated, and employee exposure monitoring performed to ensure the utilized engineering controls are effectively capturing the materials.

B. Work Practices - SOPs for work involving nanomaterials are required. SOPs will be reviewed by OHS and/or the Chemical Safety Committee.

    1. Wet methods for the manufacture or fabrication of nanomaterials are preferred. This will decrease the probability of inhalation exposures by reducing airborne particles. Processes that utilize other techniques will be evaluated on an individual basis and work practices developed.

    2. All operations will take place in a designated area. Labs approved for this work have at least a fume hood, hand washing facilities, and emergency shower and eyewash stations. All labs and lab workers are required to follow the UK Chemical Hygiene Plan. In this document, all lab workers are required to dress appropriately, not store consumables in the lab, not eat, drink, smoke, apply makeup or lip balm in the lab, and to wash hands before leaving the lab.

    3. Additional templates for Material Specific and Operations Specific SOPs can be found at the following website: GoodNanoGuide

C. Personal Protective Clothing- Standard laboratory protective equipment will be worn which includes: lab coat, safety glasses and closed toed shoes.

    1. Gloves shall be worn when handling engineered nanomaterials. Selection shall be based on available data. Current testing of glove materials can include particles in the nano size range, i.e. viruses. Ensure gloves have been tested by the manufacture for protection against nanomaterials. When nanomaterials are in suspension, the solvent will dictate the glove material. General compatible glove material information can be found in the UK Chemical Hygiene Plan (CHP) or for assistance on glove material compatibility contact the specific glove manufacturer or contact UK Occupational Health and Safety (OHS) at 7-3827.

    2. Respirators - In general, respiratory protection should not be required for work with engineered nanomaterials. OHS will evaluate operations to determine if available engineering controls are not adequate and will assign appropriate respirators. Affected individuals will be enrolled in lab specific respiratory protection programs that will require fit testing and training.

D. Clean-up and disposal - Standard techniques will be used to clean up spills and disposal of nanomaterials. Refer to UK Hazardous Waste Manual for specific information of call 3-6280.

    1. Dry material spills outside of the fume hood or clean bench will be considered a hazardous materials spill. If lab personnel are not part of a respiratory protection program, then the SOP will indicate that the lab will be cleared and secured. Environmental Management (EM) will be contacted to clean. EM employees have the PPE and training required for cleaning spills in the lab.

2. Liquid spills will be evaluated based on the solvent the materials are suspended in. Due to typical research quantities needed in a lab, it is not anticipated that these spills will be large. Small spills will be handled by lab personnel following lab specific SOPs that have been developed. Particularly hazardous solvent spills will be identified in the lab SOP and the appropriate course of action will be described.

3. Disposal- Nanomaterials in themselves do not constitute a hazardous waste. All local, state, and federal regulation must be followed for wastes that meet certain criteria. Prior to working with engineered nanomaterials, the appropriate waste stream will be determined and written in the specific SOP.

E. Medical Surveillance - Engineered nanomaterials that contain materials regulated by current OSHA standards will be subject to the requirements of those standards. NIOSH is currently working on recommendations as to when medical surveillance should be implemented for workers potentially exposed to nanomaterials, regulated, and not otherwise regulated.

1. The need for medical surveillance for nanomaterials that are not otherwise regulated will be assessed on an individual project/operation basis. A risk-based approach will be taken using such factors as route of entry, available toxicological data, engineering and work practice controls, duration of activity, and results of exposure monitoring. The medical surveillance will be a cooperation between the laboratory worker, the Principal Investigator of the laboratory, Occupational Health and Safety, as well as a medical provider if needed.

2. OSHA regulated material - Medical surveillance may be required for research involving these hazardous materials. A review of the requirement will be done for each nanomaterial utilized and a determination made.

    i. Asbestos
    ii. Coal tar pitch volatiles
    iii. 13 listed OSHA carcinogens (29 CFR1910.1003)
    iv. alpha-Naphthylamine
    v. Methyl chloromethyl ether
    vi. beta-Naphthylamine
    vii. Benzidine
    viii. 4-aminodiphenyl
    ix. Ethyleneimine
    x. beta-propiolactone
    xi. 2-Acetylaminafluorene
    xii. 4-Dimethlyaminoazobenzene
    xiii. N-Nitrosodimethylamine
    xiv. Vinyl chloride

xv. Inorganic arsenic
xvi. Lead
xvii. Chromium (VI)
xviii. Cadmium
xix. Coke oven emissions
xx. Bloodborne Pathogens
xxi. Cotton dust
xxii. 1,2-Dibromo-3-chloropropane
xxiii. Acrylonitrile
xxiv. Ethylene oxide
xxv. Formaldehyde
xxvi. Methylenedianiline
xxvii. 1,3-Butadiene
xxviii. Methylene chloride
xxix. Titanium Dioxide
xxx. Carbon nanotubes and nanofibers

If this chapter is applicable to your lab, please include your lab specific information.

CHAPTER 11

PLANNING FOR EMERGENCIES

Planning and practicing for emergencies are an essential component of laboratory safety. Workers in labs should have the knowledge necessary to assess their risks from a small spill or release of a chemical or a small trash can fire, if they have received proper training. The most important aspect of this training is being able to differentiate between an incidental situation and an emergency. Practice in emergency procedures and evacuation drills will provide lab workers with the insight they need to make this differentiation. Contact the Fire Marshal (257-6326) for information on fire extinguisher training.

An incidental release is one that does not cause an imminent health or safety hazard to lab workers and does not have to be cleaned up immediately to prevent death or serious injury to employees. Lab workers should prepare for and handle their own incidental spills or releases. If an accident does occur, please refer to Appendix VI for appropriate reporting procedures.

The following is a list of life-threatening situations. If any of these situations occur the emergency procedures of the following section need to be followed:

1. High concentrations of toxic substances
2. Situation that could lead to bodily injury or death
3. Imminent danger to life and health (IDLH) environments
4. Situation that presents an oxygen deficient atmosphere
5. Condition that poses a fire or explosion hazard
6. A situation that requires immediate attention because of the danger posed to employees in the area

EMERGENCY PROCEDURES FOR SELECTED EMERGENCIES

Fires and Other Life-Threatening Situations

The four actions below must be taken by whoever discovers a fire that cannot be put out safely by someone trained in fire extinguisher handling. Other life-threatening situations such as equipment failure, rupture of containers, or failure of control equipment which results in uncontrolled release of a hazardous chemical into the workplace also require that the below actions be taken. Actual emergency conditions may require the procedures to be followed in a different order, depending on the layout of the laboratory, time of day, the number of people present and the location of the emergency relative to doors and alarm stations or telephones.

1. Alert personnel in the immediate vicinity. Explain the nature and extent of the emergency. Give instructions to sound the alarm and call for assistance.

2. Only where safe and possible: turn off any heat sources, confine the fire or emergency, shut the fume hood sash and close any doors. These measures can help to prevent the spread of vapors, gases, or fire.

3. Evacuate the building or hazardous area. Use the evacuation alarm system. Follow posted evacuation procedures. Assemble at your lab's designated meeting point. Practice evacuation and assembly in drills.

4. Summon aid from a safe location and call 911. Give location and explain the emergency.

Clothing Fire and Severe Thermal Burns

Thermal burns from a clothing fire or large splash of hot material can be life threatening if they are deep, extensive, or located on critical areas of the body. Severe burns of the hands, feet, face, and genital areas are considered critical.

To extinguish a clothing fire:

- Stop the person on fire from running!

- Drop the person to the floor. Standing will allow flames to spread upward to eyes and nose.

- Roll the person to snuff out the flames.

- Cool the person. Remove smoldering clothing. Use cold water or ice packs to cool burns and minimize injury.

- Get medical assistance immediately.

Chemical Splash to the Eyes or Skin

The most important emergency measure if chemicals are splashed to the eyes or skin is immediate flushing with water in the emergency eyewash and/or shower. Most splashes need at least 15 minutes of washing. Get medical assistance immediately after flushing.

The following are instructions for using the eyewash or safety shower.

Using an Eyewash

- Always wash with tepid water or eye solution from the inside edges of the eyes to the outside; this will help to avoid washing the chemicals back into the eyes or into an unaffected eye.

- Water or eye solution should **NOT** be directly aimed onto the eyeball but aimed at the base of the nose.

- Flush eyes and eyelids with water or eye solution for a **minimum** of 15 minutes. “Roll” eyes around to ensure full rinsing.

- Immediately seek medical attention.

Using a Safety Shower

- Stand directly under the shower head.

- Pull handle to activate shower.

- Wash with tepid water for a **minimum** of 15 minutes.

- To turn off the shower push the handle up.

Accidental Release and Response Procedures

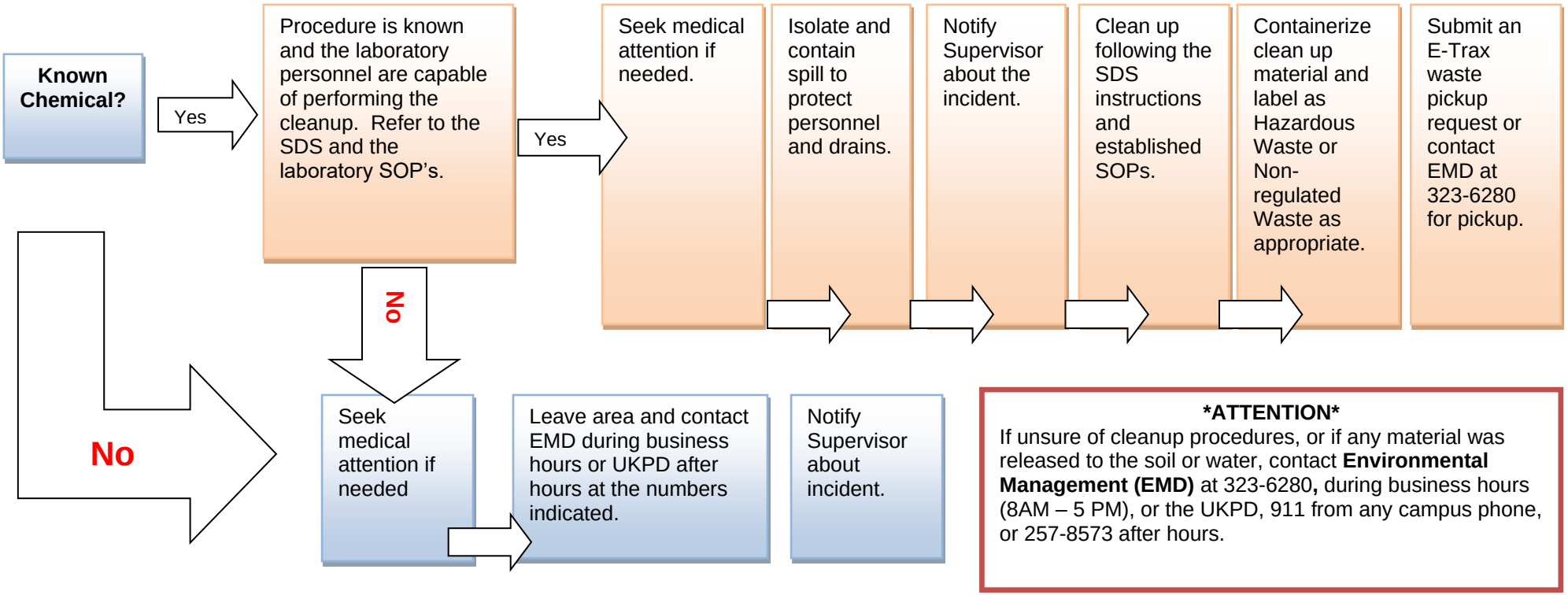
If handled properly, a spill may be nothing more than a nuisance. If handled improperly, a spill can seriously disrupt activities and the work of your colleagues. At worst, a spill can cause bodily harm or property damage.

To prepare for spills, you should do the following:

- Learn about the hazards for the chemicals in the laboratory.
- Write response procedures to address the hazards.
- Ensure personnel have the correct equipment and training to follow the written procedures.

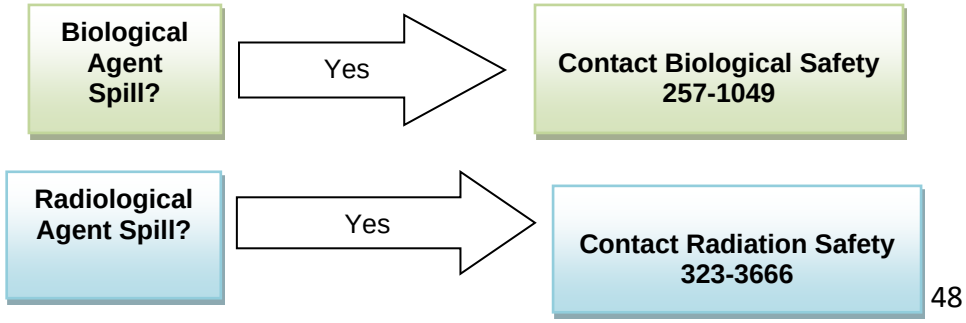
More information about Chemical Spill Response Planning in Laboratories can be found at the American Chemical Society Website.

Laboratory Spill Release Flow Chart



ATTENTION

If unsure of cleanup procedures, or if any material was released to the soil or water, contact **Environmental Management (EMD)** at 323-6280**,** during business hours (8AM – 5 PM), or the UKPD, 911 from any campus phone, or 257-8573 after hours.



Basic Spill Kit Supplies

Gloves	Acid/Base neutralizer
Eye protection	Mercury Spill kit
Vermiculite/oil dry	Spill pads

This page intentionally left blank.

APPENDIX I

OSHA LABORATORY STANDARD

(a) **Scope and application:**

(1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(2) Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

(i) For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

(ii) Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

(iii) Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

(3) This section shall not apply to:

(i) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart 2, even if such use occurs in a laboratory.

(ii) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

(A) Procedures using chemically impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

(B) Commercially prepared kits such as those used in performing pregnancy tests in which all the reagents needed to conduct the test are contained in the kit.

(b) **Definitions:**

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

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

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

"**Chemical Hygiene Officer**" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and

implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

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

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

"**Compressed gas**" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70° F (21.1° C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130° F (54.4° C) regardless of the pressure at 70° F (21.1° C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100° F (37.8° C) as determined by ASTM D-323-72.

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

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

"**Employee**" means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals during his or her assignments.

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

"**Flammable**" means a chemical that falls into one of the following categories:

(i) "**Aerosol, flammable**" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) "**Gas, flammable**" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) "**Liquid, flammable**" means any liquid having a flash point below 100° F (37.8° C), except any mixture having components with flash points of 100° C or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) "**Solid, flammable**" means a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"**Flash point**" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100° F (37.8° C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flash point by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100° F (37.8° C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

*Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any of the flash point determination methods specified above.

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

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether a chemical is to be considered hazardous for purposes of this standard.

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

"Laboratory scale" means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

"**Laboratory-type hood**" means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

"**Laboratory use of hazardous chemicals**" means handling or use of such chemicals in which all the following conditions are met:

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

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

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

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

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

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

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

"**Select carcinogen**" means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or
(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or
(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or
(C) After oral dosages of less than 50 mg/kg of body weight per day.

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

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

(c) **Permissible exposure limits:** For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

(d) **Employee exposure determination:**

(1) **Initial monitoring.** The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

(2) **Periodic monitoring.** If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.
(3) **Termination of monitoring.** Monitoring may be terminated in accordance with the relevant standard.
(4) **Employee notification of monitoring results.** The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

(e) **Chemical hygiene plan - General.** (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

(1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:
(i) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and
(ii) Capable of keeping exposures below the limits specified in paragraph (c) of this section.
(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.
(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection.
(i) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;
(ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular

attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

(iii) A requirement that Laboratory chemical hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

(iv) Provisions for employee information and training as prescribed in paragraph (f) of this section;

(v) The circumstances under which a laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

(vi) Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

(vii) Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and

(viii) Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:
(A) Establishment of a designated area;
(B) Use of containment devices such as Laboratory chemical hoods or glove boxes;
(C) Procedures for safe removal of contaminated waste; and
(D) Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

(f) **Employee information and training.**

(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

(3) Information. Employees shall be informed of:

(i) The contents of this standard and its appendices which shall be made available to employees;

(ii) The location and availability of the employer's Chemical Hygiene Plan;

(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

(iv) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

(v) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

(4) Training.

(i) Employee training shall include:

(A) Methods and observations that may be used to detect the presence or

release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(B) The physical and health hazards of chemicals in the work area; and

(C) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

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

(g) **Medical consultation and medical examinations.**

(1) The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

(i) Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

(ii) Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

(iii) Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

(2) All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

(3) Information provided to the physician. The employer shall provide the following information to the physician:

(i) The identity of the hazardous chemical(s) to which the employee may have been exposed;

(ii) A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

(iii) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) Physician's written opinion.

(i) For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

(C) Any medical condition which may be revealed during the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

(D) A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

(ii) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

(h) **Hazard identification.**

(1) With respect to labels and material safety data sheets:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals and ensure that they are readily accessible to laboratory employees.

(2) The following provisions shall apply to chemical substances developed in the laboratory:

(i) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

(ii) If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

(iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of safety data sheets and labeling.

(i) **Use of respirators.** Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

(j) **Recordkeeping.**

(1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

(2) The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

(k) **Dates.**

(1) Effective date. This section shall become effective May 1, 1990.

(2) Start-up dates.

(i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

(ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(l) **Appendices.** The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

APPENDIX A TO 1910.1450

National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

To assist employers in developing an appropriate laboratory Chemical Hygiene Plan (CHP), the following non-mandatory recommendations were based on the National Research Council's (NRC) 2011 edition of "Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards." This reference, henceforth referred to as "Prudent Practices," is available from the National Academies Press, 500 Fifth Street NW., Washington DC 20001 (www.nap.edu). "Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by recognized authorities in the laboratory community through the sponsorship of the NRC. However, these recommendations do not modify any requirements of the OSHA Laboratory standard. This appendix presents pertinent recommendations from "Prudent Practices," organized into a form convenient for quick reference during operation of a laboratory and during development and application of a CHP. For a detailed explanation and justification for each recommendation, consult "Prudent Practices."

"Prudent Practices" deals with both general laboratory safety and many types of chemical hazards, while the Laboratory standard is concerned primarily with chemical health hazards as a result of chemical exposures. The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized in order toto adapt them for this purpose. However, their sense has not been changed.

Section F contains information from the U.S. Chemical Safety Board's (CSB) Fiscal Year 2011 Annual Performance and Accountability report and Section F contains recommendations extracted from the CSB's 2011 case study, "Texas Tech University Laboratory Explosion," available from: https://www.csb.gov/texas-tech-university-chemistry-lab-explosion/.

Culture of Safety

With the promulgation of the Occupational Safety and Health Administration (OSHA) Laboratory standard (29 CFR 1910.1450), a culture of safety consciousness, accountability, organization, and education has developed in industrial, governmental, and academic laboratories. Safety and training programs have been implemented to promote the safe handling of chemicals from ordering to disposal, and to train laboratory personnel in safe practices. Laboratory personnel must realize that the welfare and safety of everyone depends on clearly defined attitudes of teamwork and personal responsibility. Learning to participate in this culture of habitual risk assessment, experiment planning, and consideration of worst-case possibilities—for oneself and one's fellow workers—is as much part of a scientific education as learning the theoretical background of experiments or the step-by-step protocols for doing them in a professional manner. A crucial component of chemical education for all personnel is to nurture basic attitudes and habits of prudent behavior so that safety is a valued and inseparable part of all laboratory activities throughout their career.

Over the years, special techniques have been developed for handling chemicals safely. Local, state, and federal regulations hold institutions that sponsor chemical laboratories accountable for providing safe working environments. Beyond regulation, employers and scientists also hold themselves personally responsible for their own safety, the safety of their colleagues and the safety of the public. A sound safety organization that is respected by all requires the participation and support of laboratory administrators, workers, and students. A successful health and safety program requires a daily commitment from everyone in the organization. To be most effective, safety and health must be balanced with, and incorporated into, laboratory processes. A strong safety and health culture is the

result of positive workplace attitudes—from the chief executive officer to the newest hire; involvement and buy-in of all members of the workforce; mutual, meaningful, and measurable safety and health improvement goals; and policies and procedures that serve as reference tools, rather than obscure rules.

In order to perform their work in a prudent manner, laboratory personnel must consider the health, physical, and environmental hazards of the chemicals they plan to use in an experiment. However, the ability to accurately identify and assess laboratory hazards must be taught and encouraged through training and ongoing organizational support. This training must be at the core of every good health and safety program. For management to lead, personnel to assess worksite hazards, and hazards to be eliminated or controlled, everyone involved must be trained.

A. General Principles

1. Minimize All Chemical Exposures and Risks

Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted. In addition to these general guidelines, specific guidelines for chemicals that are used frequently or are particularly hazardous should be adopted.

Laboratory personnel should conduct their work under conditions that minimize the risks from both known and unknown hazardous substances. Before beginning any laboratory work, the hazards and risks associated with an experiment or activity should be determined and the necessary safety precautions implemented. Every laboratory should develop facility-specific policies and procedures for the highest-risk materials and procedures used in their laboratory. To identify these, consideration should be given to past accidents, process conditions, chemicals used in large volumes, and particularly hazardous chemicals.

Perform Risk Assessments for Hazardous Chemicals and Procedures Prior to Laboratory Work:

(a) Identify chemicals to be used, amounts required, and circumstances of use in the experiment. Consider any special employee or laboratory conditions that could create or increase a hazard. Consult sources of safety and health information and experienced scientists to ensure that those conducting the risk assessment have sufficient expertise.

(b) Evaluate the hazards posed by the chemicals and the experimental conditions. The evaluation should cover toxic, physical, reactive, flammable, explosive, radiation, and biological hazards, as well as any other potential hazards posed by the chemicals.

(c) For a variety of physical and chemical reasons, reaction scale-ups pose special risks, which merit additional prior review and precautions.

(d) Select appropriate controls to minimize risk, including use of engineering controls, administrative controls, and personal protective equipment (PPE) to protect workers from hazards. The controls must ensure that OSHA’s Permissible Exposure Limits (PELs) are not exceeded. Prepare for contingencies and be aware of the institutional procedures in the event of emergencies and accidents.

One sample approach to risk assessment is to answer these five questions:

(a) What are the hazards?

(b) What is the worst thing that could happen?

(c) What can be done to prevent this from happening?

(d) What can be done to protect from these hazards?

(e) What should be done if something goes wrong?

2. Avoid Underestimation of Risk

Even for substances of no known significant hazard, exposure should be minimized; when working with substances that present special hazards, special precautions should be taken. Reference should be made to the safety data sheet (SDS) that is provided for each chemical. Unless otherwise known, one should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are toxic.

Determine the physical and health hazards associated with chemicals before working with them. This determination may involve consulting literature references, laboratory chemical safety summaries (LCSSs), SDSs, or other reference materials. Consider how the chemicals will be processed and determine whether the changing states or forms will change the nature of the hazard. Review your plan, operating limits, chemical evaluations and detailed risk assessment with other chemists, especially those with experience with similar materials and protocols.

Before working with chemicals, know your facility's policies and procedures for how to handle an accidental spill or fire. Emergency telephone numbers should be posted in a prominent area. Know the location of all safety equipment and the nearest fire alarm and telephone.

3. Adhere to the Hierarchy of Controls

The hierarchy of controls prioritizes intervention strategies based on the premise that the best way to control a hazard is to systematically remove it from the workplace, rather than relying on employees to reduce their exposure. The types of measures that may be used to protect employees (listed from most effective to least effective) are: engineering controls, administrative controls, work practices, and PPE. Engineering controls, such as chemical hoods, physically separate the employee from the hazard. Administrative controls, such as employee scheduling, are established by management to help minimize the employees' exposure time to hazardous chemicals. Work practice controls are tasks that are performed in a designated way to minimize or eliminate hazards. Personal protective equipment and apparel are additional protection provided under special circumstances and when exposure is unavoidable.

Face and eye protection is necessary to prevent ingestion and skin absorption of hazardous chemicals. At a minimum, safety glasses, with side shields, should be used for all laboratory work. Chemical splash goggles are more appropriate than regular safety glasses to protect against hazards such as projectiles, as well as when working with glassware under reduced or elevated pressures (e.g., sealed tube reactions), when handling potentially explosive compounds (particularly during distillations), and when using glassware in high-temperature operations. Do not allow laboratory chemicals to come in contact with skin. Select gloves carefully to ensure that they are impervious to the chemicals being used and are of correct thickness to allow reasonable dexterity while also ensuring adequate barrier protection.

Lab coats and gloves should be worn when working with hazardous materials in a laboratory.

Wear closed-toe shoes and long pants or other clothing that covers the legs when in a laboratory where hazardous chemicals are used. Additional protective clothing should be used when there is significant potential for skin-contact exposure to chemicals. The protective characteristics of this clothing must be matched to the hazard. Never wear gloves or laboratory coats outside the laboratory or into areas where food is stored and consumed.

4. Provide Laboratory Ventilation

The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere using hoods and other ventilation devices. To determine the best choice for laboratory ventilation using engineering controls for personal protection, employers are referred to Table 9.3 of the 2011 edition of ‘‘Prudent Practices.’’ Laboratory chemical hoods are the most important components used to protect laboratory personnel from exposure to hazardous chemicals.

(a) Toxic or corrosive chemicals that require vented storage should be stored in vented cabinets instead of in a chemical hood.

(b) Chemical waste should not be disposed of by evaporation in a chemical hood.

(c) Keep chemical hood areas clean and free of debris at all times.

(d) Solid objects and materials, such as paper, should be prevented from entering the exhaust ducts as they can reduce the air flow.

(e) Chemical hoods should be maintained, monitored and routinely tested for proper performance.

A laboratory ventilation system should include the following characteristics and practices:

(a) Heating and cooling should be adequate for the comfort of workers and operation of equipment. Before modification of any building HVAC, the impact on laboratory or hood ventilation should be considered, as well as how laboratory ventilation changes may affect the building HVAC.

(b) A negative pressure differential should exist between the amount of air exhausted from the laboratory and the amount supplied to the laboratory to prevent uncontrolled chemical vapors from leaving the laboratory.

(c) Local exhaust ventilation devices should be appropriate to the materials and operations in the laboratory.

(d) The air in chemical laboratories should be continuously replaced so that concentrations of odoriferous or toxic substances do not increase during the workday.

(e) Laboratory air should not be recirculated but exhausted directly outdoors.

(f) Air pressure should be negative with respect to the rest of the building. Local capture equipment and systems should be designed only by an experienced engineer or industrial hygienist.

(g) Ventilation systems should be inspected and maintained on a regular basis. There should be no areas where air remains static or areas that have unusually high airflow velocities.

Before work begins, laboratory workers should be provided with proper training that includes how to use the ventilation equipment, how to ensure that it is functioning properly, the consequences of improper use, what to do in the event of a system failure or power outage, special considerations, and the importance of signage and postings.

5. Institute a Chemical Hygiene Program

A comprehensive chemical hygiene program is required. It should be designed to minimize exposures, injuries, illnesses and incidents. There should be a regular, continuing effort that includes program oversight, safe facilities, chemical hygiene planning, training, emergency preparedness and chemical security. The chemical hygiene program must be reviewed annually and updated as necessary whenever new processes, chemicals, or equipment is implemented. Its recommendations should be followed in all laboratories.

6. Observe the PELs and TLVs

OSHA's Permissible Exposure Limits (PELs) must not be exceeded. The American Conference of Governmental Industrial Hygienists' Threshold Limit Values (TLVs) should also not be exceeded.

B. Responsibilities

Persons responsible for chemical hygiene include, but are not limited to, the following:

1. Chemical Hygiene Officer

(a) Establishes, maintains, and revises the chemical hygiene plan (CHP).

(b) Creates and revises safety rules and regulations.

(c) Monitors procurement, use, storage, and disposal of chemicals.

(d) Conducts regular inspections of the laboratories, preparations rooms, and chemical storage rooms, and submits detailed laboratory inspection reports to administration.

(e) Maintains inspection, personnel training, and inventory records.

(f) Assists laboratory supervisors in developing and maintaining adequate facilities.

(g) Seeks ways to improve the chemical hygiene program.

2. Department Chairperson or Director

(a) Assumes responsibility for personnel engaged in the laboratory use of hazardous chemicals.

(b) Provides the chemical hygiene officer (CHO) with the support necessary to implement and maintain the CHP.

(c) After receipt of laboratory inspection report from the CHO, meets with laboratory supervisors to discuss cited violations and to ensure timely actions to protect trained laboratory personnel and facilities and to ensure that the department remains in compliance with all applicable federal, state, university, local and departmental codes and regulations.

(d) Provides budgetary arrangements to ensure the health and safety of the departmental personnel, visitors, and students.

3. Departmental Safety Committee reviews accident reports and makes appropriate recommendations to the department chairperson regarding proposed changes in the laboratory procedures.

4. Laboratory Supervisor or Principal Investigator has overall responsibility for chemical hygiene in the laboratory, including responsibility to:

(a) Ensure that laboratory personnel comply with the departmental CHP and do not operate equipment or handle hazardous chemicals without proper training and authorization.

(b) Always wear personal protective equipment (PPE) that is compatible to the degree of hazard of the chemical.

(c) Follow all pertinent safety rules when working in the laboratory to set an example.

(d) Review laboratory procedures for potential safety problems before assigning to other laboratory personnel.

(e) Ensure that visitors follow the laboratory rules and assumes responsibility for laboratory visitors.

(f) Ensure that PPE is available and properly used by each laboratory employee and visitor.

(g) Maintain and implement safe laboratory practices.

(h) Provide regular, formal chemical hygiene and housekeeping inspections, including routine inspections of emergency equipment;

(i) Monitor the facilities and the chemical fume hoods to ensure that they are maintained and function properly. Contact the appropriate person, as designated by the department chairperson, to report problems with the facilities or the chemical fume hoods.

5. Laboratory Personnel

(a) Read, understand, and follow all safety rules and regulations that apply to the work area;

(b) Plan and conduct each operation in accordance with the institutional chemical hygiene procedures;

(c) Promote good housekeeping practices in the laboratory or work area.

(d) Notify the supervisor of any hazardous conditions or unsafe work practices in the work

area.

(e) Use PPE as appropriate for each procedure that involves hazardous chemicals.

C. The Laboratory Facility

General Laboratory Design Considerations Wet chemical spaces and those with a higher degree of hazard should be separated from other spaces by a wall or protective barrier wherever possible. If the areas cannot be separated, then workers in lower hazard spaces may require additional protection from the hazards in connected spaces.

1. Laboratory Layout and Furnishing

(a) Work surfaces should be chemically resistant, smooth, and easy to clean.

(b) Hand washing sinks for hazardous materials may require elbow, foot, or electronic controls for safe operation.

(c) Wet laboratory areas should have chemically resistant, impermeable, slip resistant flooring.

(d) Walls should be finished with a material that is easy to clean and maintain.

(e) Doors should have view panels to prevent accidents and should open in the direction of egress.

(f) Operable windows should not be present in laboratories, particularly if there are chemical hoods or other local ventilation systems present.

2. Safety Equipment and Utilities

(a) An adequate number and placement of safety showers, eyewash units, and fire extinguishers should be provided for the laboratory.

(b) Use of water sprinkler systems is resisted by some laboratories because of the presence of electrical equipment or water reactive materials, but it is still generally safer to have sprinkler systems installed. A fire large enough to trigger the sprinkler system would have the potential to cause far more destruction than the local water damage.

D. Chemical Hygiene Plan (CHP)

The OSHA Laboratory standard defines a CHP as ‘‘a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace.’’ (29 CFR 1910.1450(b)). The Laboratory Standard requires a CHP: ‘‘Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan.’’ (29 CFR 1910.1450(e)(1)). The CHP is the foundation of the laboratory safety program and must be reviewed and updated, as needed, and at least on an annual basis to reflect changes in policies and personnel. A CHP should be facility specific and can assist in promoting a culture of safety to protect workers from exposure to hazardous materials.

1. The Laboratory's CHP must be readily available to workers and capable of protecting workers from health hazards and minimizing exposure. Include the following topics in the CHP:

(a) Individual chemical hygiene responsibilities;

(b) Standard operating procedures;

(c) Personal protective equipment, engineering controls and apparel;

(d) Laboratory equipment;

(e) Safety equipment;

(f) Chemical management;

(g) Housekeeping;

(h) Emergency procedures for accidents and spills;

(i) Chemical waste;

(j) Training;

(k) Safety rules and regulations;

(l) Laboratory design and ventilation;

(m) Exposure monitoring;

(n) Compressed gas safety;

(o) Medical consultation and examination.

It should be noted that the nature of laboratory work may necessitate addressing biological safety, radiation safety and security issues.

2. Chemical Procurement, Distribution, and Storage

Prudent chemical management includes the following processes:

Chemical Procurement:

(a) Information on proper handling, storage, and disposal should be known to those who will be involved before a substance is received.

(b) Only containers with adequate identifying labels should be accepted.

(c) Ideally, a central location should be used for receiving all chemical shipments.

(d) Shipments with breakage or leakage should be refused or opened in a chemical hood.

(e) Only the minimum amount of the chemical needed to perform the planned work should be

ordered.

(f) Purchases of high risk chemicals should be reviewed and approved by the CHO.

(g) Proper protective equipment and handling and storage procedures should be in place before receiving a shipment.

Chemical Storage:

(a) Chemicals should be separated and stored according to hazard category and compatibility.

(b) SDS and label information should be followed for storage requirements.

(c) Maintain existing labels on incoming containers of chemicals and other materials.

(d) Labels on containers used for storing hazardous chemicals must include the chemical identification and appropriate hazard warnings.

(e) The contents of all other chemical containers and transfer vessels, including, but not limited to, beakers, flasks, reaction vessels, and process equipment, should be properly identified.

(f) Chemical shipments should be dated upon receipt and stock rotated.

(g) Peroxide formers should be dated upon receipt, again dated upon opening, and stored away from heat and light with tightfitting, nonmetal lids.

(h) Open shelves used for chemical storage should be secured to the wall and contain 3/4-inch lips. Secondary containment devices should be used as necessary.

(i) Consult the SDS and keep incompatibles separate during transport, storage, use, and disposal.

(j) Oxidizers, reducing agents, and fuels should be stored separately to prevent contact in the event of an accident.

(k) Chemicals should not be stored in the chemical hood, on the floor, in areas of egress, on the benchtop, or in areas near heat or in direct sunlight.

(l) Laboratory-grade, flammable-rated refrigerators and freezers should be used to store sealed chemical containers of flammable liquids that require cool storage. Do not store food or beverages in the laboratory refrigerator.

(m) Highly hazardous chemicals should be stored in a well-ventilated and secure area designated for that purpose.

(n) Flammable chemicals should be stored in a spark-free environment and in approved flammable-liquid containers and storage cabinets. Grounding and bonding should be used to prevent static charge buildups when dispensing solvents.

(o) Chemical storage and handling rooms should be controlled-access areas. They should have proper ventilation, appropriate signage, diked floors, and fire suppression systems.

Chemical Handling:

(a) As described above, a risk assessment should be conducted prior to beginning work with any hazardous chemical for the first time.

(b) All SDS and label information should be read before using a chemical for the first time.

(c) Trained laboratory workers should ensure that proper engineering controls (ventilation) and PPE are in place.

Chemical Inventory:

(a) Prudent management of chemicals in any laboratory is greatly facilitated by keeping an accurate inventory of the chemicals stored.

(b) Unneeded items should be discarded or returned to the storeroom.

Transporting Chemicals:

(a) Secondary containment devices should be used when transporting chemicals.

(b) When transporting chemicals outside of the laboratory or between stockrooms and laboratories, the transport container should be break-resistant.

(c) High-traffic areas should be avoided.

Transferring Chemicals:

(a) Use adequate ventilation (such as a fume hood) when transferring even a small amount of a particularly hazardous substance (PHS).

(b) While drum storage is not appropriate for laboratories, chemical stockrooms may purchase drum quantities of solvents used in high volumes. Ground and bond the drum and receiving vessel when transferring flammable liquids from a drum to prevent static charge buildup.

(c) If chemicals from commercial sources are repackaged into transfer vessels, the new containers should be labeled with all essential information on the original container.

Shipping Chemicals: Outgoing chemical shipments must meet all applicable Department of Transportation (DOT) regulations and should be authorized and handled by the institutional shipper.

3. Waste Management

A waste management plan should be in place before work begins on any laboratory activity. The plan should utilize the following hierarchy of practices:

(a) Reduce waste sources. The best approach to minimize waste generation is by reducing the scale of operations, reducing its formation during operations, and, if possible, substituting less hazardous chemicals for a particular operation.

(b) Reuse surplus materials. Only the amount of material necessary for an experiment should be purchased, and, if possible, materials should be reused.

(c) Recycle waste. If waste cannot be prevented or minimized, the organization should consider recycling chemicals that can be safely recovered or used as fuel.

(d) Dispose of waste properly. Sink disposal may not be appropriate. Proper waste disposal methods include incineration, treatment, and land disposal. The organization's environmental health and safety (EHS) office should be consulted in determining which methods are appropriate for different types of waste.

Collection and Storage of Waste:

(a) Chemical waste should be accumulated at or near the point of generation, under the control of laboratory workers.

(b) Each waste type should be stored in a compatible container pending transfer or disposal. Waste containers should be clearly labeled and kept sealed when not in use.

(c) Incompatible waste types should be kept separate to ensure that heat generation, gas evolution, or another reaction does not occur.

(d) Waste containers should be segregated by how they will be managed. Waste containers should be stored in a designated location that does not interfere with normal laboratory operations. Ventilated storage and secondary containment may be appropriate for certain waste types.

(e) Waste containers should be clearly labeled and kept sealed when not in use. Labels should include the accumulation start date and hazard warnings as appropriate.

(f) Non-explosive electrical systems, grounding and bonding between floors and containers, and non-sparking conductive floors and containers should be used in the central waste accumulation area to minimize fire and explosion hazards. Fire suppression systems, specialized ventilation systems, and dikes should be installed in the central waste accumulation area. Waste management workers should be trained in proper waste handling procedures as well as contingency planning and emergency response. Trained laboratory workers most familiar with the waste should be actively involved in waste management decisions to ensure that the waste is managed safely and efficiently. Engineering controls should be implemented as necessary, and personal protective equipment should be worn by workers involved in waste management.

4. Inspection Program

Maintenance and regular inspection of laboratory equipment are essential parts of a laboratory safety program. Management should participate in the design of a laboratory inspection program to ensure that the facility is safe and healthy, workers are adequately trained, and proper procedures are being followed.

Types of inspections: The program should include an appropriate combination of routine inspections, self-audits, program audits, peer inspections, EHS inspections, and inspections by external entities.

Elements of an inspection:

(a) Inspectors should bring a checklist to ensure that all issues are covered and a camera to document issues that require correction.

(b) Conversations with workers should occur during the inspection, as they can provide valuable information and allow inspectors an opportunity to show workers how to fix problems.

(c) Issues resolved during the inspection should be noted.

(d) An inspection report containing all findings and recommendations should be prepared for management and other appropriate workers.

(e) Management should follow-up on the inspection to ensure that all corrections are implemented.

5. Medical Consultation and Examination

The employer must provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations that the examining physician determines to be necessary, whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory. If an employee encounters a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee must be provided an opportunity for a medical consultation by a licensed physician. All medical examinations and consultations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place. The identity of the hazardous chemical, a description of the incident, and any signs and symptoms that the employee may experience must be relayed to the physician.

6. Records

All accident, fatality, illness, injury, and medical records and exposure monitoring records must be retained by the institution in accordance with the requirements of state and federal regulations (see 29 CFR part 1904 and § 1910.1450(j)). Any exposure monitoring results must be provided to affected laboratory staff within 15 working days after receipt of the results (29 CFR 1910.1450(d)(4)).

7. Signs

Prominent signs of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers;

(b) Location signs for safety showers, eyewash stations, other safety and first aid equipment, and exits; and

(c) Warnings at areas or equipment where special or unusual hazards exist.

8. Spills and Accidents

Before beginning an experiment, know your facility's policies and procedures for how to handle an accidental release of a hazardous substance, a spill or a fire. Emergency response planning and training are especially important when working with highly toxic compounds. Emergency telephone numbers should be posted in a prominent area. Know the location of all safety equipment and the nearest fire alarm and telephone. Know who to notify in the event of an emergency. Be prepared to provide basic emergency treatment. Keep your co-workers informed of your activities so they can respond appropriately. Safety equipment, including spill control kits, safety shields, fire safety equipment, PPE, safety showers and eyewash units, and emergency equipment should be available in well marked highly visible locations in all chemical laboratories. The laboratory supervisor or CHO is responsible for ensuring that all personnel are aware of the locations of fire extinguishers and are trained in their use. After an extinguisher has been used, designated personnel must promptly recharge or replace it (29 CFR 1910.157(c)(4)). The laboratory supervisor or CHO is also responsible for ensuring proper training and providing supplementary equipment as needed.

Special care must be used when handling solutions of chemicals in syringes with needles. Do not recap needles, especially when they have been in contact with chemicals. Remove the needle and discard it immediately after use in the appropriate sharps containers. Blunt-tip needles are available from a number of commercial sources and should be used unless a sharp needle is required to puncture rubber septa or for subcutaneous injection.

For unattended operations, laboratory lights should be left on, and signs should be posted to identify the nature of the experiment and the hazardous substances in use. Arrangements should be made, if possible, for other workers to periodically inspect the operation. Information should be clearly posted indicating who to contact in the event of an emergency. Depending on the nature of the hazard, special rules, precautions, and alert systems may be necessary.

9. Training and Information

Personnel training at all levels within the organization, is essential. Responsibility and accountability throughout the organization are key elements in a strong safety and health program. The employer is required to provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area (29 CFR 1910.1450(f)). This information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training should be determined by the employer. At a minimum, laboratory personnel should be trained on their facility's specific CHP, methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released), the physical and health hazards of chemicals in the work area and means to protect themselves from these hazards. Trained laboratory personnel must know shut-off procedures in case of an emergency. All SDSs must be made available to the employees.

E. General Procedures for Working with Chemicals

The risk of laboratory injuries can be reduced through adequate training, improved engineering, good housekeeping, safe work practice and personal behavior.

1. General Rules for Laboratory Work with Chemicals

(a) Assigned work schedules should be followed unless a deviation is authorized by the laboratory supervisor.

(b) Unauthorized experiments should not be performed.

(c) Plan safety procedures before beginning any operation.

(d) Follow standard operating procedures at all times.

(e) Always read the SDS and label before using a chemical.

(f) Wear appropriate PPE at all times.

(g) To protect your skin from splashes, spills and drips, always wear long pants and closed-toe shoes.

(h) Use appropriate ventilation when working with hazardous chemicals.

(i) Pipetting should never be done by mouth.

(j) Hands should be washed with soap and water immediately after working with any laboratory chemicals, even if gloves have been worn.

(k) Eating, drinking, smoking, gum chewing, applying cosmetics, and taking medicine in laboratories where hazardous chemicals are used or stored should be strictly prohibited.

(l) Food, beverages, cups, and other drinking and eating utensils should not be stored in areas where hazardous chemicals are handled or stored.

(m) Laboratory refrigerators, ice chests, cold rooms, and ovens should not be used for food storage or preparation.

(n) Contact the laboratory supervisor, Principal Investigator, CHO or EHS office with all safety questions or concerns.

(o) Know the location and proper use of safety equipment.

(p) Maintain situational awareness.

(q) Make others aware of special hazards associated with your work.

(r) Notify supervisors of chemical sensitivities or allergies.

(s) Report all injuries, accidents, incidents, and near misses.

(t) Unauthorized persons should not be allowed in the laboratory.

(u) Report unsafe conditions to the laboratory supervisor or CHO.

(v) Properly dispose of chemical wastes.

Working Alone in the Laboratory

Working alone in a laboratory is dangerous and should be strictly avoided. There have been many tragic accidents that illustrate this danger. Accidents are unexpected by definition, which is why coworkers should always be present. Workers should coordinate schedules to avoid working alone.

Housekeeping

Housekeeping can help reduce or eliminate a number of laboratory hazards. Proper housekeeping includes appropriate labeling and storage of chemicals, safe and regular cleaning of the facility, and proper arrangement of laboratory equipment.

2. Nanoparticles and Nanomaterials

Nanoparticles and nanomaterials have different reactivities and interactions with biological systems than bulk materials and understanding and exploiting these differences is an active area of research. However, these differences also mean that the risks and hazards associated with exposure to engineered nanomaterials are not well known. Because this is an area of ongoing research, consult trusted sources for the most up to date information available. Note that the higher reactivity of many nanoscale materials suggests that they should be treated as potential sources of ignition, accelerants, and fuel that could result in fire or explosion. Easily dispersed dry nanomaterials may pose the greatest health hazard because of the risk of inhalation. Operations involving these nanomaterials deserve more attention and more stringent controls than those where the nanomaterials are embedded in solid or suspended in liquid matrixes.

Consideration should be given to all possible routes of exposure to nanomaterials including inhalation, ingestion, injection, and dermal contact (including eye and mucous membranes). Avoid handling nanomaterials in the open air in a free particle state. Whenever possible, handle and store dispersible nanomaterials, whether suspended in liquids or in a dry particle form, in closed (tightly sealed) containers. Unless cutting or grinding occurs, nanomaterials that are not in a free form (encapsulated in a solid or a nanocomposite) typically will not require engineering controls. If a synthesis is being performed to create nanomaterials, it is not enough to only consider the final material in the risk assessment, but consider the hazardous properties of the precursor materials as well.

To minimize laboratory personnel exposure, conduct any work that could generate engineered nanoparticles in an enclosure that operates at a negative pressure differential compared to the laboratory personnel breathing zone. Limited data exist regarding the efficacy of PPE and ventilation systems against exposure to nanoparticles. However, until further information is available, it is prudent to follow standard chemical hygiene practices. Conduct a hazard evaluation to determine PPE appropriate for the level of hazard according to the requirements set forth in OSHA’s Personal Protective Equipment standard (29 CFR 1910.132).

3. Highly Toxic and Explosive/Reactive Chemicals/Materials

The use of highly toxic and explosive/ reactive chemicals and materials has been an area of growing concern. The frequency of academic laboratory incidents in the U.S. is an area of significant concern for the Chemical Safety Board (CSB). The CSB issued a case study on an explosion at Texas Tech University in Lubbock, Texas, which severely injured a graduate student handling a high-energy metal compound. Since 2001, the CSB has gathered preliminary information on 120 different university laboratory incidents that resulted in 87 evacuations, 96 injuries, and three deaths.

It is recommended that each facility keep a detailed inventory of highly toxic chemicals and explosive/reactive materials. There should be a record of the date of receipt, amount, location, and responsible individual for all acquisitions, syntheses, and disposal of these chemicals. A physical inventory should be performed annually to verify active inventory records. There should be a procedure in place to report security breaches, inventory discrepancies, losses, diversions, or suspected thefts.

Procedures for disposal of highly toxic materials should be established before any experiments begin, possibly even before the chemicals are ordered. The procedures should address methods for decontamination of any laboratory equipment that comes into contact with highly toxic chemicals. All waste should be accumulated in clearly labeled impervious containers that are stored in unbreakable secondary containment.

Highly reactive and explosive materials that may be used in the laboratory require appropriate procedures and training. An explosion can occur when a material undergoes a rapid reaction that results in a violent release of energy. Such reactions can happen spontaneously and can produce pressures, gases, and fumes that are hazardous. Some reagents pose a risk on contact with the atmosphere. It is prudent laboratory practice to use a safer alternative whenever possible.

If at all possible, substitutes for highly acute, chronic, explosive, or reactive chemicals should be considered prior to beginning work and used whenever possible.

4. Compressed Gas

Compressed gases expose laboratory personnel to both chemical and physical hazards. It is essential that these are monitored for leaks and have the proper labeling. By monitoring compressed gas inventories and disposing of or returning gases for which there is no immediate need, the laboratory can substantially reduce these risks. Leaking gas cylinders can cause serious hazards that may require an immediate evacuation of the area and activation of the emergency response system. Only appropriately trained hazmat responders may respond to stop a leaking gas cylinder under this situation.

F. Safety Recommendations—Physical Hazards

Physical hazards in the laboratory include combustible liquids, compressed gases, reactives, explosives and flammable chemicals, as well as high pressure/energy procedures, sharp objects and moving equipment. Injuries can result from bodily contact with rotating or moving objects, including mechanical equipment, parts, and devices. Personnel should not wear loose fitting clothing, jewelry, or unrestrained long hair around machinery with moving parts.

The Chemical Safety Board has identified the following key lessons for laboratories that address both physical and other hazards:

(1) Ensure that research-specific hazards are evaluated and then controlled by developing specific written protocols and training.

(2) Expand existing laboratory safety plans to ensure that all safety hazards, including physical hazards of chemicals, are addressed.

(3) Ensure that the organization’s EHS office reports directly to an identified individual/office with organizational authority to implement safety improvements.

(4) Develop a verification program that ensures that the safety provisions of the CHP are communicated, followed, and enforced at all levels within the organization.

(5) Document and communicate all laboratory near-misses and previous incidents to track safety, provide opportunities for education and improvement to drive safety changes at the university.

(6) Manage the hazards unique to laboratory chemical research in the academic environment. Utilize available practice guidance that identifies and describes methodologies to assess and control hazards.

(7) Written safety protocols and training are necessary to manage laboratory risk.

G. Emergency Planning

In addition to laboratory safety issues, laboratory personnel should be familiar with established facility policies and procedures regarding emergency situations. Topics may include, but are not limited to:

(1) Evacuation procedures—when it is appropriate and alternate routes;

(2) Emergency shutdown procedures—equipment shutdown and materials that should be stored safely;

(3) Communications during an emergency—what to expect, how to report, where to call or look for information;

(4) How and when to use a fire extinguisher;

(5) Security issues—preventing tailgating and unauthorized access;

(6) Protocol for absences due to travel restrictions or illness;

(7) Safe practices for power outage;

(8) Shelter in place—when it is appropriate;

(9) Handling suspicious mail or phone calls;

(10) Laboratory-specific protocols relating to emergency planning and response;

(11) Handling violent behavior in the workplace; and

(12) First-aid and CPR training, including automated external defibrillator training if available.

It is prudent that laboratory personnel are also trained in how to respond to short-term, long-term and large-scale emergencies. Laboratory security can play a role in reducing the likelihood of some emergencies and assisting in preparation and response for others. Every institution, department, and individual laboratory should consider having an emergency preparedness plan. The level of detail of the plan will vary depending on the function of the group and institutional planning efforts already in place.

Emergency planning is a dynamic process. As personnel, operations, and events change, plans will need to be updated and modified. To determine the type and level of emergency planning needed,

laboratory personnel need to perform a vulnerability assessment. Periodic drills to assist in training and evaluation of the emergency plan are recommended as part of the training program.

H. Emergency Procedures

(1) Fire alarm policy. Most organizations use fire alarms whenever a building needs to be evacuated—for any reason. When a fire alarm sounds in the facility, evacuate immediately after extinguishing all equipment flames. Check on and assist others who may require help evacuating.

(2) Emergency safety equipment. The following safety elements should be met:

a. A written emergency action plan has been provided to workers;

b. Fire extinguishers, eyewash units, and safety showers are available and tested on a regular basis; and

c. Fire blankets, first-aid equipment, fire alarms, and telephones are available and accessible.

(3) Chemical spills. Workers should contact the CHO or EHS office for instructions before cleaning up a chemical spill. All SDS and label instructions should be followed, and appropriate PPE should be worn during spill cleanup.

(4) Accident procedures. In the event of an accident, immediately notify appropriate personnel and local emergency responders. Provide an SDS of any chemical involved to the attending physician. Complete an accident report and submit it to the appropriate office or individual within 24 hours.

(5) Employee safety training program. New workers should attend safety training before they begin any activities. Additional training should be provided when they advance in their duties or are required to perform a task for the first time. Training documents should be recorded and maintained. Training should include hands-on instruction of how to use safety equipment appropriately.

(6) Conduct drills. Practice building evacuations, including the use of alternate routes. Practice shelter-in-place, including plans for extended stays. Walk the fastest route from your work area to the nearest fire alarm, emergency eye wash and emergency shower. Learn how each is activated. In the excitement of an actual emergency, people rely on what they learned from drills, practice and training.

(7) Contingency plans. All laboratories should have long-term contingency plans in place (e.g., for pandemics). Scheduling, workload, utilities, and alternate work sites may need to be considered.

I. Laboratory Security

Laboratory security has evolved in the past decade, reducing the likelihood of some emergencies and assisting in preparation and response for others. Most security measures are based on the laboratory's vulnerability. Risks to laboratory security include, but are not limited to:

(1) Theft or diversion of chemicals, biologicals, and radioactive or proprietary materials, mission-critical or high-value equipment;

(2) Threats from activist groups;

(3) Intentional release of, or exposure to, hazardous materials;

(4) Sabotage or vandalism of chemicals or high-value equipment;

(5) Loss or release of sensitive information; and

(6) Rogue work or unauthorized laboratory experimentation. Security systems in the laboratory are used to detect and respond to a security breach, or a potential security breach, as well as to delay criminal activity by imposing multiple layered barriers of increasing stringency. A good laboratory security system will increase overall safety for laboratory personnel and the public, improve emergency preparedness by assisting with preplanning, and lower the organization's liability by incorporating more rigorous planning, staffing, training, and command systems and implementing emergency communications protocols, drills, background checks, card access systems, video surveillance, and other measures. The security plan should clearly delineate response to security issues, including the coordination of institution and laboratory personnel with both internal and external responders.

[76 FR 33609, June 8, 2011; 77 FR 17888, March 26, 2012; 78 FR 4325, Jan. 22, 2013]

APPENDIX B TO 1910.1450

REFERENCES (NON-MANDATORY)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory.

(a) **Materials for the development of the Chemical Hygiene Plan:**

1. American Chemical Society, Safety in Academic Chemistry Laboratories, 4th edition, 1985.
2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.
3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL, 1978.
4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing Co., NY, 1978.
5. Kaufman, James A., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.
6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.
7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.
8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, DC, 1981.
9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, J. Chem. Ed., American Chemical Society, Easlon, PA, 1981.
10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA, 18042, Vol. I, 1967, Vol. II, 1971, Vol. III, 1974.
11. Steere, Norman V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.
12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.

(b) **Hazardous Substances Information:**

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211-4438.
2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.
4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.
5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.
6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).

7. IARC Monographs on the Evaluation of the Carcinogenic Risk of chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).
8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).
9. Occupational Health Guidelines, NIOSH/OSHA. NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.
10. Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes).
11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of documents US. Govt. Printing Office, Washington, DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.
14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications. Park Ridge, NJ, 1981.

(c) **Information on Ventilation:**

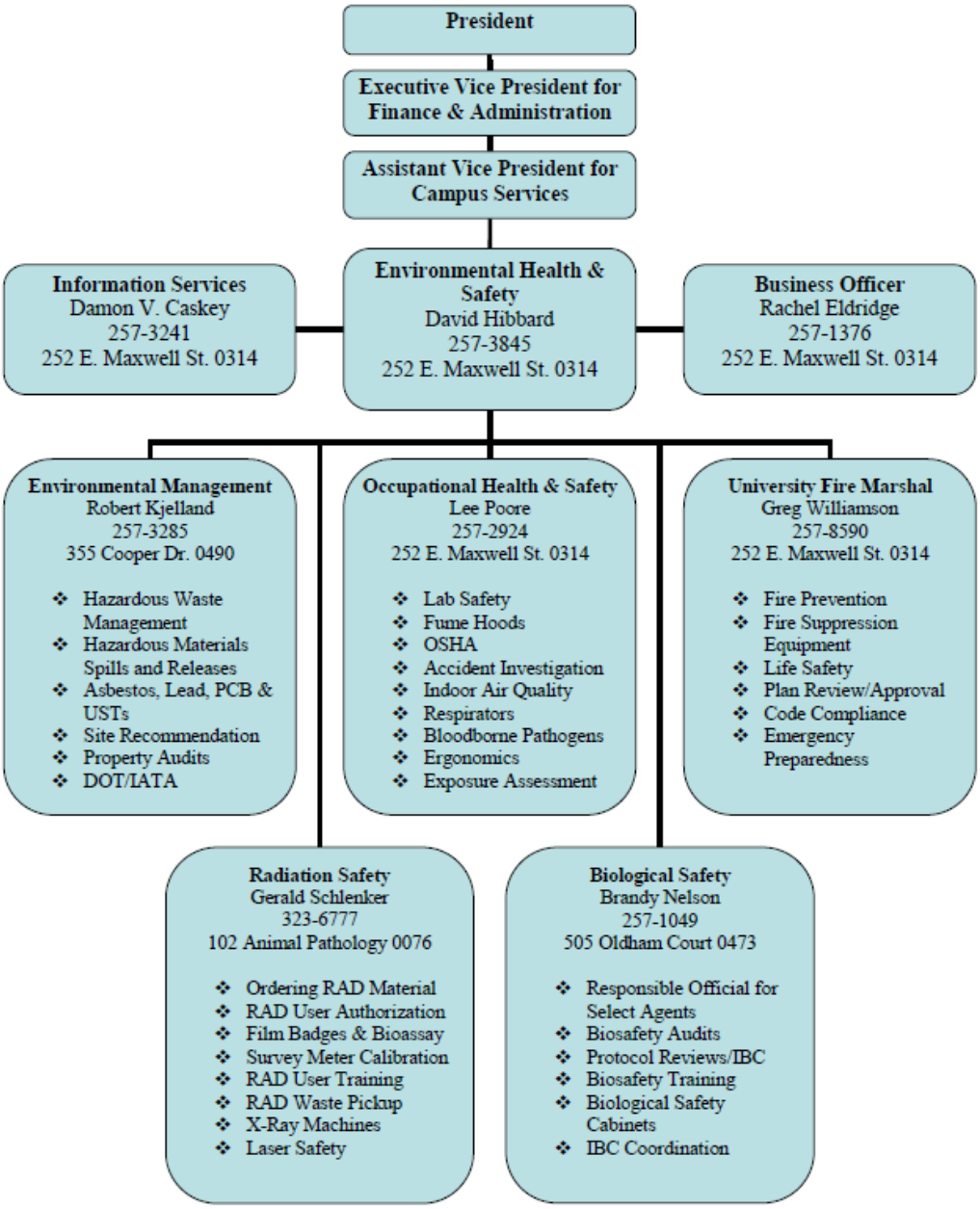
1. American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.
2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y. 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.
4. - National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.
   - Safety Standard for Laboratories in Health-Related Institutions, NFPA, 56c, 1980.
   - Fire Protection Guide on Hazardous Materials, 7th edition, 1978.
   - National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF7-1980, 1101 16th Street, NW., Washington, DC 20036.

(d) **Information on Availability of Referenced Material:**

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.
2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

APPENDIX II

University of Kentucky
Environmental Health and Safety Division



APPENDIX III

LABORATORY INSPECTION GUIDELINES

The following guide has been developed to assist you in your scheduled safety surveillance of laboratories and departments under your auspices as lab supervisor. This guide is by no means all encompassing, however information contained after each item should assist you in determining whether your area may be in full, partial or non-compliance.

Keep in mind that all federal, state and University rules, recommendations and regulations determine the compliance of our area concerning OSHA, EPA, NIH, CDC, and DOT. If you have any specific questions on the information below, please contact Occupational Health and Safety (257-3827).

1. Entrances, Exits, Hallways and Stairways - All entrances, exits, hallways and stairways must be clear and unobstructed.

2. Showers/Eye Wash - Any area which deals with corrosive, flammable or otherwise hazardous material is required to have immediate access to eyewash and drench shower facilities. Eye wash bottles are not adequate equipment. All showers and eye wash equipment must be in full operational order and unobstructed. Monthly inspections are required.

3. Personal Protective Equipment - Personal Protective Equipment such as goggles, masks, gloves, and cover gowns must be readily available and not worn outside the immediate work areas. Lab coats and appropriate shoes shall be worn to avoid any contact with harmful materials. Respirators shall be used when applicable. Evidence of respirator training and certification must be readily available.

4. Fire Extinguisher/Inspection and Location - All fire extinguishers must be inspected annually. Extinguishers must be properly mounted, unobstructed and be properly labeled for the intended use. Training classes are offered through the UK Fire Marshal.

5. Pressurized Cylinders - All cylinders must be stored in proper locations. All cylinders must be secured in an upright position and properly restrained to prevent falling. Containers must be labeled for contents and usage. Maximum number of cylinders of a flammable gas shall be not more than 3 (10” x 50”) per 500 ft^2 in an unsprinkled space or not more than 6 (10” x 50”) in a sprinkled space of 500 ft^2. Liquefied gas cylinders in laboratory work areas shall not

exceed 3 cylinders (9” x 30”) in a sprinkled space or exceed 2 cylinders (9” x 30”) in an unsprinkled space.

6. Room Use Identification - All access doors must be marked when rooms or areas are being used for chemical, biological, or radioactive purposes as outlined in the UK Chemical Hygiene Plan. All doors must remain closed and the vision panel must remain unobstructed. Unattended labs shall always be locked.

7. Underwriters Laboratories (UL) Electrical Equipment and Cords - Only UL-approved equipment and cords are authorized for use. Only UL listed multiple outlet strips equipped with 15 AMP circuit breakers are approved.

8. Laboratory chemical fume hood operation - Face Velocities should be between 80 and 150 fpm at the working sash height with an optimum level of 100 fpm. The sash should never be higher than 12 inches except **when accessing equipment**. Hoods should not be located in high traffic areas or under air supply vents. The hood must have user spill protection and cup sinks must have spill guards.

9. Biological Safety Cabinets – Inspection and certification is required annually or any time the hood is moved or has had maintenance performed. Cabinets must not be located near high traffic areas or air supply ducts.

10. Hazardous Chemicals - All chemicals must be appropriately labeled and shall not be placed near or over floor drains. Flammable liquids must be stored in appropriate containers. There should be no more than 5 gallons of solvents or Class IA or IB flammables per 100 ft^2 out in the lab. No more than 10 gallons per 100 ft^2 should be in flammable storage cabinets. For larger storage capacities and long-term storage of flammables and solvents, an approved storage area should be used. For more information consult the UK Fire Marshal.

11. Hazardous Waste Disposal - Hazardous waste training is required for all employees who handle hazardous material. The Office of Environmental Management (EM) provides online training at https://ehs.uky.edu/env/hazardous_training.php.

12. Equipment and Utility Labeling - Refrigerators, ice machines and microwaves must be labeled for intended use. Food, personal medication, and hazardous materials shall not be housed in the same refrigerator. All utility and plumbing lines need to be labeled and indicate the product contained, i.e., gas, water, etc.

13. Location of Cut-off Valves/Circuit Breakers - All cut off valves and breakers must be properly labeled.

14. General Safety (Dress, Eating, Smoking, etc.) - Eating, drinking, smoking, and applying cosmetics is not permitted in a wet lab. Lab personnel shall not wear loose clothing (e.g. saris, dangling neckties, overly large or ragged lab coats), skimpy clothing (e.g. shorts and/or halter-tops), torn clothing, or unrestrained long hair. Perforated shoes, sandals, or cloth sneakers are not to be worn in labs.

15. Use of Flame and Heat - No heat generating devices should be left unattended.

16. Ventilation - Airflow in most labs should be “negative” with respect to the corridor. Laboratory doors shall be kept closed when laboratory procedures are in progress. Volatile hazardous materials shall not be used on the open bench top.

17. Housekeeping/Drains Flushed - All unnecessary material, boxes, and containers must be disposed of in the appropriate manner. All drains, including floor drains and cup sinks should be flushed with water on a weekly basis to eliminate sewer odors. Proper housekeeping must be maintained to provide adequate clearance of sprinkler systems and emergency equipment.

18. Sharps (Glass, Scalpel, Blades, Syringes, Etc.) - All sharps, needles and glass must be disposed of in an approved, labeled container. Glass containers and other potentially sharp objects shall not be disposed of in common office refuse. Containers must not be overfilled and must be labeled and sealed with tape when ready for disposal.

19. Emergency lighting - Where necessary, emergency lighting units shall be properly mounted and unobstructed. If emergency lighting exists, it should be checked periodically to ensure functionality.

20. Emergency Plans/Posted Numbers - All emergency and contingency plans and evacuation routes shall be clearly posted in conspicuous places. A list of emergency numbers and contacts must be kept updated and posted alongside the emergency plans.

21. Safety Manuals - Manuals must be current and readily available for all employees.

22. Accidents Reported/Investigated - All accidents must be reported to the immediate supervisor for the completion of the appropriate form. File copies of

reported incidents and accidents must be on hand, as well as the action taken to alleviate the safety hazard in the future.

23. Safety Training - This area is designated for lab safety training which is required by law.

Inspection Results

EHS is proud to announce the adoption of BioRAFT, a cloud-based laboratory inspection software system: https://uky.bioraft.com/.
After the laboratory inspection has concluded, laboratory personnel will be sent an automatic email through BioRAFT concerning the violations that need correction and helpful tips to aid in the correction process. Any concerns or questions can be discussed through the BioRAFT messaging platform, or by emailing the inspector directly.

Effective January 1, 2007, inspections will document violations that persist year after year as a Repeat Violation. When a Repeat Violation is documented, a follow-up inspection will be conducted within 30 calendar days from the date the violation was documented. If the violation has not been corrected at the time of the follow-up inspection, the violation is referred to the appropriate senior academic official or administrative official for action.

If a Willful Violation is documented, the violation is immediately referred to the appropriate senior academic official or administrative official for action.

If a Facility Violation is documented, Occupational Health and Safety (OHS) will forward a notice of deficiency to the appropriate department for correction, e.g., Physical Plant Division, Fire Marshal's Office.

It is the department's responsibility to determine how best to follow-up and ensure these violations are corrected. Many departments have used their safety committees for this function. OHS remains available to assist in correcting any and all violations.

APPENDIX III

LABORATORY SELF INSPECTION FORM

Department: _____ Building: _____ Room Number: _____

Department Safety Officer: _____ Inspector: _____

Lab Supervisor: _____ Inspection Date: _____

Chairman: _____ Re-inspection Due: _____

S=Satisfactory; U=Unsatisfactory

Item	S	U	Comment	Corrective Action Taken
1. Entrances, exits, hallways, stairways				
2. Showers/eye wash operative				
3. Personal protective equipment				
4. Fire extinguishers/inspection & location				
5. Pressurized cylinders: storage/usage label				
6. Room use identification/labeling				
7. UL Electrical equipment & cords				
8. Laboratory chemical hood operation				
9. Biological safety cabinets				
Certification				
Use				
10. Hazardous Chemicals				
Labeling				
Storage/amount/location				
Handling				

APPENDIX III (cont'd)

Laboratory Self Inspection Form

Item	S	U	Comments	Corrective Action Taken
11. Hazardous Waste Disposal				
Training certificate				
Labeling				
Storage				
Disposal				
12. Equipment and utility labeling				
13. Location of cut-off valves/circuit breakers				
14. General safety (dress, eating, smoking, etc.)				
15. Use of flame and heat				
16. Ventilation				
17. Housekeeping/drains flushed				
18. Sharps (glass, scalpel, blades, syringe, etc.)				
19. Emergency lighting				
20. Emergency plan/posted numbers				
21. Safety manuals				
22. Accidents reported/investigated				
23. Safety training: Date: _____				
Subject: _____				

Laboratory safety questions? Call Occupational Health and Safety at 257-3827, for information and referrals.

APPENDIX IV

GLOVE SELECTION GUIDANCE

Resistant Properties of Selected Materials by Chemical Class

Chemicals	Butyl	CPE	Viton™/ neoprene	Natural rubber	Neoprene	Nitrile + PVC	Nitrile	PE	PVA	PVC	Viton	Butyl/ neoprene
Acids, carboxylic and aliphatic												
Unsubstituted	R	r	r	**	rr	**	rr	NN	**	**	**	R
Polybasic					rr	rr	rr	rr	n	rr		
Aldehydes												
Aliphatic and alicyclic	RR	NN	r	**	NN	nn	NN	**	NN	NN	**	r
Aromatic and heterocyclic	rr		n	nn	nn	n	nn	NN	rr	N		r
Amides	rr			**	nn		nn	nn			nn	
Amines, aliphatic and alicyclic												
Primary	**	**	n	NN	**		rr		nn	**	**	
Secondary	**		n	NN	nn		**		**	NN	nn	n
Tertiary	**	**		**	**	**	**		**	**	rr	
Polyamine	**			NN	**	nn				NN	rr	
Cyanides					r							
Esters, carboxylic												
Formats			n							n		n
Acetates	**	**	n	NN	nn	nn	NN	NN	**	NN	n	**

Higher monobasic	nn	nn	**	NN	nn		nn	NN	rr	NN		**
Polybasic			r	r	r		**			rr		r
Aromatic phthalate	rr		r	**	**		**			nn	rr	r
Ethers Aliphatic	** **	 rr	 **	 NN	 **	 **	 **		 **	 **		 **
Halogen compounds Aliphatic, unsubstituted Aliphatic, substituted Aromatic, unsubstituted Polynuclear Vinyl halides	nn ** nn	nn nn	r r	NN NN N NN	NN rr nn	NN n	NN nn nn	NN NN	** **	NN NN N n n	** rr rr rr rr	n n
Heterocyclic compounds Epoxy compounds Furan derivatives	** nn		 nn	**	nn		nn	NN	**	nn NN	NN nn	 n
Hydrazines	**	nn	n	**	**		**		nn	**	**	n
Hydrocarbons Aliphatic and alicyclic Aromatic	 N **	 r rr	 r r	 NN NN	 ** NN	 ** NN	 ** **	 ** NN	 ** **	 NN NN	 RR RR	 n r

Hydroxyl compounds Aliphatic and alicyclic Primary Secondary Tertiary Polyols Aromatic	RR rr r r **	rr rr	rr r ** r	nn ** ** rr **	** ** rr rr **	nn ** rr rr **	** rr rr rr **	** **	** rr nn	** ** ** ** **	rr rr rr	** r ** r
Inorganic acids	**	**	rr	**	**	**	**	**	n	**	rr	**
Inorganic base	r	r		RR	RR	**	RR	**	n	**	rr	r
Inorganic gases	**	r	n	n	r			**		**	**	**
Inorganic salts**	r		n	**	r	r	r			R		
Isocyanates				NN	n				rr			
Ketones, aliphatic	**	NN	n	NN	NN	N	**	NN	**	NN	NN	**
Nitriles, aliphatic	rr			NN	**			NN	rr	NN	rr	
Nitro compounds Unsubstituted	rr	r		NN	**		nn		**	**	**	
Organo-phosphorous compounds			r									r
Peroxides				r								
Sulfur compounds Thiols			**									n

Legend:

RR, R, rr and r represent positive degrees of resistance.
NN, N, nn and n represent degrees of poor resistance.
Double characters indicate that the rating is based on test data.
Single characters indicate that the rating is based on qualitative data.

Upper-case letters indicate a large body of consistent data.
Lower-case letters indicate either a small quantity of data or inconsistent information.
Asterisks (**) mean that the material varied considerably in its resistance to chemicals within a given class and data for specific chemicals should be used if available.

Butyl - Butyl rubber
PVC - Polyvinyl chloride
PE - Polyethylene

Nitrile + PVC - Nitrile rubber + polyvinyl chloride

Natural rubber - same
CPE - Chlorinated polyethylene
Viton - same

PVA - Polyvinyl alcohol

Nitrile - Nitrile rubber
Neoprene - same
Viton™/Neoprene - layered material, 1st material on surface
Butyl/Neoprene - layered material, 1st material on surface

Taken from CRC Handbook of Laboratory Safety, 3rd edition.

Chemical Resistance to Common Glove Materials*
(E=Excellent, G=Good, F=Fair, P=Poor)

Chemical	Natural Rubber	Neoprene	Nitrile	Vinyl
Acetaldehyde	G	G	E	G
Acetic acid	E	E	E	E
Acetone	G	G	G	F
Acrylonitrile	P	G	-	F
Ammonium hydroxide	G	E	E	E
Aniline	F	G	E	G
Benzaldehyde	F	F	E	G
Benzene	P	F	G	F
Benzyl chloride	F	P	G	P
Bromine	G	G	-	G
Butane	P	E	-	P
Calcium hypochlorite	P	G	G	G
Carbon disulfide	P	P	G	F
Carbon tetrachloride	P	F	G	F
Chlorine	G	G	-	G
Chloroacetone	F	E	-	P
Chloroform	P	F	G	P
Chromic Acid	P	F	F	E
Cyclohexane	F	E	-	P
Dibenzyl ether	F	G	-	P
Dibutyl phthalate	F	G	-	P
Diethanolamine	F	E	-	E
Diethyl ether	F	G	E	P
Dimethyl sulfoxide	-	-	-	-
Ethyl acetate	F	G	G	F
Ethylene dichloride	P	F	G	P
Ethylene glycol	G	G	E	E
Ethylene trichloride	P	P	-	P
Fluorine	G	G	-	G
Formaldehyde	G	E	E	E
Formic acid	G	E	E	E
Glycerol	G	G	E	E
Hexamine	P	E	-	P
Hydrobromic acid (40%)	G	E	-	E
Hydrochloric acid (conc)	G	G	G	E
Hydrofluoric acid (30%)	G	G	G	E
Hydrogen peroxide	G	G	G	E
Iodine	G	G	-	G
Methylamine	G	G	E	E
Methyl cellosolve	F	E	-	P
Methyl chloride	P	E	-	P
Methyl ethyl ketone	F	G	G	P
Methylene chloride	F	F	G	F
Monoethanolamine	F	E	-	E
Morpholine	F	E	-	E
Naphthalene	G	G	E	G
Nitic acid (conc)	P	P	P	G
Perchloric acid	F	G	F	E
Phenol	G	E	-	E
Phosphoric acid	G	E	-	E
Potassium hydroxide (sat)	G	G	G	E
Propylene dichloride	P	F	-	P
Sodium hydroxide	G	G	G	E
Sodium hypochlorite	G	P	F	G
Sulfuric acid (conc)	G	G	F	G
Toluene	P	F	G	F

Trichloroethylene	P	F	G	F
Tricresyl phosphate	P	F	-	F
Triethanolamine	F	E	E	E
Trinitrotoluene	P	E	-	P

Aromatic and halogenated hydrocarbons will attack all types of natural and synthetic glove materials. Should swelling occur, the user should change to fresh gloves and allow the swollen gloves to dry and return to normal.

No data on the resistance to dimethyl sulfoxide of natural rubber, neoprene, nitrile rubber, or vinyl materials are available; the manufacturer of the substance recommends the use of butyl rubber gloves.

**Taken from Prudent Practices for Handling Hazardous Chemicals in Laboratories, 1981.*

Other web resources:

http://www.chemrest.com

http://www.ansell-edmont.com/download/Ansell_7thEditionChemicalResistanceGuide.pdf

APPENDIX V

EXAMPLES OF INCOMPATIBLE CHEMICALS

From: "Safety in Academic Chemistry Laboratories" by the American Chemical Society

Chemical	Is Incompatible With
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium)	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury (in manometers, for example), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid and chromium	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen Sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids

Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	All other chemicals
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium Peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals, or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), Hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen: flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (see also, chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric Acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural

Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing agents

APPENDIX VI

ACCIDENT REPORTING PROCEDURES

All accidents, injuries, or illnesses must be reported as quickly as possible.

The following accidents MUST BE REPORTED to Occupational Health and Safety IMMEDIATELY by calling (859) 227-7499. A representative of the University of Kentucky's OHS Department will need to obtain the required information.

- Any fatal accident requiring hospitalization of one or more people; any injury/illness that results in the loss of consciousness
- Any injury that results in 2nd degree burns to more than 30% of the body or 3rd degree burns to more than 20% of the body,
- Any incident that results in an amputation,
- Or any incident that results in injuries and/or illnesses to more than two employees

Refer to the University's Occupational Injury and Exposure Protocol for Laboratories for accident reporting for laboratories. The chart is below.

STUDENT OR VISITOR ACCIDENTS

Any faculty or staff member witnessing or being informed of an accident involving a student or a visitor should report the accident using the University's Incident Reporting System. This system will generate a form referred to as, Form 6. Please forward this form to OHS at: jerhin2@uky.edu.

EMPLOYEE ACCIDENTS

Employee accidents should be reported immediately by the employee's supervisor. *Student workers receiving pay* other than scholarships, fellowships, student loans, or grants *are considered employees*. All employee accidents are to be reported to **UK Workers' Comp Care** by calling **1-800-440-6285**.

Also, the accident, injury, or illness should be reported internally using the University's Form 6.

For all accidents/incidents at UK HealthCare please report at Care Web.

PROPERTY DAMAGE ACCIDENTS

Property Damage accidents such as fire, water, wind, theft, and other property damage claims are not reported on any one form. After a loss is discovered, the loss should be reported to the Department head who will contact the University's Risk Manager at 859-257-3372.

OCCUPATIONAL INJURY OR EXPOSURE PROTOCOL FOR LABORATORIES

Compliance with the NIH Guidelines for Recombinant DNA requires that the University of Kentucky, as a recipient of NIH funds, "report any significant problems, violations of the NIH Guidelines, or any significant research-related accidents or illnesses" (Sections IV-B-1-j, -2-b-(7), -3-c-(2), -7-a-(3)). Compliance with the Occupational Safety and Health Act General Duty Clause requires that the University of Kentucky provide "a place of employment which [is] free from recognized hazards that are causing or are likely to cause death or serious physical harm to [its] employees" (Sec. 5 Duties).

DEFINITIONS:

Infectious Agent Microorganisms capable of invasion and multiplication in humans, animals, plants, or insects.

Large Spill A spill of greater than 50 mL of hazardous material that occurs outside a biological safety cabinet, chemical fume hood, or other containment device.

Recombinant DNA (rDNA) Defined by the NIH as molecules that are constructed outside living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in a living cell or molecules that result from the replication of those described above. The definition has been expanded to cover all nucleic acids.

Occupational Exposure Any potential exposure to chemical, radiological, or biological hazard in the workplace with or without the presence of a physical injury.

Reportable Incident Any accident that leads to personal injury or illness. Any breach of containment. Any violation of the NIH Guidelines. Examples of reportable incidents include but are not limited to large spills, needle-sticks, animal bites from infected animals, and unprotected skin exposures to biological, chemical, or radiological hazards.

PERFORM APPROPRIATE RESPONSE AS INDICATED BY INJURY.
FOR MEDICAL EMERGENCIES CALL 911 OR GO TO THE EMERGENCY ROOM.

- Injury or Exposure Requiring Medical Attention.
- Injury or Exposure Requiring Only First Aid. Follow Flowchart on Reverse Side.

UK EMPLOYEES

8:00 am-4:30 pm

- Call UK Worker's Care at 9-1-800-440-6285.
- Report a potential occupational exposure to chemical hazard, radiation hazard, rDNA, or infectious agent.
- An appointment will be made for you at UHS.

4:30 pm-8:00 am & holidays

- Call UK Worker's Care at 9-1-800-440-6285.
- Report a potential occupational exposure to chemical hazard, radiation hazard, rDNA, or infectious agent.
- An appointment will be made for you at UHS the next working day.

VISITING SCIENTISTS, VOLUNTEERS, AND OTHERS

- Contact your local health care provider/physician.
- Report a potential occupational exposure to chemical hazard, radiation hazard, rDNA, or infectious agent.

UK STUDENTS

8:00 am-4:30 pm

- Call UHS at 323-APPT.
- Report a potential occupational exposure to chemical hazard, radiation hazard, rDNA, or infectious agent.
- An appointment will be made for you at UHS.

4:30 pm-8:00 am & holidays

- Call UHS physician on call at 323-5321.
- Ask for UHS physician. Report a potential occupational exposure to chemical hazard, radiation hazard, rDNA, or infectious agent.
- Make an appointment at UHS the next working day.

OCCUPATIONAL INJURY OR EXPOSURE PROTOCOL FOR LABORATORIES

DEFINITIONS:

Strain An injury to a muscle in which the muscle fibers tear as a result of overstretching. Typical symptoms are localized pain, stiffness, inflammation, and bruising (e.g. back, shoulder, wrist).

Contusion An injury to biological tissues in which capillaries are damaged allowing blood to seep into the surrounding tissue. Also known as a bruise.

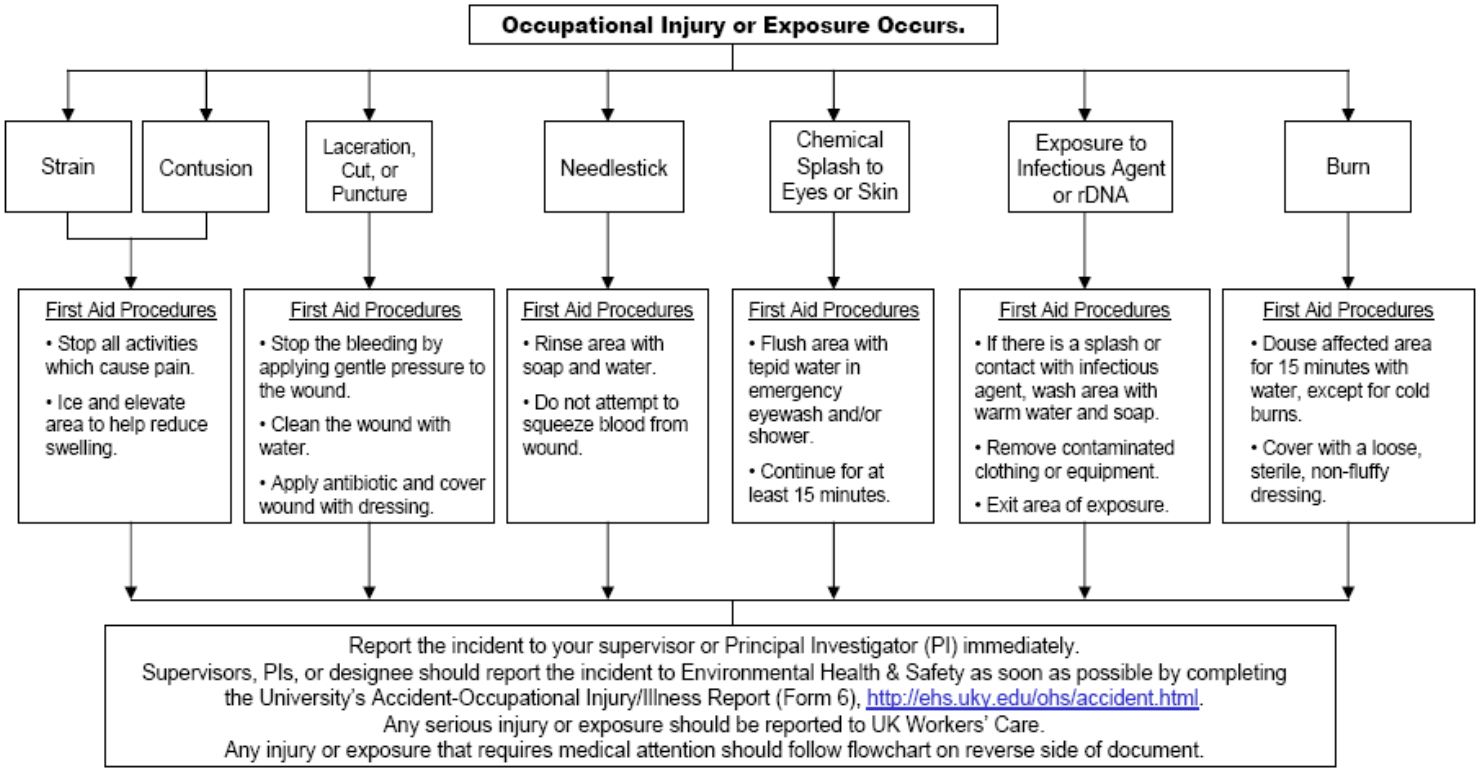
Laceration/Cut/Puncture An open wound where the skin is torn, cut, or punctured.

Burn A type of injury caused by heat, cold, electricity, chemicals, or radiation.

Needlestick An injury that results from sharps potentially contaminated with another persons blood or other potentially infectious material.

Exposure to Infectious Agent An exposure via contact, ingestion, inhalation, or absorption to an infectious agent such as HIV, TB, Hepatitis A, or other human or zoonotic disease.

Serious Injury or Exposure Any fatal accident, any accident requiring hospitalization of one or more people, any injury/illness that results in the loss of consciousness, any injury that results in 2nd degree burns to more than 30% of the body or 3rd degree burns to more than 20% of the body, any incident that results in amputation, or any incident that results in injuries and/or illnesses to more than two employees.



APPENDIX VII

NATIONAL TOXICOLOGY PROGRAM
THE Fourteenth Report on Carcinogens

Substances Listed in the Fourteenth Report on Carcinogens
Bold entries indicate new or changed listings in the Fourteenth Report on Carcinogens.

Known to Be Human Carcinogens

Aflatoxins
Alcoholic Beverage Consumption
4-Aminobiphenyl
Analgesic Mixtures Containing Phenacetin (see Phenacetin and Analgesic Mixtures Containing Phenacetin)
Aristolochic Acids
Arsenic and Inorganic Arsenic Compounds
Asbestos
Azathioprine
Benzene
Benzidine (see Benzidine and Dyes Metabolized to Benzidine)
Beryllium and Beryllium Compounds
Bis(chloromethyl) Ether and Technical-Grade Chloromethyl Methyl Ether
1,3-Butadiene
1,4-Butanediol Dimethanesulfonate
Cadmium and Cadmium Compounds
Chlorambucil
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (see Nitrosourea Chemotherapeutic Agents)
Chromium Hexavalent Compounds
Coal Tars and Coal-Tar Pitches
Coke-Oven Emissions
Cyclophosphamide
Cyclosporin A
Diethylstilbestrol
Dyes Metabolized to Benzidine (Benzidine Dye Class) (see Benzidine and Dyes Metabolized to Benzidine)
Epstein-Barr Virus (see Viruses: Eight Listings)
Erionite
Estrogens, Steroidal
Ethylene Oxide
Formaldehyde

Hepatitis B Virus (see Viruses: Eight Listings)
Hepatitis C Virus (see Viruses: Eight Listings)
Human Immunodeficiency Virus Type 1 (see Viruses: Eight Listings)
Human Papillomaviruses: Some Genital-Mucosal Types (see Viruses: Eight Listings)
Human T-Cell Lymphotropic Virus Type 1 (see Viruses: Eight Listings)
Kaposi Sarcoma–Associated Herpesvirus (see Viruses: Eight Listings)
Melphalan
Merkel Cell Polyomavirus (see Viruses: Eight Listings)
Methoxsalen with Ultraviolet A Therapy
Mineral Oils: Untreated and Mildly Treated
Mustard Gas
2-Naphthylamine
Neutrons (see Ionizing Radiation)
Nickel Compounds (see Nickel Compounds and Metallic Nickel)
Radon (see Ionizing Radiation)
Silica, Crystalline (Respirable Size)
Solar Radiation (see Ultraviolet Radiation Related Exposures)
Soot
Strong Inorganic Acid Mists Containing Sulfuric Acid
Sunlamps or Sunbeds, Exposure to (see Ultraviolet Radiation Related Exposures)
Tamoxifen
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin
Thiotepa
Thorium Dioxide (see Ionizing Radiation)
Tobacco Smoke, Environmental (see Tobacco-Related Exposures)
Tobacco Smoking (see Tobacco-Related Exposures)
Tobacco, Smokeless (see Tobacco-Related Exposures)
o-Toluidine
Trichloroethylene
Ultraviolet Radiation, Broad-Spectrum (see Ultraviolet Radiation Related Exposures)
Vinyl Chloride (see Vinyl Halides [selected])
Wood Dust
X-Radiation and Gamma Radiation (see Ionizing Radiation)

Reasonably Anticipated to Be Human Carcinogens

Acetaldehyde
2-Acetylaminofluorene
Acrylamide
Acrylonitrile
Adriamycin
2-Aminoanthraquinone
o-Aminoazotoluene

1-Amino-2,4-dibromoanthraquinone
2-Amino-3,4-dimethylimidazo[4,5-*f*]quinoline (see Heterocyclic Amines [Selected])
2-Amino-3,8-dimethylimidazo[4,5-*f*]quinoxaline (see Heterocyclic Amines [Selected])
1-Amino-2-methylanthraquinone
2-Amino-3-methylimidazo[4,5-*f*]quinoline (see Heterocyclic Amines [Selected])
2-Amino-1-methyl-6-phenylimidazo[4,5-*b*]pyridine (see Heterocyclic Amines [Selected])
Amitrole
o-Anisidine and Its Hydrochloride
Azacitidine
Basic Red 9 Monohydrochloride
Benz[*a*]anthracene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzo[*b*]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzo[*j*]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzo[*k*]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzo[*a*]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzotrichloride
2,2-Bis(bromomethyl)-1,3-propanediol (Technical Grade)
Bis(chloroethyl) Nitrosourea (see Nitrosourea Chemotherapeutic Agents)
Bromodichloromethane
1-Bromopropane
Butylated Hydroxyanisole
Captafol
Carbon Tetrachloride
Ceramic Fibers (Respirable Size)
Chloramphenicol
Chlorendic Acid
Chlorinated Paraffins (C_{12}, 60% Chlorine)
Chloroform
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (see Nitrosourea Chemotherapeutic Agents)
3-Chloro-2-methylpropene
4-Chloro-*o*-phenylenediamine
Chloroprene
p-Chloro-*o*-toluidine and Its Hydrochloride
Chlorozotocin (see Nitrosourea Chemotherapeutic Agents)
Cisplatin
Cobalt and Cobalt Compounds That Release Cobalt Ions *In Vivo* (see Cobalt-Related Exposures)
Cobalt–Tungsten Carbide: Powders and Hard Metals (see Cobalt-Related Exposures)
p-Cresidine
Cumene
Cupferron
Dacarbazine

Danthron
2,4-Diaminoanisole Sulfate
2,4-Diaminotoluene
Diazoaminobenzene
Dibenz[*a,h*]acridine (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenz[*a,j*]acridine (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenz[*a,h*]anthracene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
7H-Dibenzo[*c,g*]carbazole (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenzo[*a,e*]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenzo[*a,h*]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenzo[*a,i*]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenzo[*a,l*]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
2,3-Dibromo-1-propanol
1,4-Dichlorobenzene
3,3′-Dichlorobenzidine and Its Dihydrochloride
Dichlorodiphenyltrichloroethane
1,2-Dichloroethane
Dichloromethane
1,3-Dichloropropene (Technical Grade)
Diepoxybutane
Diesel Exhaust Particulates
Di(2-ethylhexyl) Phthalate
Diethyl Sulfate
Diglycidyl Resorcinol Ether
3,3′-Dimethoxybenzidine (see 3,3′-Dimethoxybenzidine and Dyes Metabolized to 3,3′-Dimethoxybenzidine)
4-Dimethylaminoazobenzene
3,3′-Dimethylbenzidine (see 3,3′-Dimethylbenzidine and Dyes Metabolized to 3,3′-Dimethylbenzidine)
Dimethylcarbamoyl Chloride
1,1-Dimethylhydrazine
Dimethyl Sulfate
Dimethylvinyl Chloride
1,6-Dinitropyrene (see Nitroarenes [Selected])
1,8-Dinitropyrene (see Nitroarenes [Selected])
1,4-Dioxane
Disperse Blue 1
Dyes Metabolized to 3,3′-Dimethoxybenzidine (3,3′-Dimethoxybenzidine Dye Class) (see 3,3′-Dimethoxybenzidine and Dyes Metabolized to 3,3′-Dimethoxybenzidine)

Dyes Metabolized to 3,3′-Dimethylbenzidine (3,3′-Dimethylbenzidine Dye Class) (see 3,3′-Dimethylbenzidine and Dyes Metabolized to 3,3′-Dimethylbenzidine)
Epichlorohydrin
Ethylene Thiourea
Ethyl Methanesulfonate
Furan
Glass Wool Fibers (Inhalable), Certain
Glycidol
Hexachlorobenzene
Hexachloroethane
Hexamethylphosphoramide
Hydrazine and Hydrazine Sulfate
Hydrazobenzene
Indeno[1,2,3-*cd*]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Iron Dextran Complex
Isoprene
Kepone
Lead and Lead Compounds
Lindane, Hexachlorocyclohexane (Technical Grade), and Other Hexachlorocyclohexane Isomers
2-Methylaziridine
5-Methylchrysene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
4,4′-Methylenebis(2-chloroaniline)
4,4′-Methylenebis(*N,N*-dimethyl) benzenamine
4,4′-Methylenedianiline and Its Dihydrochloride
Methyleugenol
Methyl Methanesulfonate
N-Methyl-*N*′-Nitro-*N*-Nitrosoguanidine (see *N*-Nitrosamines: 15 Listings)
Metronidazole
Michler’s Ketone
Mirex
Naphthalene
Nickel, Metallic (see Nickel Compounds and Metallic Nickel)
Nitrilotriacetic Acid
o-Nitroanisole
Nitrobenzene
6-Nitrochrysene (see Nitroarenes [Selected])
Nitrofen
Nitrogen Mustard Hydrochloride
Nitromethane
2-Nitropropane
1-Nitropyrene (see Nitroarenes [Selected])
4-Nitropyrene (see Nitroarenes [Selected])

N-Nitrosodi-*n*-butylamine (see *N*-Nitrosamines: 15 Listings)
N-Nitrosodiethanolamine (see *N*-Nitrosamines: 15 Listings)
N-Nitrosodiethylamine (see *N*-Nitrosamines: 15 Listings)
N-Nitrosodimethylamine (see *N*-Nitrosamines: 15 Listings)
N-Nitrosodi-*n*-propylamine (see *N*-Nitrosamines: 15 Listings)
N-Nitroso-*N*-ethylurea (see *N*-Nitrosamines: 15 Listings)
4-(*N*-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone (see *N*-Nitrosamines: 15 Listings)
N-Nitroso-*N*-methylurea (see *N*-Nitrosamines: 15 Listings)
N-Nitrosomethylvinylamine (see *N*-Nitrosamines: 15 Listings)
N-Nitrosomorpholine (see *N*-Nitrosamines: 15 Listings)
N-Nitrosonornicotine (see *N*-Nitrosamines: 15 Listings)
N-Nitrosopiperidine (see *N*-Nitrosamines: 15 Listings)
N-Nitrosopyrrolidine (see *N*-Nitrosamines: 15 Listings)
N-Nitrososarcosine (see *N*-Nitrosamines: 15 Listings)
o-Nitrotoluene
Norethisterone
Ochratoxin A
4,4′-Oxydianiline
Oxymetholone
Pentachlorophenol and By-products of Its Synthesis
Phenacetin (see Phenacetin and Analgesic Mixtures Containing Phenacetin)
Phenazopyridine Hydrochloride
Phenolphthalein
Phenoxybenzamine Hydrochloride
Phenytoin and Phenytoin Sodium
Polybrominated Biphenyls
Polychlorinated Biphenyls
Procarbazine and Its Hydrochloride
Progesterone
1,3-Propane Sultone
β-Propiolactone
Propylene Oxide
Propylthiouracil
Reserpine
Riddelliine
Safrole
Selenium Sulfide
Streptozotocin (see Nitrosourea Chemotherapeutic Agents)
Styrene
Styrene-7,8-oxide
Sulfallate
Tetrachloroethylene

Tetrafluoroethylene
Tetranitromethane
Thioacetamide
4,4′-Thiodianiline
Thiourea
Toluene Diisocyanates
Toxaphene
2,4,6-Trichlorophenol
1,2,3-Trichloropropane
Tris(2,3-dibromopropyl) Phosphate
Ultraviolet Radiation A (see Ultraviolet Radiation Related Exposures)
Ultraviolet Radiation B (see Ultraviolet Radiation Related Exposures)
Ultraviolet Radiation C (see Ultraviolet Radiation Related Exposures)
Urethane
Vinyl Bromide (see Vinyl Halides [Selected])
4-Vinyl-1-cyclohexene Diepoxide
Vinyl Fluoride (see Vinyl Halides [Selected])

LAB SPECIFIC TRAINING REQUIREMENTS

Annually the PI and Laboratory Supervisors need to review the requirements of the Chemical Hygiene Plan (CHP) as well as any changes that have occurred in the lab, and update their CHP as needed Below is a list of topics that need to be reviewed.

- The location and availability of the OSHA Lab Standard, the laboratory's Chemical Hygiene Plan (CHP), chemical reference materials (such as safety data sheets), and permissible exposure limits for applicable chemicals.

- The signs and symptoms associated with exposure to the hazardous chemicals with which employees work.

- Detection methods and observations that may be used to detect the presence or release of a hazardous chemical in the lab (e.g. odor, monitoring equipment, or visual appearance).

- The physical and health hazards of the chemicals with which employees work.

- Work practices, personal protective equipment, and emergency procedures to be used to ensure protection from overexposure to the hazardous chemicals with which employees work; and

- How to use personal protective equipment and limitations of personal protective equipment.

In addition to the training provided by the Laboratory Supervisor, it is the employee’s responsibility to request information and training when unsure how to handle a hazardous chemical or laboratory procedure and to follow all health and safety rules while working in the lab.

LABORATORY-SPECIFIC INITIAL SAFETY TRAINING RECORD FORM

Employee Name_____ Student/Employee ID #_____

Laboratory (Building and Lab room number(s))_____

Principal Investigator_____

This checklist is provided to laboratories to use as guidance for lab specific safety training. Additional training can be added as needed. Once the training checklist has been completed please add to the Chemical Hygiene Plan.

Check when complete	Topic
Emergencies	
	Reporting procedures for medical, fire, or safety emergencies
	Basic building alarms, worker response to alarms, and evacuation procedures
	Location and use of emergency equipment such as eyewash stations, fire extinguisher, fire pull stations, safety showers, etc.
	Reporting requirements for laboratory incidents and accidents, especially relating to personal injury
	Location and use of spill kit (for chemicals and biological agents), first aid kit
	Location of emergency contact information, including University Police (257-8573)
General Lab Safety	
	Contact information for lab personnel, stockroom, building operator
	Operations requiring prior P.I. approval
	Food and beverages are not to be consumed in the laboratories. Designated food storage and eating areas defined
	Facility requirements (Door to laboratory closed, no gloves hands in hallways, use secondary transport containers)
	Storage and use of personal protective equipment (PPE) (gloves, lab coat, safety glasses)
	PPE work practices (closed toe shoes, no shorts, disposable gloves donning and doffing, hand washing, removal of lab coats before leaving the lab, etc.)
	Non-chemical physical and health hazards specific for lab (pumps, sonicators, etc.)
	Lab Specific Protocols/Standard Operating Procedures location and use
	Proper use of safety equipment such as fume hood, biosafety cabinet, glove boxes
	Proper handling of broken glass, razor blades, needles, syringes, or other sharps
	Identification of all biological, chemical, radiological, and other hazards within the laboratory
Physical Hazards	
	Hazards and proper use of compressed gases and cryogenic materials (https://ehs.uky.edu/ohs/cgc2.html)
	Procedures for safe setup, use and deactivation of high-pressure reactions
	Vacuum pump and vacuum lines
	Safe set up, proper PPE and use of lasers (https://ehs.uky.edu/docs/pdf/rad_laser_safety_manual.pdf)
	Electrical Safety (https://ehs.uky.edu/fire/electrical.html)
	Laboratory Ergonomics Checklist
	Laser Safety officer name and phone number
Chemical Safety	
	Location and access instruction for a copy of the laboratory chemical inventory, Chemical Hygiene Plan, and other safety information

	Safety Data Sheets location and use
	Highly hazardous chemicals used and the corresponding Standard Operating Procedures
	Methods to control exposure to highly hazardous chemicals
	Detection methods and observation that may be used to detect the presence or release of a hazardous chemical in the lab (odors, monitoring equipment, visual appearance) and appropriate actions if detected
	Hazardous chemical labeling system used in the lab
	Specific use of laboratory fume hoods and monitoring devices
	Chemical storage procedures (labeling and storage)
	Chemical spill procedure, including cleanup and reporting
	Identification of signs and symptoms associated with exposure to the hazards specific to the laboratory
Hazardous Waste	
	Location of Hazardous Waste containers
	Appropriate labeling of Hazardous Waste (Hazardous Waste and contents)
	Appropriate storage of Hazardous Waste (in a compatible container with a tightfitting lid)
	When full, filled out Hazardous Waste ticket (E-Trax) stored in appropriate area
Biological Safety	
	Applicable online training has been completed. https://ehs.uky.edu/classes/classes_biosafety_0001.php)
	Review, location and instruction for access to the exposure control plan for blood borne pathogens, infectious agents, and/or recombinant materials (if in use). This information is located within the approved IBC registration form, accessed at topaz.uky.edu, and may be printed for ease of access.
	Location of step stool and safe practices for its use
	Location and proper use of laboratory disinfectants
	Signs and symptoms associated with exposure the hazards specific to the laboratory, including an infectious agents or recombinant DNA and routes of potential exposure (skin contact, eye splash, etc.)
	Reporting requirements for laboratory incidents and accidents, especially resulting in personal injury or exposure to infectious agents and/or recombinant DNA https://ehs.uky.edu/ohs/accident.html
	Waste triage procedures (ex: disposal of biohazard waste vs. radiological or chemical waste vs. sharps) (https://ehs.uky.edu/docs/pdf/bio_waste_flowchart_0001.pdf)
	Autoclave procedures, particularly pertaining to decontamination of biohazard waste (https://ehs.uky.edu/biosafety/autoclave_0001.php)
	Standard microbiological procedures and guidelines listed in HHS/CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL) (http://www.cdc.gov/biosafety/publications/bmbl5/)
	NIH Guidelines for Research Involving Recombinant DNA Molecules (https://osp.od.nih.gov/biotechnology/nih-guidelines/)
Radiation Safety	
	Location of Radiation Safety Officer name and number
	Onsite, Initial, Basic and Advanced Training taken in order to be authorized to use radioactive materials
	Location of monthly wipe test
	Specific training needed to utilize analytical X-Ray equipment

I have trained the employee on the above laboratory-specific information.

PI/Supervisor Signature_____ Date:_____

I understand the above laboratory-specific information that was presented by my PI/Supervisor. If I do not understand a procedure I will ask for clarification from my Supervisor or the Principal Investigator of the laboratory before I begin work.

Employee's Signature:_____ Date:_____

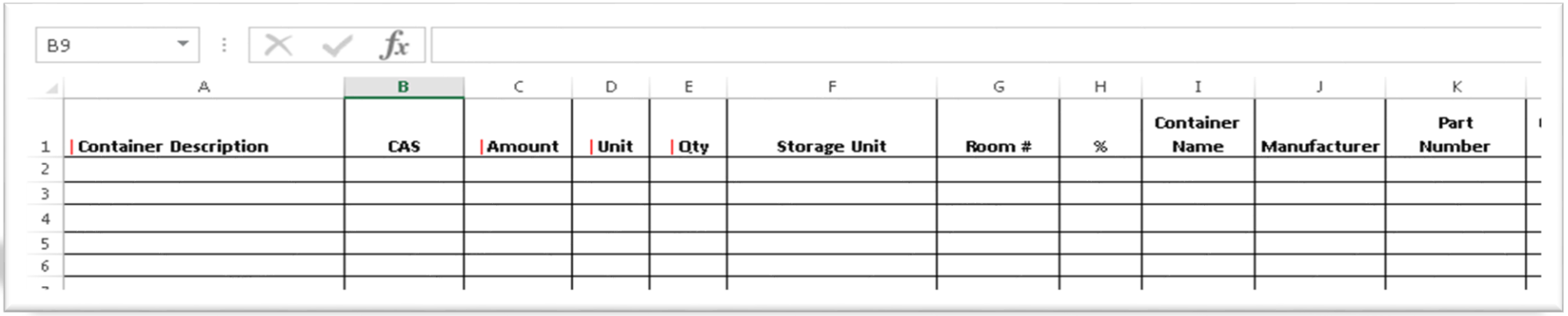
Lab Specific Refresher Documentation
Training Documentation for Laboratory

Below is a check list for the required University of Kentucky Laboratory Safety Training as well as Lab Specific Training (refer to Chapter 6, for more details). ***Please date when each training was taken in the table below.***
Lab Specific training should be done initially for a new employee and when one of the following conditions have changed in the lab:

- A new process, piece of equipment or chemical is introduced into the laboratory
- A new process, piece of equipment or chemical is added to an existing procedure
- A scale up of a procedure, such as increasing from 5 milligrams to 5 grams
- Laboratory Remodel

Name	**Chemical Hygiene Plan Initial**	**Chemical Hygiene Plan Annual Refresher**	**Hazardous Waste (Annual Requirement)**	**Fire Extinguisher Training (Annual Requirement)**	**Initial Lab Specific Training**	**Lab Specific Training**

Chemical Inventory & Hazardous Waste Management System



	A	B	C	D	E	F	G	H	I	J	K
1	| Container Description	CAS	| Amount	| Unit	| Qty	Storage Unit	Room #	%	Container Name	Manufacturer	Part Number
2											
3											
4											
5											
6											

| denotes required field

Chematix/E-Trax is UK's current system for managing chemical inventories and hazardous waste processing. To gain access to Chematix, UK's Hazardous waste training must be taken. The person then will be assigned to a lab either by the PI or a Chematix administrator.

The following attributes can be used to describe chemicals:

Primary attributes: Chemical Name*, CAS, Amount*, Unit*, Number of Containers*, % Concentration*#

Secondary attributes: Manufacturer, Part Number, Chematix Barcode, Storage Unit, Expiry Date, SDS URL, and four custom data fields.

* Required field
# Where the concentration is a measure of purity, this value can be left blank. Where concentration is a measure of chemical strength, e.g. Hydrochloric acid, 37%, this value must be included in the % concentration field.

When tracking your inventory, particular care should be taken when recording Chemicals of Interest (COIs) controlled under the "Chemical Facilities Anti-Terrorism Standards" (CFATS) (), Carcinogens (pg. 101), and highly toxic and

explosive/reactive materials (pg. 72). Compressed gas cylinders are chemical and must be entered into the chemical inventory system as well.

UK units track their inventory in different ways. Some units track and label every chemical container that enters the facility. Others list the maximum quantity they have in the lab to avoid the labor of tracking individual containers. Some units use different software to track their inventory, then annually export their inventory for import into Chematix. ***Regardless of how you manage your inventory, your chemical inventory is compliant as long as Chematix is reviewed and updated annually or when significant changes are made.***

For questions, contact Robert Thomas in OHS at 257-4016 or trobert@uky.edu. You can access the chemical inventory/hazardous waste system at https://etrax.chematix.com/Chematix/

CHEMICAL FACILITY ANTI-TERRORISM STANDARD

The Department of Homeland Security has issued a regulation entitled "Chemical Facilities Anti-Terrorism Standards" (CFATS). This rule applies to all entities that possess certain hazardous chemicals and is intended to prevent the intentional misuse of these chemicals via theft, sabotage, or attack. The regulation requires subject facilities to estimate the types and quantities of the chemicals on hand, and, in some cases, to develop site security plans and measures, perform training and drills, and maintain records. The Final Rule requires that University of Kentucky laboratories and non-laboratories collect and submit chemical inventories for a list of chemicals called *Chemicals of Interest* (COI).

If the laboratory has a significant amount of a COI, then OHS needs to be notified at 859-257-4016.

All COIs, including those present in a mixture, are required to be submitted. However, only those mixtures at concentrations equal to or greater than ten percent (10%) by weight are required to be submitted.

Below is a shortened list of chemicals that are either near the reporting threshold or have a different reporting percentage.

COI	CAS #	Percentage
Ammonium Nitrate	**6484522**	
Arsenic trichloride	**7784341**	
Boron tribromide	**10294334**	
Boron trichloride	**10294345**	
Chlorine	**7782505**	**9.77%**
Chloroform	**67663**	
Hydrogen fluoride (anhydrous)	**7664393**	
Hydrogen Peroxide	**7722841**	

COI	CAS #	Percentage
Nitric Acid	**7697372**	
Nitric oxide	**10102439**	**3.83%**
Phosgene	**75445**	**0.17 %**
Phosphine	**7803512**	**0.67%**
Phosphorus trichloride	**2125683**	**3.48 %**
Sodium nitrate	**7631994**	
Sulfur tetrafluoride	**7783600**	**1.33 %**
Thiodiglycol	**111488**	
Titanium tetrachloride	**7550450**	

Laboratory Signage

ADMITTANCE TO AUTHORIZED PERSONNEL ONLY

CAUTION: The following hazards are present within this area:

☐ 
Flammables
Self Reactives
Pyrophorics
Self-Heating
Emits Flammable Gas
Organic Peroxides

☐ 
Oxidizers

☐ 
Explosives
Self Reactives
Organic Peroxides

☐ 
Corrosives

☐ 
Carcinogen
Respiratory Sensitizer
Reproductive Toxicity
Target Organ Toxicity
Mutagenicity
Aspiration Toxicity

☐ 
Irritant
Dermal Sensitizer
Acute toxicity (harmful)
Narcotic Effects
Respiratory Tract
Irritation

☐ 
Acute Toxicity (severe)

☐ 
Gas Under Pressure

☐ Biohazards
IBC #

(Biohazard symbol here)

☐ Human pathogens
☐ Viral vectors

BSL click here

Special procedures required for entry or exit:

☐ Strong Magnetic Field
☐ Electrical Hazard
☐ Laser (Class_____)
☐ Radioactive Material

_____
_____

Room Number: _____

Department: _____

Principal Investigator: _____ **Supervisor:** _____

Emergency and After Hours Contacts for this Laboratory:

Name	Office Location	Office Phone	Cell or Home Phone

University of Kentucky
ENVIRONMENTAL HEALTH AND SAFETY

Biological Safety	257-1049
Environmental Management	323-6280
Occupational Health and Safety	257-3242
Radiation Safety	323-6777

IN CASE OF EMERGENCY CALL 911

The information on this sign must be updated at least annually or in the event of any change of emergency contacts or special hazards.

Prepared by: _____ Date Posted: _____

Laboratory-Specific

STANDARD OPERATING PROCEDURES

University of Kentucky
Department of Occupational Health and Safety
252 E. Maxwell St.
(859) 257-2924

Please fill out and place in Ch. 3 of the Laboratory Safety Manual

---

Building: _____ Room: _____
Department: _____ PI: _____

Section 1: (check one)

☐ Process ☐ Hazardous Chemical ☐ Hazard Class

Section 2: Describe process, chemical hazard, or hazard class

Section 3: Potential Hazards

Section 4: Personal Protective Equipment

Section 5: Engineering Controls

Section 6: Special Handling and Storage Procedures

Section 7: Spill and Accident Procedures

Section 8: Decontamination Procedures

Section 9: Waste Disposal Procedures

Section 10: SDS Location

Section 11: Protocol

Borrowed from Michigan State University

Laboratory Specific Standard Operating Procedures

Guidelines for Preparing SOPs

- **Section 1** Check the appropriate box indicating process, chemical hazard, or hazard Class

- **Section 2** Describe process, hazardous chemical, or hazard class
  Process- Describe the process and list all chemicals involved
  Hazardous Chemical- List the chemical name, common name and any other abbreviations
  Hazard class- Describe the hazards associated with a particular group of similar chemicals, list the ones used in the lab

- **Section 3** Potential Hazards
  Describe both physical and health hazards associated with process, hazard, or class

- **Section 4** PPE
  Indicate the level of PPE needed including (but not limited to) gloves, goggles, face shields, aprons, and lab coats

- **Section 5** Engineering Controls
  List the engineering controls used to prevent and reduce exposure
  Example Fume hoods

- **Section 6** Special Handling and Storage Procedures
  Indicate specific areas used for storage, including storage compatibility. List policies regarding access and dating procedures, such as dating peroxide formers

- **Section 7** Spill and Accident Procedures
  List who and how spills will be handled. Indicate where emergency equipment is located and the location of emergency numbers

- **Section 8** Decontamination Procedures
  List procedures including cleaning solutions and solvents that may be used

- **Section 9** Waste Disposal
  Indicate which substances are required to be picked up by hazardous waste. ensure all hazardous waste is appropriately labeled "Hazardous Waste" and has a ticket on it.

- **Section 10** SDS Location
  Indicate the location of all SDS and any other chemical or safety manuals In the lab

- **Section 11** Protocol
  List specific procedures for working with this particular process, chemical hazard, or hazard class