Laboratory Specific Chemical Hygiene Plan for Research Laboratories

This template is designed to provide an organizational framework for ensuring compliance of the individual laboratory with the OSHA Laboratory Standard [29 CFR 1910.1450]. This completed template should be used in conjunction on with the institutional UK Chemical Hygiene Plan. Other formats for the information contained in this document are acceptable if the content possesses all OSHA Laboratory Standard-required elements. Refer to the institutional UK Chemical Hygiene Plan for a list of these requirements. It is the responsibility of the laboratory's Principal Investigator/Laboratory designated Chemical Hygiene Officer (CHO) to compile, review and update this Laboratory Specific Chemical Hygiene Plan no less than annually.

The Department of Research Safety reserves the right to request a copy of the laboratory's Lab Specific Chemical Hygiene Plan for the purposes of review and to ensure its completion and compliance with the OSHA Laboratory Standard. Upon annual Laboratory Safety inspection, the laboratory's specific CHP will be checked to ensure its annual review has been completed and that all lab staff have documented lab specific training.

Sections of the UK Laboratory-Specific CHP:

1) Principal Investigator/Laboratory Chemical Hygiene Officer ID and review signature page
2) Laboratory Personnel page, with documentation of understanding of the CHP
3) Laboratory Personnel Training Documentation
4) Laboratory Specific Emergency Contacts
5) Laboratory Locations and Activities
6) Materials and Procedures requiring PI/Laboratory Chemical Hygiene Officer and/or departmental approval
7) Laboratory Specific Policies
8) a. Controlling Hazards - Lab Activities and PPE Hazard Assessment
   b. Controlling Hazards - Chemical Hazards in the Laboratory
   c. Controlling Hazards - High Risk Procedures in the Laboratory
9) Safe Operation of Engineering Controls
10) Standard Operating Procedures (SOP)
11) Laboratory Specific Exposure Monitoring and Medical Surveillance
12) Laboratory Specific Chemical Inventory and Safety Data Sheets
13) Supplementary records, documentation, resources or references.
14) The OSHA Laboratory Standard (29 CFR 1910.1450)

Directions: Please complete all sections of this template. Questions or requests for assistance with or completion of a Laboratory-Specific Chemical Hygiene Plan may be emailed to labsafety@uky.edu .

Section 1: ID and Review

Lab-Specific Chemical Hygiene Plan

Principal Investigator (PI):

Department:

Designated Chemical Hygiene Officer (CHO):
(if none, this designation defaults to the listed Principal Investigator)

Emergency Contact for the Laboratory and phone:

This Chemical Hygiene Plan (CHP) is specific to the following building(s) & room number(s):

Laboratories engaged in the laboratory use of hazardous chemicals must maintain a lab-specific Chemical Hygiene Plan (CHP) which conforms to the requirements of 29 CFR 1910.1450, the Occupational Safety and Health Administration (OSHA) Occupational Exposure to Hazardous Chemicals in Laboratories Standard (Lab Standard). University of Kentucky laboratories may use this document to develop their lab-specific CHP. This cover page must specify the Principal Investigator and specific laboratory spaces where this CHP is used. In addition, all lab employees shall document required trainings such as Lab-Specific Training and any trainings specific to particularly hazardous chemicals or procedures, by placing signed training forms in the CHP.

The contents of the Lab Specific Chemical Hygiene Plan, Laboratory Safety Manual, and any lab-specific information herein have been reviewed and revised as necessary. Personnel under my supervision have been informed of all hazards in the above listed spaces, any required controls for the safe handling of hazardous chemicals, have been trained in the procedures for safe work with hazardous chemicals and are knowledgeable in emergency response procedures for the laboratory.

PI Signature and Date: _____

Designated CHO Signature and Date: _____

Date of Annual Review	PI Signature	Designated CHO Signature

Research Safety

Important Telephone Numbers:
UK Workers Care: 1-800-440-6285
University Health Services: 859-323-APPT
UHS After Business Hours: 859-323-5321
FOR ALL EMERGENCIES CALL 911 and/or PROCEED TO UK CHANDLER HOSPITAL EMERGENCY DEPARTMENT

Lab Specific CHP Section 2: **Labo**ratory Personnel

Principal Investigator:

Department:

Designated Chemical Hygiene Officer:
(if none, this designation defaults to the listed Principal Investigator)

I have read and understand the contents of the Lab-Specific Chemical Hygiene Plan, including any SOPs for safe conduct of procedures utilizing chemicals which present a hazard to human health. I have been made aware of the hazards present in our laboratory, the controls that need to be implemented, and the response procedures should an emergency occur in the laboratory. I hereby acknowledge that I will comply with requirements, policies and work practices described in this plan, including completion of required training(s).

Date	Personnel Name (printed)	Personnel Signature

Research Safety

Important Telephone Numbers:
UK Worker's Care at 1-800-440-6285
University Health Services (UHS): (859) 323-APPT
UHS after hours: (859) 323-5321
For emergencies call 911 and/or proceed to UK Chandler Hospital Emergency Department

Lab Specific CHP Section 3: **Personnel Training Documentation**

The OSHA Laboratory Standard requires the following for training laboratory personnel, to be provided by the PI/Laboratory-designated lab Chemical Hygiene Officer:

- 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.).
- The physical and health hazards of chemicals in the work area.
- The measures workers can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect workers from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
- The applicable details of the employer's written CHP.

The first trainings listed below are required of all personnel working in wet labs at the University of Kentucky. Add any others required for or by the lab that are provided by internal (i.e. Biosafety Training, Radia. on Safety Training, or hands-on training of specific procedures in the lab) or external (i.e. CITI) sources.

- **Chemical Hygiene/Laboratory Safety Initial and Annual Refresher Training** (online modules hosted by UK Research Safety)
- **Hazardous Waste** (online module hosted by UK EHS)
- **Fire Extinguisher** (online module hosted by UK EHS) **students under the age of 18 not enrolled at the university are exempted from the requirement for completion of this training*
- **Lab Specific Training** (general checklist provided by UK Research Safety, see next page)

Name of Training	**Notes (how to access training, specific individuals only, etc.)**

Please attach copies of lab-provided training materials and signed statements by employees attesting to completion and understanding of the training.

Research Safety

Laboratory Specific General Safety Training Record

Name of individual:	**Linkblue ID#:**
Principal Investigator:	**Designated CHO**
Building(s)/Room(s) of active work:	

This checklist may be used by University of Kentucky research laboratories to document laboratory-specific safety training for personnel. Other training on materials and procedures specific to the lab shall be added and documented as needed. Training documentation for laboratory personnel shall be stored in the laboratory's Chemical Hygiene Plan or Laboratory Safety Manual.

Please place a check mark to show that training on the topic has been completed by the above-named individual.

Emergencies	
	Location of emergency contact information for UK Police and response to medical, fire, or other emergencies.
	Worker response to building, facility, and safety equipment alarms (i.e., chemical fume hood, glove box, biological safety cabinet) including the review of established building emergency evacuation routes.
	Location and proper use of emergency equipment such as eyewash stations, fire extinguishers, fire pull stations, safety showers, first aid, and spill kits for the materials in use.
	Procedures for seeking medical attention. Reporting requirements for laboratory incidents, accidents, and near misses, particularly those relating to personal injury.
General Lab Safety	
	Contact information for lab operations (i.e., Principal Investigator, the designated Laboratory CHO, departmental safety liaison, facility manager, custodial services).
	Food and beverages are prohibited in the laboratory. Designated food storage and eating areas are defined for the individual.
	The physical, chemical, biological and radiological hazards of the materials present in the lab and the signs and symptoms of exposure.
	Laboratory and facilities requirements including but not limited to: • Doors to laboratory remained closed to the common corridors • Appropriate lab attire (closed toe shoes, no shorts, long hair restrained) • No gloved hands, lab coats or other PPE in hallways, restrooms, elevators and other public areas • Use of rigid-sided, lidded, and leak-proof secondary transport containers for hazardous materials • Required approvals and training for procedures and/or materials • Room or Equipment User Logs
	Types of personal protective equipment (PPE) to be used for procedures and where they are stored. The minimum PPE required of all University of Kentucky wet labs are disposable gloves, lab coat, and eye protection.
	Proper use of and any hazards presented by laboratory equipment. (i.e., thermal, electrical, mechanical). Examples of hazardous equipment are vacuum pumps, sonicators, Bunsen burners, UV lamps, microtomes, anesthesia equipment, hot plates, etc.
	Daily work practices including but not limited to: • Donning and safe doffing of PPE, particularly disposable gloves • Proper and frequent handwashing • Proper storage and disposal of materials in use
	Proper disposal of distinct types of waste in the laboratory (i.e., chemicals, biohazards, radiological, sharps)
Chemical Safety (for laboratories using hazardous chemicals)	
	Familiarity with the content and location of: • Occupational Safety and Health Administration (OSHA)Laboratory Standard [29 CFR 1910.1450] • UK General Chemical Hygiene Plan • Laboratory Specific Chemical Hygiene Plan, including Standard Operating Procedures (SOP) • Safety Data Sheets (SDS) for laboratory chemicals

Chemical Safety (cont.)	
	Detection methods, signs or symptoms of exposure or release of hazardous chemicals in the lab (i.e., odors, monitoring equipment, visual appearance) and the proper course of action if detected.
	Location of all PPE needed for procedures
	Proper use of the chemical fume hood, glovebox, blast shielding, or other exposure protection equipment and their monitoring devices/methods.
	Proper chemical segregation and storage based on hazard and compatibility, including chemical labeling requirements
	Chemical spill procedures and required reporting
Biological Safety (for laboratories using biological hazards)	
	Location and proper use of laboratory disinfectants
	Signs and symptoms associated with exposure to the hazards specific to the laboratory, including infectious agents to humans, plants, or animals, recombinant or synthetic nucleic acid materials and routes of potential exposure (needle stick, skin contact, eye splash, etc.)
	Reporting requirements for laboratory incidents and accidents, especially resulting in personal injury and/or exposure to **infectious agents and/or recombinant or synthetic nucleic acid materials**
	Biohazardous waste triage procedures (ex: autoclave vs use of effective disinfectants)
	Autoclave procedures, particularly pertaining to decontamination of biohazard waste
	Standard microbiological procedures and guidance in HHS/CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL)
	Familiarity with the NIH Guidelines for Research Involving Recombinant DNA Molecules and the lab's Institutional Biosafety Committee protocol
	Proper use of Biological Safety Cabinets (BSCs), if applicable
	Biological spill procedures and required reporting
Radiation Safety (for laboratories using radiological materials or equipment with radioactive sources)	
	Location of Radiation Safety Officer name and number
	Onsite, Initial, Basic and Advanced Training, completed in order, for authorization to use radioactive materials
Hazardous Waste (for laboratories generating hazardous waste)	
	Location and types of hazardous waste containers
	Appropriate labeling of hazardous waste
	Proper hazardous waste storage and waste ticketing procedures

I have trained the above-named individual on the topics noted above as they pertain to the scope of work, materials and procedures used in my laboratory.

Principal Investigator or Designated CHO signature:

Principal Investigator/Designated CHO name (printed):

I have been instructed about, have read, and understand the contents and concepts presented to me, as described above, and agree to abide by the principles and instructions that have been provided to me in this training. I understand that if I have any questions about the training, materials, the information presented, or if I experience any problems in performing my tasks with potential hazards, it is my responsibility to seek clarification from the Principal Investigator or designated Laboratory Chemical Hygiene Officer.

Laboratory Personnel signature:

Laboratory Personnel name (printed):

Lab Specific CHP Section 4: **Emergency Contacts and Procedures**

Principal Investigator (PI) Name	
PI Office Location	
PI Office Phone	
PI Emergency Phone	
Designated Chemical Hygiene Officer (CHO) Name	
CHO Office Location	
CHO Office Phone	
CHO Emergency Phone	
Building or Facility Manager Name	
Building or Facility Manager Phone	
Departmental Safety Liaison Name (if applicable)	
Departmental Safety Liaison Phone	

The laboratory's emergency evacuation route and meeting point, according to the Building Emergency Action Plan (BEAP):

Chemical Spill Kit location and contents:

EMERGENCIES: 911 For all emergencies call 911 and/or proceed to the UK Chandler Emergency Department

UK Police: (859) 257-8573
PPD Emergencies: (859) 257-2830
UK Worker's Care: (800) 440-6285
University Health Services: (859) 323-2778

Lab Specific CHP Section 5: **Laboratory Locations and Activities Covered by the CHP**

Building	Rooms	Room Assigned to the PI (Y/N)	Shared Facility (Y/N)	Primary Activities of this location ***(i.e., microscopy, tissue culture, reagent preparation, chemical glovebox use, experimental procedures/reactions, animal work)***

Lab Specific CHP Section 6: **Materials or Procedures requiring Prior Approval**

Are there specific tasks, procedures or materials that require advance approval of the PI, Lab CHO, or Department before work commences? Please list any required approvals here.

PI/Laboratory Supervisor/designated lab CHO: Please check if not applicable to the laboratory.

☐ This laboratory has no requirements for obtaining prior approval for specific materials or procedures.

PLEASE PRINT

Task/Material Requiring Approval	Individual/Role Requesting Approval	Name of official issuing approval and date of approval, if received

Please attach any supplementary instructions or information to this section of the Lab Specific CHP

Lab Specific CHP Section 7: **Laboratory Specific Policies**

Lab Specific Policies not covered elsewhere in the CHP
(e.g., No personnel shall work unaccompanied after 6 pm and on weekends, Lab coats must be worn in the lab regardless of work performed, etc.).

☐ **PI/designated lab CHO: Please check and sign if there are no applicable additional policies for the laboratory.**

☐ Lab coats must be worn at all times regardless of whether work is performed.

☐ To limit the spread of chemical contamination, use of personal electronic devices (e.g., laptops, ipads, cell phones, earbuds) is ☐ prohibited ☐discouraged in the following situations:

☐ To promote awareness of surroundings, including building and lab alarm sounds, use of earbuds or headphones is restricted as follows:

☐ The following areas are designated as "PPE free" areas: (Enter Description of Areas that apply). Prior to working in these areas, remove all PPE and wash hands.:

☐ Working alone requires prior approval from Principal Investigator/Laboratory Director in the following situations:

☐ Unattended experiments must be approved by Principal Investigator/Laboratory Director if they involve:

☐ Heat ☐ Circulating tap water ☐ Possible runaway reaction ☐ Other:

☐ ☐Other (Please describe):

Lab Specific CHP Section 8 (a): **Laboratory Activities and PPE Hazard Assessment**

Personal protective equipment (PPE) is usually required to perform procedures safely. The minimum PPE for procedures in wet labs at the University of Kentucky includes a lab coat, and eye protection suitable for the procedures performed. Various types of PPE in laboratory research might include:

- Protective clothing (e.g., lab coats, smocks, aprons)
- Eye and face protection (e.g., safety glasses, chemical goggles, UV or laser resistant eyewear, face shields,
- Hand protection – gloves (e.g., insulated, cut resistant, disposable or reusable)
- Respiratory protection – respirators (e.g., N95, PAPR, half/full/filtering facepiece)
- Head protection (e.g., bonnets, hard hats)
- Hearing protection (e.g., reusable muffs, reusable or disposable ear plugs)
- Protective footwear (e.g., steel-toed boots, shoe covers)

PPE should not be used as a substitute for engineering controls such as chemical fume hoods, gloveboxes, biosafety cabinets, process enclosures, *etc*., or as a substitute for good work practices and attention to washing hands after PPE is removed. The use of engineering controls such as chemical fume hoods reduces the potential for exposure yet does not eliminate the need for wearing the proper PPE.

When PPE is needed, regulations require that a hazard assessment be performed to identify the specific hazards of concern and the PPE required for protection from those hazards. This hazard assessment may be done for a work area, or for a specific experiment, job, or task. PPE is selected based on this hazard assessment. The Laboratory Standard requires the hazard assessment be documented in writing.

This form can be used to satisfy the hazard assessment and documentation requirements. Once completed, the form must be maintained in the Chemical Hygiene Plan. It also can be to train employees regarding the hazards associated with their work and the PPE required for their tasks. Employees must also receive training on the correct use, maintenance, and limitations of engineering controls and PPE. The PI/Lab CHO is responsible for providing or arranging for this training.

Respiratory protection may be needed for chemical handling when there are not sufficient engineering controls in place. If you believe respiratory protection is warranted, you must also contact UK Occupational Health and Safety or complete the form at: https://ohs.uky.edu/form/respiratory-hazard-assessment-fo?check_logged_in=1

The PPE listed as required in this document is based on the UK institutional Chemical Hygiene Plan and represents the minimum PPE that must be worn in each circumstance. Contact the UK Research Safety at labsafety@uky.edu if there are cases in the laboratory when less PPE may be appropriate based the presence of additional controls or other extenuating circumstances.

For more information on PPE, visit: researchsafety.uky.edu/chemical-safety

PPE Requirements per Location

Determine the minimum PPE requirements for entry into or working in labs or other spaces with hazards based on the hazard level of the chemicals within and the procedures performed. PPE for entry requirements and hazard communication in the form of the GHS pictographs shall be indicated on door signage.

A combination of clothing and shoes that fully cover the legs and feet is required when working in spaces that have hazardous chemicals, which includes almost all lab spaces. Similarly, there are requirements to have the legs covered in spaces with other hazards that could pose a risk to individuals, such as physical hazards or biological and radioactive materials that pose an exposure risk.

UK's minimum PPE requirements in wet labs are lab coat, eye protection and gloves for the procedures performed. Please outline any **minimum** lab PPE requirements for each space of the lab, if additional PPE to the UK miminum for wet labs is required for sufficient personnel protection. Include the shoe and clothing requirements, if applicable.

Location	Minimum PPE

Task and Materials Based Hazard Assessment and PPE Requirements

Mark all hazards and operations performed in the Lab. Review the applicable PPE for all checked items.
Be sure to indicate when stricter PPE usage is to be implemented in the space. This chart is not a substitute for lab specific SOPs.

Activity performed in lab?	Materials Involved	Applicable PPE	Engineering Controls and Potential Hazards
☐	Liquid chemicals	***Lab Coat*****:** required ***Eyewear*****:** Safety glasses or goggles required; face shield required if high splash risk ***Gloves*****:** Compatible gloves required ***Other:*** In case of anticipated possible splashes on whole body, chemical resistant coverall or apron	Other controls: Engineering controls based on properties of chemicals and procedures. Potential Hazards: • Skin burn • Eye damage • Skin irritation • Eye irritation • Skin sensitization (systemic reaction) • Spill on floor

Activity performed in lab?	Materials Involved	Applicable PPE	Engineering Controls and Potential Hazards
☐	Dry chemicals	***Lab Coat*****:** Required *Eyewear*: Safety glasses required; dust proof safety goggles for higher hazard chemicals ***Gloves*****:** Compatible gloves required; protective sleeves recommended ***Respiratory Protection*****:** Respirator required if engineering controls are insufficient.	Other controls: Engineering controls based on properties of chemicals and procedures. Potential Hazards: • Inhalation of airborne particles • Contact with Eyes • Dermatitis • Skin burning • Contaminated floor and surfaces
☐	Highly exothermic reactions	***Lab Coat*****:** Flame-resistant lab coat ***Eyewear*****:** Goggles and face shield required ***Gloves*****:** Compatible gloves required; additional fire resistant gloves may be necessary depending on the task ***Other*****:** Non-synthetic street clothing required	Other controls: Engineering controls based on procedures. Potential Hazards: • Fire • Explosion • Skin/eye contact with chemicals • Skin/Eye contact with hot liquids • Inhalation of vapors/gases • Spill on floor and surfaces
☐	Corrosive liquids	***Lab Coat*****:** Lab coat required; chemical-resistant (FR/CP) lab coat recommended ***Eyewear*****:** Safety glasses or goggles required ***Gloves*****:** Compatible gloves required ***Other*****:** In case of anticipated possible splashes on whole body, chemical resistant coverall or apron	Other controls: Engineering controls based on properties of chemicals and procedures. Potential Hazards: • Eye/Skin/Respiratory burn • Eye damage • Inhalation of corrosive vapors/gases • Spill on floor
☐	Flammable liquids	***Lab Coat*****:** Lab coat required; flame resistant (FR) lab coat recommended based on fire hazard ***Eyewear*****:** Safety glasses or goggles required *Gloves*: Compatible gloves required ***Other*****:** In case of anticipated possible splashes on whole body, chemical resistant coverall or apron	Other controls: Engineering controls based on properties of chemicals and procedures. Potential Hazards: • Fire • Explosion • Skin/Eye absorption • Inhalation of vapors/gases • Spill and evaporation in lab

Activity performed in lab?	Materials Involved	Applicable PPE	Engineering Controls and Potential Hazards
☐	Pyrophoric or water reactive compounds outside of glove box	***Lab Coat*****:** Flame-resistant lab coat required ***Eyewear*****:** Goggles required; face shield recommended ***Gloves*****:** Compatible gloves required; Flame-resistant gloves recommended ***Other*****:** Non-synthetic street clothing required	Other controls: Engineering controls based on properties of chemicals and procedures. Potential Hazards: • Fire • Explosion • Skin/Eye burn/damage • Inhalation of vapors/gases
☐	Explosive Compounds	***Lab Coat*****:** Flame resistant lab coat ***Eyewear*****:** Goggles + face shield required ***Gloves*****:** Heavyweight gloves, such as anti-static PVC gauntlets, required	Engineering Controls • Use blast shield Other Controls: Based on procedures Potential Hazards: • Fire • Explosion • Skin/Eye burn/damage • Inhalation of vapors/gases
☐	Particularly hazardous substances (PHSs) - select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity	***Lab Coat*****:** Lab coat required ***Eyewear*****:** Safety glasses or goggles required ***Gloves*****:** Compatible gloves required ***Other*****:** Disposable sleeve guards may be recommended	Other controls: Engineering controls based on procedures. Potential Hazards: • Inhalation of gases and vapors • Eye/Skin absorption • Eye/Skin irritation • Skin/respiratory sensitization
☐	Toxic chemicals	***Lab Coat*****:** Lab coat required ***Eyewear*****:** Safety glasses or goggles required ***Gloves*****:** Compatible Gloves required	Other controls: Engineering controls based on procedures. Potential Hazards: • Inhalation of gases and vapors • Eye/Skin absorption • Eye/Skin irritation • Skin/respiratory sensitization

Activity performed in lab?	Materials Involved	Applicable PPE	Engineering Controls and Potential Hazards
☐	Engineered nanomaterials in solution	***Lab Coat*****:** Disposable Tyvek-type coveralls or Lab coat based on materials ***Eyewear*****:** Safety glasses or goggles required ***Gloves*****:** Compatible gloves required; double gloves recommended; Choose the proper gloves based on the solvent used	Other controls: Engineering controls based on procedures. Potential Hazards: • Eye/Skin absorption • Eye/Skin irritation • Skin/respiratory sensitization • Eating/drinking of contaminated food/drinks • Spill and surface contamination
☐	Engineered nanomaterials as dust/particles	***Lab Coat*****:** Disposable Tyvek-type coveralls or Lab coat, dependent on materials ***Eyewear*****:** Safety glasses or goggles required ***Gloves*****:** Compatible gloves required; double gloves recommended ***Respiratory Protection:*** Required if engineering controls are insufficient	Other controls: Engineering controls based on procedures. Potential Hazards: • Inhalation of airborne particles • Eye/Skin absorption • Eye/Skin irritation • Skin/respiratory sensitization • Eating/drinking of contaminated food/drinks • Spill and surface contamination
☐	Chemically preserved animal and/or human specimens	***Lab Coat*****:** Gown or lab coat required ***Eyewear*****:** Safety glasses or goggles required ***Gloves*****:** Compatible gloves required	Other controls: • Chemical fume hood • Necropsy downdraft table • Perfusion station • Local Exhaust Potential Hazards: • Inhalation of gases and vapors • Eye/Skin absorption • Eye/Skin irritation • Eating/drinking of contaminated food/drinks • Exposure to formaldehyde
☐	Cryogenic liquids or dry ice (including working with cryogenic dewars)	***Lab Coat*****:** Lab coat required ***Eyewear*****:** Safety glasses or goggles required; face shield required when handling cryogenic liquids or cryogenically frozen tubes ***Gloves*****:** Insulated cryogenic gloves required	Potential Hazards: • Skin burn • Eye burn • Asphyxiation • Frostbite of limbs

Activity performed in lab?	Materials Involved	Applicable PPE	Engineering Controls and Potential Hazards
☐	Compressed gases	***Lab Coat*:** Lab coat required ***Eyewear*:** Safety glasses or goggles required ***Gloves*:** Gloves required dependent on task (e.g., work gloves when handling cylinders, chemical-resistant gloves when making/breaking connections with non-inert gases) ***Respiratory Protection*:** May be needed when handling toxic gases	Other Controls: • Gas cabinets and/or monitors may be required depending on type of gas. Potential Hazards: • Inhalation of gases and vapors • Eye/Skin absorption • Asphyxiation • Explosion
☐	Hydrofluoric acid	***Lab Coat*:** Lab coat required; chemical-resistant (FR/CP) lab coat recommended (refer to lab SOP) ***Eyewear***: Safety goggles and face shield required (refer to lab SOP) ***Gloves*:** Neoprene gloves or double-nitrile gloves required (refer to lab SOP) ***Other*:** Acid resistant apron required (refer to lab SOP)	Other Controls • Engineering controls based on procedures • Calcium Gluconate gel Potential Hazards: • Inhalation of HF vapors • Eye/Skin absorption • Systemic poisoning • Eating/drinking of contaminated food/drinks • Eye/Skin burn
☐	Aqua regia	***Lab Coat*:** Lab coat required; chemical-resistant (FR/CP) lab coat recommended (refer to lab SOP) ***Eyewear*:** Safety goggles required; Face shield recommended (refer to lab SOP) ***Gloves*:** Neoprene gloves required (refer to lab SOP) ***Other*:** Neoprene gauntlets and apron may be required (refer to lab SOP)	Other Controls • Engineering controls based on procedures Potential Hazards: • Inhalation of acid vapors and toxic gases • Eye/Skin absorption • Eating/drinking of contaminated food/drinks • Eye/Skin/Respiratory burn • Explosion
☐	Piranha solution	***Lab Coat***: Lab coat required; chemical-resistant (FR/CP) lab coat recommended (refer to lab SOP) ***Eyewear*:** Safety goggles required; Face shield recommended (refer to lab SOP) ***Gloves*:** Neoprene gloves required (refer to lab SOP) ***Other*:** Neoprene gauntlets and apron may be required (refer to lab SOP)	Other Controls • Engineering controls based on procedures Potential Hazards: • Inhalation of acid vapors and toxic gases • Eye/Skin absorption • Eating/drinking of contaminated food/drinks • Eye/Skin/Respiratory burn • Explosion

Activity performed in lab?	Materials Involved	Applicable PPE	Engineering Controls and Potential Hazards
☐	Bromine	***Lab Coat*****:** Lab coat required; chemical-resistant (FR/CP) lab coat recommended (refer to lab SOP) ***Eyewear*****:** Safety goggles required; Face shield recommended ***Gloves*****:** Fluorinated rubber gloves required for liquid bromine; nitrile or neoprene gloves required for aqueous solutions of bromine	Other Controls • Engineering controls based on procedures Potential Hazards: • Inhalation of gas and vapor • Eye/Skin absorption • Skin/ Eye burn and damage • Respiratory irritation
☐	Phenol	***Lab Coat*****:** Lab coat required; chemical-resistant (FR/CP) lab coat recommended ***Eyewear*****:** Safety glasses or goggles required ***Gloves*****:** Double Nitrile gloves, Neoprene ***Other*****:** Neoprene gauntlets and apron may be required	Other Controls • Engineering controls based on procedures Potential Hazards: • Eye/Skin absorption • Respiratory irritation • Eating/drinking of contaminated food/drinks • Respiratory and skin sensitizer • Skin/ Eye burn • Germ cell mutagen
☐	Animal Surgery	***Lab Coat*****:** Lab coat required ***Eyewear*****:** Safety glasses or goggles recommended; ***Gloves*****:** Nitrile or latex gloves required; puncture-resistant gloves may be recommended Additional, depending on materials administered.	Other controls: • Local Exhaust • Use of tightly sealed and uncracked induction chambers • Use of dated and weighed scavenger cannisters • Use of somniflow • Use of certified anesthesia vaporizer Potential Hazard: • Exposure to anesthetics
☐	Perfusion using paraformaldehyde	***Lab Coat*****:** Lab coat required ***Eyewear*****:** Safety glasses or goggles required ***Gloves*****:** Nitrile gloves required ***Respiratory Protection*****:** Dependent on location of work, if engineering controls are unavailable.	Other controls: • Chemical fume hood • Necropsy downdraft table • Perfusion station • Local Exhaust Potential Hazard: • Skin sensitizer, skin burns • Irritation to the eyes, nose, throat, and respiratory system; • Lacrimation • Cough; wheezing

Additional Activities

Please any additional activities not previously listed and describe the hazards and PPE. The purpose of this chart is to describe discrete tasks with limited chemical use. Lengthy chemical procedures and processes are to be documented in the CHP as lab SOP an example has been provided. Attach additional pages as needed.

Task or Activity	Applicable PPE	Engineering Controls and Potential Hazards
Handling hot items (e.g., autoclaved materials, furnaces, heated glassware, water or oil bath)	***Lab Coat*****:** Lab coat required *Eyewear*: Safety glasses or goggles required ***Gloves*****:** Thermally insulated gloves required; wear chemical-resistant gloves underneath, as needed	Mild to severe skin burns
Removing freezer vials from liquid nitrogen	***Lab Coat*****:** Lab coat required *Eyewear*: Safety glasses and face shield required ***Gloves*****:** Insulated cryogenic gloves required; wear nitrile or latex gloves underneath if handling biological vials ***Other***: Closed-toed, impermeable shoes required	Skin burn, frostbite
Centrifuge	***Eyewear*****:** Safety glasses or goggles required ***Other*****:** If centrifuging hazardous materials, wear additional PPE to match the hazard	Explosion, burst tubes, contaminated centrifuge. Exposure to materials through splash, abrasions.

Lab Specific CHP Section 8 (b): **Chemical Hazards Present in the Lab**

Please check all that apply. Enter requested information where indicated.

	CHEMICAL HAZARDS	If checked, enter requested information where indicated.
☐	Acrylamide (unpolymerized)	☐ Used to make gels ☐ For use in other chemical reactions
☐	Aqua Regia	
☐	Biologically-derived toxins (e.g., diptheria toxin, cholera toxin)	List:
☐	β-Mercaptoethanol	
☐	Chloroform	☐ Not stabilized ☐ Stabilized with:
☐	Compressed Gas Cylinders	List:
☐	Corrosives	List:
☐	Cryogens (e.g., liquid nitrogen and dry ice)	List:
☐	Cyanide Salts (e.g., potassium cyanide and sodium cyanide)	List:
☐	Dichloromethane/ Methylene Chloride	
☐	Diethyl ether	
☐	Ethidium Bromide	
☐	Explosives (including Picric Acid)*	List:
☐	Flammable Liquids	List:
☐	Formalin, formaldehyde solutions, and paraformaldehyde	
☐	Hydrofluoric Acid	
☐	HF Releasers (e.g., sodium fluoride, PMSF, potassium fluoride)	List:
☐	Nanomaterials (e.g., carbon nanotubes, dendrimers, lipid-based)	List:
☐	My lab synthesizes nanomaterials	

☐ Nitric Acid

☐ Oxidizers List:

☐ Osmium Tetroxide

☐ Perchloric Acid

☐ High Hazard Use (procedures include concentrations greater than 70% or heating)

☐ Phenol

☐ Phosgene

☐ Piranha solution

☐ Pressure and Vacuum* List equipment/materials:

☐ Reactive Chemicals: pyrophoric, water sensitive, water reactive, and other highly reactive materials (e.g., trichlorosilane, nickel carbonyl, aluminum hydride, potassium metal) List:

☐ Sodium Azide*

- No SOP needed for sodium azide present at <1% in a pre-made kit
- Generic SOP when used as preservative
- Lab-specific SOP required when used in chemical reactions

☐ Sulfuric Acid

☐ Tetrahydrofuran

☐ **PHS**: Acutely toxic, toxic to reproduction, or carcinogenic **liquids** (e.g. dimethylformamide, toluene) List:

☐ PHS List is available as a separate document elsewhere.

☐ **PHS**: Acutely toxic, toxic to reproduction, or carcinogenic **solids/powders, suspensions or solutions** (e.g. imidazole, trypan blue, tamoxifen, doxorubicin) List:

☐ PHS List is available as a separate document elsewhere.

☐ **PHS**: Acutely toxic, toxic to reproduction, or carcinogenic **gases** (e.g. chlorine, carbon monoxide) List:

☐ PHS List is available as a separate document elsewhere.

Lab Specific CHP Section 8 (c): **High Risk Procedures in the Lab**

High-risk chemical procedures are lab procedures that pose significant risk of serious injury or major property damage if a malfunction were to occur (such as a utility outage, runaway reaction, container failure, or chemical spill/release) and/or which require any of the following:

- Engineering controls **more specialized** than good room ventilation, chemical fume hoods, biological safety cabinets and/or local exhaust such as snorkel or canopy hoods.*
- Personal protective equipment **in addition to** gloves, lab coats, eye/face protection and/or chemical or thermal protective aprons or sleeves.
- **Chemical-specific first aid** treatments or antidotes.

*More specialized engineering controls include (but are not limited to): inert-atmosphere glove boxes used for employee safety, ventilated gas cabinets, oxygen monitors, and/or toxic gas monitors.

A lab-specific SOP, approved by the PI and kept with this plan, is required for all high-risk procedures!

Please check all that apply:

☐ Use of liquid nitrogen or other cryogens in large quantities or in a manner that could displace oxygen. Specify cryogen(s), amount(s), task (if applicable), location {Building and Room number) and approximate room dimensions:

- "Large quantities" include any cryogen piped in from a tank located outside the building.
- For Liquid Nitrogen, "large quantities" would be more than one freezer and one attached liquid cylinder per room. Filling a cryocart or cooler is a task that could displace oxygen.
- Re-evaluation is required if the above-mentioned quantities or tasks move to a different room, or if there is a significant change in procedures or ventilation.

☐ Heating of concentrated perchloric acid (70% or higher). Indicate location, concentration, amount, and frequency of use:

☐ Use of chemicals that are GHS Acutely Toxic Category 1 by inhalation or skin contact in the concentration purchased. List acutely toxic chemicals in the lab:

☐ Creation or synthesis of nanomaterials where the nano-sized compound is particularly hazardous or high risk. List materials created, including size of particles, and indicate if materials are created as a powder or in suspension:

☐ Use of chemicals for which an antidote or specific first-aid treatment is required (e.g., HF, phenol). List chemical, quantities and concentration in use.

☐ Use of reactive, pyrophoric & explosive chemicals. List chemicals and quantities use.

☐ Chemical procedures involving pressure, vacuum, or heat when failure of the container could result in significant physical hazards, exposure to toxic materials, or fire. List procedures:

☐ Other chemical high risk procedures meeting the definition at the top of this section. List specific procedures/equipment and hazards:

☐ **Our lab does not perform any chemical high-risk procedures based on the definition and examples listed above.**

Signature of PI/Lab Chemical Hygiene Officer_____

Lab Specific CHP Section 9: Safe Operations of Engineering Controls

Please check all that apply.

☐ **Chemical fume hood (CFH)**

1. **Ensure the CFH has been certified within the last year.** The last certification date is found on a brightly colored sticker on the side of the CFH and is placed by UK OHS at the time of certification. If a CFH has not been certified within the year or has any other signage indicating it is out of order, it shall not be used.
2. **Verify that hood is under negative pressure** by doing the following:
   - ☐ Check digital monitor for flow rate between 80 and 120 fpm. When sash is at maximum safe height indicated on hood (indicated on the certification sticker), flow rate should be close to that shown on most recent certification sticker.
   - ☐ Check magnehelic gauge to verify that pressure needle lines up closely with set point.
   - ☐ Other:

a. **Position sash correctly for work:**

☐ **CFH Vertical Sash:** Hood sash moves vertically – keep sash in lowest practical position while working (no higher than 18" opening). Sash must come down to shoulder height or lower.

☐ **CFH Combination Sash**

- For maximum flexibility, route tubes and cords under airfoil or through access at side of hood. If this is not possible, route these connections under the sash. Avoid running tubes or cords between horizontal sash panels.
- Keep horizontal panels closed and move sash vertically during work. Keep sash in lowest practical position while working. Sash must come down to shoulder height or lower. Alternatively, close sash vertically. Place one sash panel between body and the work in the hood. Work with arms reaching around this sash panel.

☐ **Biological safety cabinet (BSC):** Our lab uses a biological safety cabinet for handling of powdered chemicals or water-based solutions/suspensions.

1. Look for certification date within the last year on sticker on or around the sash. If the BSC has not been certified within the last year, it shall not be used for work. Contact the UK contracted vendor listed on the certification sticker to arrange its certification. NOTE: BSCs shall not be used for volatile chemicals.
2. With BSC turned on, verify flow rate by referencing the set point listed on the certification sticker or marked on the magnahelic guage.
3. Work with slow, gentle motions to prevent disruption of laminar flow.
4. Decontaminate BSC after use with suitable disinfectants (refer to approved IBC protocol)

☐ **Local snorkel exhaust:** Our lab has "snorkel" exhaust to remove hazardous vapors from the benchtop. The snorkel must be placed as close as possible to the point of contaminant generation (typically within 4 – 6 inches). Contact UK OHS if you exhibit signs of exposure to hazardous or volatile chemicals or otherwise believe the lab snorkel is not capturing contaminants or odors sufficiently.

☐ **Other:**

For "Other" (e.g., inert gas environment glovebox) Please attach instructions to ensure safe operations by lab personnel.

Lab Specific CHP Section 10: **Standard Operating Procedures**

The OSHA Lab Standard requires documented standard operating procedures for laboratory work involving hazardous chemicals. Please review the UK institutional CHP for more detailed information on SOP requirements.

No single format for a lab SOP is required, but to be considered valid, **SOP must include:**

1) Lab-specific information
2) Hazard identification
3) Hazard controls (administrative, engineering and PPE)
4) Stepwise description of how the procedure is performed safely
5) Instructions for exposure, emergencies, and spill procedures
6) Instructions for proper disposal of chemical or experimental waste
7) Documented personnel training on and understanding of the SOP

A SOP fillable template for use by research labs is available on the Research Safety website and also attached to this section of the Lab Specific CHP Template.

To assist in the laboratory's documentation of SOPs, please reference the following page. This chart provides guidance for when a Lab Specific SOP is absolutely required, versus using more general guidelines and generic SOPs (available on the Research Safety website or elsewhere) to cover multiple processes and chemicals.

Please consult the manufacturers' SDS or NIH PubChem for GHS categorization of the chemicals in use in laboratory procedures. The level of hazard of both the chemical as well as the procedures determine how SOPs are documented.

If further assistance is required, please email labsafety@uky.edu

Please attach all general SOPs or guidelines AND Laboratory-Specific SOPs to this section of the Lab- Specific CHP

General Chemical Description:	Particularly Hazardous Substances and High Risk Chemicals	Hazardous Chemicals
SOP Requirement for Lab:	**Lab-Specific SOP** **Required** for the procedures in the lab. Maintain copy in CHP	May use general hazard class guidelines or SOP. Maintain copy in CHP unless procedures call for greater than the minimum PPE for wet labs and/or if engineering controls (e.g., CFH) are not available.
GHS Hazard Class (refer to SDS or PubChem)	**GHS Hazard Category**	
Acutely toxic – *dermal or inhalation*	1 or 2	3 or 4
Acutely toxic – *oral*	1 or 2	3 or 4
Carcinogen	1, 1A or 1B, 2	
Reproductive Hazard (Fetal or Fertility)	1, 1A or 1B, 2	
Mutagen	1A, 1B, 2	
Specific Target Organ toxicity	Single Exposure: 1 and 2	Repeated Exposure: 1, 2
Sensitizer (skin or respiratory)	Dermal 1A, Respiratory 1, 1B	
Respiratory irritant		3
Skin Corrosion/irritation		1A, 1B, 1C
Eye Damage/Irritation		1
Substances which, in contact with water, emit flammable gases	1, 2	3
Pyrophoric gas, liquid, or solid	1	
Explosives	Unstable or Div 1.1 – 1.3	Div 1.4 – 1.6
Self-reactive or Organic peroxides	Type A and B	Type C, D, E, F, or G
Self-heating	1	2
Flammable		Liquid, Solid, Gas, aerosol: 1,2,3
Oxidizing	Liquid & solid 1	Liquid & solid 2, 3, gas: 1, 2, 3
Gases under pressure	Acutely toxic gases; Pyrophoric gases: Refrigerated liquified gases (cryogens) in large quantities.	Simple Asphyxiants
Corrosive to Metals	1	
OTHER HAZARDS & DESIGNATIONS		
*Non-GHS Carcinogen Designations	NTP Known or reasonably anticipated; IARC Group 1, 2A, or 2B; OSHA listed carcinogens	
Nanoparticles	Synthesis of nanoparticles with chemical components	Use of preformulated nanoparticles for use in vitro or in vivo applications
Investigational Drugs	If properties of the drug are unknown, it is considered a high hazard risk. Consecutive procedures with the drug, after synthesis, require an SOP Investigational Drugs received from or shipped to other investigators must be shipped with an OSHA 29 CFR 1910.1200 compliant SDS. Ref: https://www.osha.gov/laws-regs/standardinterpretations/1991-09-09-0	ONLY investigational drugs synthesized and worked with solely in the PI's lab. SOP for component chemicals maintained in CHP.
EU/Other	Contact with water yields toxic gas; Contact with acids yields (very) toxic gas	Toxic by Eye Contact
EU/Other	Reacts violently with water; Corrosive to Respiratory Tract	May form explosive peroxides
EU/Other	Explosive when dry; Explosive with or without air contact; Strong Hydrogen Fluoride Releaser	Lachrymator

Standard Operating Procedure:

Laboratory Information

Department:	
Principal Investigator(s):	
Designated Chemical Hygiene Officer:	
Laboratory **emergency contact** (name and phone):	
Laboratory phone:	
Designated area (s) of these procedures with chemicals(s): (building and room):	
Agent storage location (building and room) and specifics regarding location/container/cabinets:	

Chemical Information

Chemical Name(s), including CAS No:	
GHS Classification and Hazard Statements (see SDS sheet provided by the chemical's manufacturer): **Example:** *Ethanol: H225: Highly Flammable liquid and vapor [Danger Flammable liquids]; H319: Causes serious eye irritation [Warning Serious eye damage/eye irritation]*	

Signs and symptoms of exposure or release	
Routes of exposure	
Required engineering controls: (i.e., chemical fume hood, biological safety cabinet, glove box, temperature control, humidity control, shielding, luer-lock syringe, in-line HEPA filter,etc.)	
Personal Protective Equipment (PPE) required for procedures:	
Known incompatibilities with chemical(s):	
Special storage and handling considerations:	
Please list the approximate amount(s) of chemical(s) utilized in all procedures	

Please describe, in a stepwise fashion, the work practices and procedures involved in the handling and utilization of this agent. **Please be clear and complete in the description of procedures (i.e., measuring, weighing, pouring, mixing, injection, mixing, transporting, administration to animals, heating, etc.).** **Be sure to include any precautionary safety steps undertaken during these procedures.** **Please submit additional pages, if necessary.**	

Waste collection and disposal procedures:	Waste chemicals shall be collected in a secured area. The area shall be free from evidence of spills. A Hazardous Waste label shall be affixed to the collection container and components shall be listed on the label as they are introduced into the container. **Do not date containers until the day of scheduled pickup**. Additionally, the container shall be marked with the hazard class of the chemical waste (i.e., Ignitable, Toxic, Reactive, Corrosive). When the container is no more than 2/3 full, date the container and submit a pick-up request in the UK waste ticketing system.
Spill procedure: Lab Specific Notes on Spill Response:	**Major spills of stock solution**: Leave the area and notify others not to enter. Report the spill to the UK Environmental Quality Management Department (EQMD)at (859) 323-6280 (M-F 8am-5pm) or after hours by dialing 911 from any on-campus phone or by contacting the UK Police at (859) 257-UKPD (8573). **Minor spills of manageable amount:** If necessary, contact EQMD for guidance. Consult manufacturer's SDS for instructions and compatibilities for your chemical (Be aware of any materials such as paper towels or water that could be incompatible with your spilled chemical!
Response procedures in the case of an incident or injury:	UK Employees: • After receiving first aid (refer to the chemical's SDS), report the occupational exposure to a hazardous chemical to UK Worker's Care at 1-800-440-6285. • If needed, an appointment will be made for the employee at UK UHS. • For severe emergency or injury, call 911 or proceed to the UK Chandler Hospital Emergency Department UK Students: • Call UHS at (859) 323-APPT to report an occupational exposure to a chemical hazard. • If needed, an appointment will be made for the employee at UK UHS. **For severe emergency or injury, call 911 or proceed to the UK Chandler Hospital Emergency Department** Additional Lab-Specific Emergency Procedures:

A copy of the manufacturer's SDS for this agent and the PI approved SOP shall be kept in the lab's Chemical Hygiene Plan (CHP). The CHP shall be stored in a location known to all laboratory personnel and is accessible during work hours.

Personnel Training

- Prior to conducting any work with (name of the chemical), designated personnel must be provided training specific to the hazard involved in working with the substance.
- The PI must provide his/her lab personnel with a copy of the SOP and a copy of the SDS provided by the manufacturer. Any further training materials must be documented and stored in the lab's Laboratory Safety Manual and available to internal UK or external oversight agency inspectors.
- The PI must ensure that his/her lab personnel have completed the initial and the consecutive annually required Chemical Hygiene trainings and Hazardous Waste training.

The undersigned have read and understood the content of this SOP and the SDS for:

Lab personnel performing procedures with this agent (typed name)	Date of hands-on training for this agent	Name of person who provided the agent specific training (typed name):	Signature of Lab Personnel

SOP Reviewed and Approved by:

PI: (typed name)	
PI: (signature and date)	
Designated Chemical Hygiene Officer(typed name)	
Designated Chemical Hygiene Officer ~~(signature and date)~~	

Lab Specific CHP Section 11: Exposure Monitoring and Medical Surveillance

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 must be established for the affected worker(s) as prescribed by the particular standard.

In some instances, may be necessary to perform personnel exposure monitoring when administrative controls, engineering controls, and PPE may not be sufficient for full protection from exposure to a hazardous chemical. This can occur when chemical exposure levels approach or exceed OSHA's Permissible Exposure Limit (PEL) and/or ACGIH's Threshold Limit Value (TLV). This is usually indicated when engineering controls, such as a chemical fume hood, cannot be used for procedures.

Please describe any specific procedures, tasks, or materials that have the potential for exposure of lab personnel to hazardous chemicals in amounts exceeding the established PEL/TLV.

PI/Laboratory-designated CHO: Please check if not applicable to the laboratory.

☐ Permissible exposure limits for hazardous chemicals in use are not exceeded in this lab.

☐ This laboratory has no requirements for exposure monitoring or medical surveillance.

Please attach any supplementary documentation, instructions, or information relevant to the specific lab's exposure monitoring or medical surveillance to this section of the Lab Specific CHP

Lab Specific CHP Section 12: **Chemical Inventory and Safety Data Sheets**

Federal regulations require that Safety Data Sheets (SDS) be maintained and readily accessible for all hazardous chemicals. University of Kentucky Research Safety, the UK CHP, the UK Chemical Safety Committee, and best practices stipulate that laboratory inventories of hazardous chemicals be updated on no less than an annual basis.

Hazardous chemicals are those with the following GHS characterizations:

- Carcinogenic or otherwise harmful to human health
- Irritant, dermal sensitization
- Corrosive
- Flammable
- Oxidizing
- Reactive/Explosive
- Toxic
- Harmful to the environment
- Liquids and gases under pressure, including liquid nitrogen tanks and compressed air cylinders

Regardless of the method the laboratory uses to inventory their hazardous chemicals, all research labs at the university are asked to update their chemical inventories in the UK online chemical inventory system every year in conjunction with the Lab Safety Inspection. This furthers compliance by keeping accurate totals of hazardous material storage within acceptable regulatory limits, informs our first responders in the event of an emergency, and facilitates prompt chemical waste pickup.

Please provide a description of where the SDSs are stored and how inventory records are maintained.

Format of the SDS: ☐ Electronic ☐ Hard Copy ☐ Other (explain below)

Location of the SDS:

Method of Maintaining Inventory: ☐ SciShield ☐ Lab Archives ☐ Quartzy ☐ Other (explain below)

Location of Inventory Records:

Title 29 —Labor
Subtitle B —Regulations Relating to Labor
Chapter XVII —Occupational Safety and Health Administration, Department of Labor
Part 1910 —Occupational Safety and Health Standards
Subpart Z —Toxic and Hazardous Substances

Authority: 33 U.S.C. 941; 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12-71 (36 FR 8754); 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), 6-96 (62 FR 111), 3-2000 (65 FR 50017), 5-2002 (67 FR 65008), 5-2007 (72 FR 31160), 4-2010 (75 FR 55355), 1-2012 (77 FR 3912), or 08-2020 (85 FR 58393); 29 CFR part 1911; and 5 U.S.C. 553, as applicable. All of subpart Z issued under 29 U.S.C. 655(b), except those substances that have exposure limits listed in Tables Z-1, Z-2, and Z-3 of § 1910.1000. The latter were issued under 29 U.S.C. 655(a). Section 1910.1000, Tables Z-1, Z-2 and Z-3 also issued under 5 U.S.C. 553, but not under 29 CFR part 1911 except for the arsenic (organic compounds), benzene, cotton dust, and chromium (VI) listings. *See Subpart Z of Part 1910 for more*

Source: 39 FR 23502, June 27, 1974, unless otherwise noted. Redesignated at 40 FR 23072, May 28, 1975.

Authority: 33 U.S.C. 941; 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12-71 (36 FR 8754); 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), 6-96 (62 FR 111), 3-2000 (65 FR 50017), 5-2002 (67 FR 65008), 5-2007 (72 FR 31160), 4-2010 (75 FR 55355), 1-2012 (77 FR 3912), or 08-2020 (85 FR 58393); 29 CFR part 1911; and 5 U.S.C. 553, as applicable.

Source: 39 FR 23502, June 27, 1974, unless otherwise noted.

Editorial Note: Nomenclature changes to part 1910 appear at 84 FR 21597, May 14, 2019.

§ 1910.1450 Occupational exposure to hazardous chemicals in laboratories.

(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 Z, 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 of 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 indvidual 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.

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 in the course of his or her assignments.

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

Health hazard means a chemical that is classified as posing one of the following hazardous effects: Acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in appendix A of the Hazard Communication Standard (§ 1910.1200) and § 1910.1200(c) (definition of “simple asphyxiant”).

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

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

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a moveable 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 of 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.

Mutagen means chemicals that cause permanent changes in the amount or structure of the genetic material in a cell. Chemicals classified as mutagens in accordance with the Hazard Communication Standard (§ 1910.1200) shall be considered mutagens for purposes of this section.

Physical hazard means a chemical that is classified as posing one of the following hazardous effects: Explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self reactive; pyrophoric (gas, liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or combustible dust. The criteria for determining whether a chemical is classified as a physical hazard are in appendix B of the Hazard Communication Standard (§ 1910.1200) and § 1910.1200(c) (definitions of "combustible dust" and "pyrophoric gas").

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 mean chemicals that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard (§ 1910.1200) shall be considered reproductive toxins for purposes of this section.

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.

(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 fume 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 particular 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 fume 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, 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 in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the 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 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 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 1910.20.

(k) [Reserved]

(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 to 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: *http://www.csb.gov/*.

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 each individual 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 general 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 by the use of 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 tight-fitting, 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 the 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.

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.

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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.

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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 (latest edition).

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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 U.S. 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.

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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.

[55 FR 3327, Jan. 31, 1990; 55 FR 7967, Mar. 6, 1990; 55 FR 12111, Mar. 30, 1990; 57 FR 29204, July 1, 1992; 61 FR 5508, Feb. 13, 1996; 71 FR 16674, Apr. 3, 2006; 76 FR 33609, June 8, 2011; 77 FR 17887, Mar. 26, 2012; 78 FR 4325, Jan. 22, 2013]