ILLINOIS STATE UNIVERSITY CHEMICAL HYGIENE PLAN

Adopted 2/13/1995

Revised 1/21/2020

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1. INTRODUCTION

a. Chemical Hygiene Plan

The purpose of this Chemical Hygiene Plan is to define work practices and procedures to help ensure that laboratory workers and employees at Illinois State University are protected from health hazards associated with the hazardous chemicals with which they work. The Chemical Hygiene Plan is part of the University's compliance with the 29CFR1910.1450 standard promulgated by OSHA entitled "Occupational Exposure to Hazardous Chemicals in Laboratories". For simplicity, this standard will be referred to as the Lab Standard in this document.

b. Explanation of the Lab Standard

The Lab Standard defines a hazardous chemical as " any chemical which is classified as health hazard or simple asphyxiant in accordance with the Hazard Communication Standard (§1910.1200)". In addition, the Lab Standard defines a laboratory as "a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis." Finally, an employee in the Lab Standard is defined as "an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments".

For the purposes of this Chemical Hygiene Plan, the employee described above will be called a laboratory worker. An example of a laboratory worker would be a research or teaching assistant, laboratory assistant, staff or faculty member instructing or performing research in a laboratory. Students in the academic laboratory would not be considered laboratory workers, although every effort should be made to meet the safety needs of the student within the guidelines of the Lab Standard.

If there is any confusion about whether a particular workplace is considered a laboratory which utilizes hazardous chemicals or whether someone is considered a laboratory worker, Environmental Health and Safety will, upon request, make this determination.

c. Responsibilities

i. Deans, Directors, and Department Chairs

Deans, Directors, and Department Chairs are to work with their organizational units to ensure that affected employees are trained on the provisions of the University Chemical Hygiene Plan and are taking action to comply with its requirements. These individuals should:

- Identify all laboratories and chemical handling areas in their organizational unit.
- Assign Lab Supervisor for each laboratory/chemical handling area.
- Assure that employee training is conducted at the time of employment and annually thereafter.
- Determine and direct the method of the enforcement and compliance of the Chemical Hygiene Plan

ii. Environmental Health and Safety

- Provide pro-active support on issues of hazard identification and evaluation; procedures for correcting unsafe conditions, control measure determination and implementation; employee information; and training programs.
- Maintain centralized environmental monitoring records, allowing employee access as required by law.

- Serve as the principal point of contact with regulatory agencies on matters of chemical hygiene at the University.
- Arrange for general safety inspections and safety equipment testing as required under the University Chemical Hygiene Plan to include, but not be limited to: showers, ventilation, and fume hoods.
- Review Principle Investigator or Laboratory Supervisors employee training records.

iii. Chemical Hygiene Officer (CHO)

- Establishing and implementing a Chemical Hygiene Plan, and updating the plan at least annually.
- Investigating accidents and chemical exposures within the department.
- Acting as a liaison between the department and EHS for laboratory safety issues.
- Maintaining records of training and exposure monitoring.
- Ensure laboratory workers receive chemical and procedure-specific training.
- Review and approve use of particularly hazardous substances.
- Approve laboratory worker's return to work following a chemical exposure requiring medical consultation.

iv. Laboratory Supervisor/Principal Investigator

Laboratory Supervisors are administrators/faculty/staff who supervise others in chemical use or handling. A principal investigator of a research project is considered to be the Laboratory Supervisor for that project. Laboratory Supervisors are to take measures that protect the health and safety of the workers under their supervision. They should:

- Ensure that action is taken to correct work practices and conditions that may result in the release of hazardous materials.
- Ensure that protective equipment is available, working and used as appropriate.
- Provide and document that employees have been trained and understand the content of the Chemical Hygiene Plan at initial assignments and whenever a new hazard is introduced.
- Identify materials considered particularly hazardous and communicate warnings to workers as appropriate. In coordination with the Chemical Hygiene Officer and EHS, Laboratory Supervisors should participate in laboratory compliance audits, at least once per year.
- [Lab Audit Template]
- Maintain accurate chemical inventories and ensure SDSs are available for all chemicals used or stored in the laboratory space under their purview.
- MSDSs that are not available online must be acquired from the manufacturer and maintained in an accessible location.
- Review MSDSs or other chemical safety information as needed to assure an understanding of the chemical hazards and protective measures of the chemicals in the laboratory.

v. Lab Workers

Laboratory workers are personnel engaged in the laboratory use of hazardous chemicals. These workers are required to:

- Understand and act in accordance with the Chemical Hygiene Plan and any laboratory-specific standard operating procedures.
- Participate in training programs.
- Practice good personal chemical hygiene
- Report all accidents and incidents to the supervisor on a timely basis.

- Review MSDSs or other chemical safety information as needed to ensure an understanding of the chemical hazards in the laboratory.

2. HAZARD RECOGNITION

All lab employees shall be knowledgeable concerning the hazards associated with the lab and with the ongoing activities within the lab. It is therefore important that staff be able to discern the hazardous properties among different chemicals they use. To do so, staff shall have a basic understanding of toxicological principles, hazard recognition, and acceptable exposure levels.

a. Hazard Identification

Although the OSHA Lab Standard (29 CFR 1910.1450) applies to the laboratory use of chemicals, the elements of the OSHA Hazard Communication Standard (29CFR1910.1200) will be implemented on chemical manufacturers, distributors, and importers labels and Safety Data Sheets (SDS). It is very important that lab employees be aware of the Hazard Communication labeling requirements and SDS format.

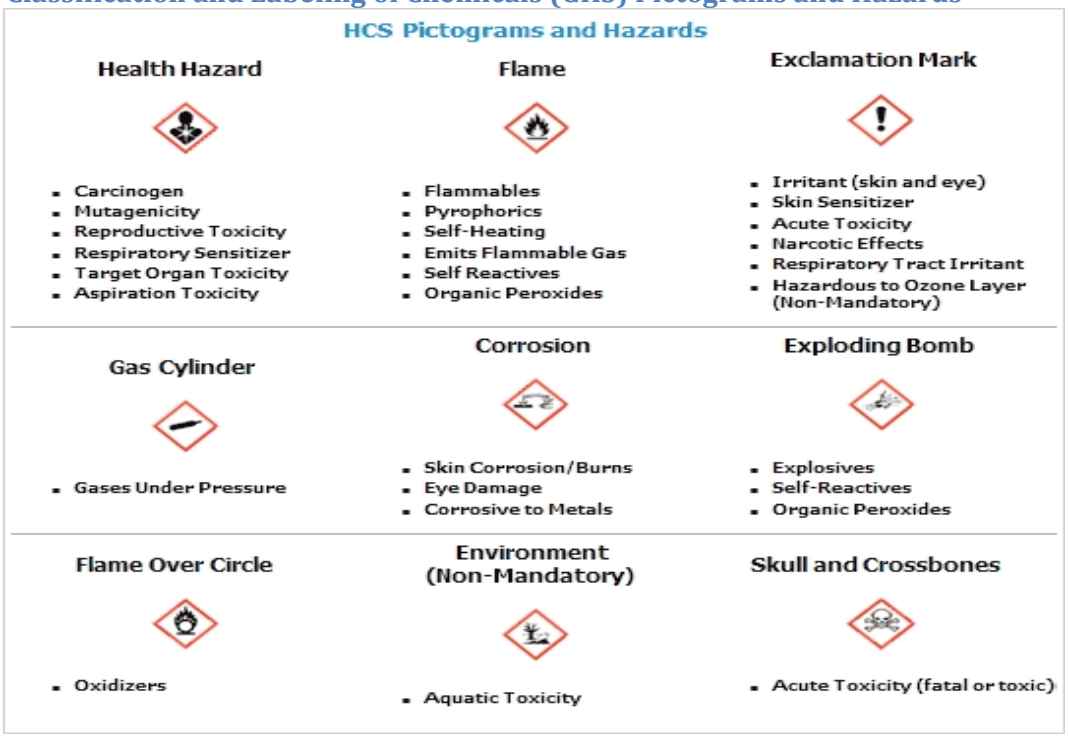
With respect to labels and Safety Data Sheets:

- Labels on incoming containers of hazardous chemicals shall not be removed or defaced.
- Secondary and transfer containers are not required to have a GHS-compliant label; however, labels must be placed on chemical containers that display the common name of the chemical and any relevant hazard information [i.e. NFPA 704 Hazard rating or Hazardous Material Information System (HMIS)].
- Safety Data Sheets that are received with incoming shipments of hazardous chemicals must be maintained and readily accessible to laboratory employees.

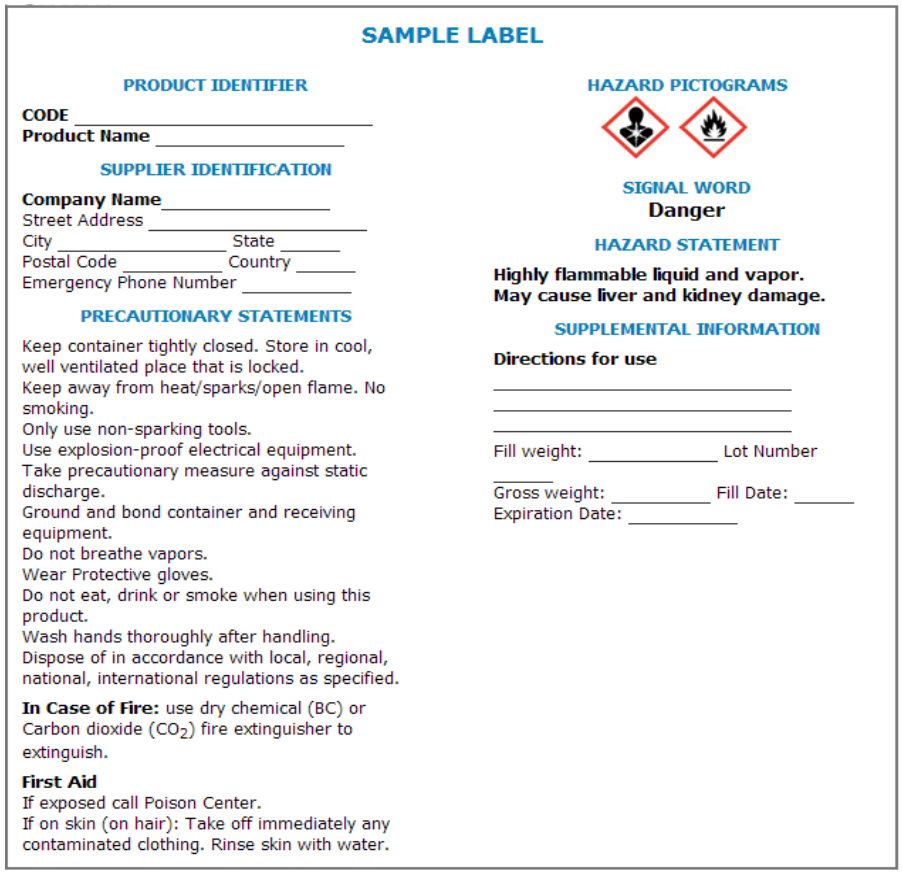
The following provisions shall apply to chemical substances developed in the laboratory:

- 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 (health hazard or simple asphyxiant).
- If the chemical is determined to be hazardous, the employer shall provide appropriate training.
- If the chemical produced is a byproduct whose composition is not known, the PI shall assume that the substance is hazardous and shall ensure that specific SOPs are developed for the use of the material and included in the lab-specific Chemical Hygiene Plan.
- If the chemical substance is produced for another user outside of the laboratory, the PI shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of Safety Data Sheets and labeling. Contact EHS for assistance with Hazard Communication compliance.

i. Figure 1: Hazard Communication Standard (HCS) Globally Harmonized System of Classification and Labeling of Chemicals (GHS) Pictograms and Hazards



ii. Figure 2: Sample Manufacturer, Importer, and Distributor HCS-Compliant Label



SAMPLE LABEL

PRODUCT IDENTIFIER

CODE _____
Product Name _____

SUPPLIER IDENTIFICATION

Company Name_____
Street Address _____
City _____ State _____
Postal Code _____ Country _____
Emergency Phone Number _____

PRECAUTIONARY STATEMENTS

Keep container tightly closed. Store in cool, well ventilated place that is locked.
Keep away from heat/sparks/open flame. No smoking.
Only use non-sparking tools.
Use explosion-proof electrical equipment.
Take precautionary measure against static discharge.
Ground and bond container and receiving equipment.
Do not breathe vapors.
Wear Protective gloves.
Do not eat, drink or smoke when using this product.
Wash hands thoroughly after handling.
Dispose of in accordance with local, regional, national, international regulations as specified.

In Case of Fire: use dry chemical (BC) or Carbon dioxide (CO_2) fire extinguisher to extinguish.

First Aid
If exposed call Poison Center.
If on skin (on hair): Take off immediately any contaminated clothing. Rinse skin with water.

HAZARD PICTOGRAMS

SIGNAL WORD
Danger

HAZARD STATEMENT

Highly flammable liquid and vapor.
May cause liver and kidney damage.

SUPPLEMENTAL INFORMATION

Directions for use

_____
_____
_____

Fill weight: _____ Lot Number _____
Gross weight: _____ Fill Date: _____
Expiration Date: _____

b. Standard Operating Procedures

Standard Operating Procedures (SOP) are required by Occupational Safety & Health Administration's (OSHA) laboratory standard section (1910.1450(e3i)) to be developed and maintained by individual laboratories. The Chemical Hygiene Plan must contain "Standard Operating Procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." Laboratories must perform a hazard assessment of the laboratory procedures to determine which SOPs must be developed. At a minimum a laboratory must have laboratory specific SOPs for the chemical and biological hazards and any agents which are used in approved animal studies.

Any chemical which has a National Fire Protection Association (NFPA) Health Rating of 2 or above or has specific handling procedures or equipment should have an SOP developed for the specific use of those chemicals. One example of a chemical is Hydrofluoric Acid. Chemicals that are rated below or have similar handling requirements can be developed as a blanket SOP. Some common examples of a blanket SOPs include: flammable liquids and corrosives. SOPs should also be developed for any Risk Group 2 Biological Agent work that is performed in a laboratory.

An SOP must contain at a minimum the specific personal protective equipment required, engineering controls, decontamination procedures, waste disposal procedures and a description of the laboratory procedure that will be performed. EHS has developed an SOP template that is accessible on the EHS website.

SOPs must be housed in the laboratories' Chemical Hygiene Plan and all employees must have access to the SOPs for the laboratory. The laboratory supervisor or PI is responsible to train all employees on appropriate handling procedures for those chemical and biological hazards covered by the standard. SOPs should be reviewed annually to ensure that the entire document is updated with any procedural or location changes. New SOPs must be developed when a new hazard is presented in the laboratory.

All SOPs for the Laboratory and Animal Use must be uploaded and stored in the Chemical Hygiene Plan.

3. WORKING WITH LABORATORY CHEMICALS

a. Administrative Procedures

i. Chemical Procurement

Chemical containers shall not be accepted by staff without accompanying labels and packaging in accordance with all appropriate regulations. All chemical shipments of peroxide forming chemicals will be dated when received and labeled with peroxide testing schedule before distributed to users.

ii. Working Alone – Unattended Operations

When working with hazardous materials, it is advisable to have a second person present, or at a minimum, maintain surveillance via telephone contact. No dangerous experiments should be run unattended unless they are fail-safe. A dangerous experiment is one which will impose an immediate threat to life, if there is a loss of water pressure, electricity or hood operation. Those experiments which cannot be safely isolated shall not be performed unattended unless a suitable monitor is present and functioning. The Principle Investigator or Lab Supervisor is responsible for making the

determination as to whether a particular process or experiment would prohibit an individual from working alone in a laboratory.

b. General Chemical Safety

i. Horseplay

Horseplay of any kind is strictly forbidden in the laboratories.

ii. Personal Hygiene

Wash promptly if skin contact is made with any chemical, regardless of corrosivity. Use emergency eyewash or shower when appropriate.

As a minimum, safety glasses will be worn in laboratories where hazardous materials are being used at all times. Safety goggles and face shields will be used to increase the level of eye protection as needed by the process.

Opened toes shoes are prohibited in laboratories.

If shorts and skirts are worn they must cover knee. If the shorts or skirt are not long enough to cover the knee a lab coat is required.

Eating, drinking, and the application of cosmetics are forbidden practices in areas where hazardous chemicals are used and shall be done only in well-defined designated areas. Do not store food in the same refrigerator with chemicals, biohazards, or radioactive materials.

Gloves are for use inside the laboratory and must not be worn outside the laboratory. Remove gloves before entering hallways.

iii. Housekeeping

Adequate means of egress shall be maintained at all times.

Access to emergency equipment, showers, eyewashes, and exits must NOT be blocked by equipment, furniture, etc.

Material CANNOT be stored within 18" of the ceiling

Fire alarm strobe enunciators must be unobstructed and visible throughout the room

Work areas and floors are not to be used for excessive storage. No unauthorized items shall be stored in the corridors.

Promptly respond to all spills according to Section 8.0(a); properly dispose of the spilled chemical and cleanup materials.

iv. Material Transport

Glass or any other containers holding hazardous or radioactive materials shall be transported using secondary containment or on carts. Some secondary containers are available for transport from the stockroom. The use of atrium stairs for the transport of hazardous chemicals and waste is strictly prohibited. Violators should be reported to the applicable departmental office or Chemical Hygiene Officer.

v. Solvent Storage and Handling

Flammable and combustible liquids in moderate amounts (less than 15 gallons) may be stored in the laboratory. Larger quantities should be stored in the bulk flammable solvent room (SLB 108) which has adequate fire suppression for large amounts of flammable materials.

Appropriate PPE shall always be donned when dispensing laboratory chemicals. Refer to the applicable Safety Data Sheet for information on proper PPE.

vi. Glassware and Laboratory Equipment

All broken glassware will be immediately disposed of in an appropriate rigid, puncture-resistant container, such as a metal trash can. Contaminated glassware should be decontaminated in a manner appropriate for the chemical or biological material used.

All laboratory equipment shall be used only for its intended purpose. Equipment must be kept in good working order and labeled "Out of Service" if broken or not functional.

vii. Vacuum and Pressure Operations

Extra precautions are necessary when working with vacuum and high pressure devices. If explosion or implosion appears possible, face shields should be worn to protect the face and neck of the user.

Note: Specific procedures should be developed for dealing with potential problems when using vacuum and pressure operations.

viii. Sinks and Refrigerators

Sinks:

- May only be used for aqueous/non-hazardous material.
- Should have water added periodically to prevent desiccation drying of the drain trap resulting in exposure to sewer gases and other organic vapors.
- Should be kept clean and free of debris.
- Electrical outlets within 5 feet of sinks must be equipped with Ground Fault Circuit Interrupters.

Refrigerators:

- Explosion proof refrigerators are to be used for storage of flammable or unstable chemicals. Under no circumstances should food or drink be stored in freezers, refrigerators or cold boxes containing chemicals.
- Chemicals and other materials must be not be stored with other incompatible chemicals. Each container must be compatible with its contents, tightly closed, and labeled.

ix. Compressed Gases

Cylinders must be stored in well ventilated areas with their protective caps screwed on and the cylinder secured (e.g., strapped or chained) to reduce the chance of the cylinder being knocked over. Do not store cylinders near heat or high traffic areas. Flammable gas cylinders should be stored separately from oxidizers. Large numbers of cylinders must be stored in approved gas cylinder storage area.

Use appropriate hand carts to move cylinders. Cylinders must be secured to the cart during transport with protective caps in place. Always consider cylinders as full and handle them with corresponding care.

Cylinders should be secured at all times, during transport, storage and use. Never move any gas cylinder while the regulator is still attached.

Always use the recommended regulator to dispense compressed gases.

Note: Please visit www.airgasace.com and register to gain access to free compressed gas cylinder safety training in the form of videos, modules, and scenarios.

x. Fume Hoods

All fume hoods must be evaluated by EHS prior to their initial use and annually thereafter.

Make sure hood has been maintained in accordance with Section 4(c).

Make sure air is entering the hood prior to starting an experiment.

Do not place your face inside of the hood.

Keep sources of emission six (6) inches inside the hood.

Minimize the storage of chemicals in the hood. Clean up all spills immediately. Periodically clean hood interior, including fluorescent bulb panel. If volatile or corrosive materials are stored in the hood, it should be in continuous operation.

Do not use the hood for disposal. Use condensers, traps, or scrubbers. See Section 3(c) for waste disposal information.

xi. Cryogenic Liquids

Loose-fitting heavy cloth or dry leather gloves should always be worn when handling anything that comes in contact with cold liquids, cold solids and/or cold vapor. Gloves should be loose fitting so that they can be removed quickly if liquids are spilled into them. A potholder or other insulation should be used between the gloves and container except when the material is in a dewar (cryogenic liquid container).

Keep dewars vertical at all times. Do not roll the container on its side. Secure dewars in restrainers to avoid spills.

Relief valves on dewars shall not be tampered with under any circumstances!

Matches, lighters, and other sources of ignition are prohibited where liquid hydrogen and oxygen are present.

Any frosting, ice formation, or excessive corrosion on safety valves may render the safety valves inoperative. In the event of any of these instances, the vessel should be taken out of service as these valves may not work, thus not allowing pressure release in the event of its buildup.

Store dewars and liquid gas cylinders in well-ventilated storage areas when not in use or connected to a closed system.

Liquid Nitrogen Safety Training

xii. Laboratory Freeze Dryers (Lyophilizers)

In order to avoid implosion, use only appropriate lyophilizer flasks and inspect for cracks or scratches that may cause failure. Do **not** substitute regular laboratory glassware for vacuum use.

Locate the unit out of the traffic flow.

Empty the condensate trap regularly and change pump oil after large loads or every six months.

xiii. Autoclaves

Sign the log book at time of use.

Any time the door is closed on the unit, assume it is fully pressurized.

Inspect the unit on a regular basis for closure alignment, cracks, damage or hot spots and clean once a month. Never leave flammable materials, debris, or plastics in or near the unit.

Under no circumstances should the door of the autoclave be opened until the interior or chamber pressure has been released.

Periodic spore checks should be performed to ensure sterilization time and temperatures have been met.

xiv. Warning Signs and Labels

Warning Signs:

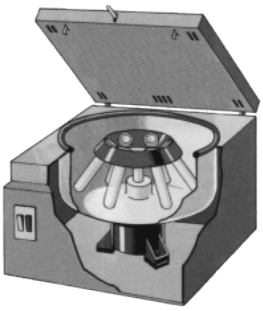
- Laboratory areas that have special or unusual hazards should be posted with warning signs, such as radiation, biological, or optical hazards.
- Other signs should be posted to show the locations of safety showers, eyewash stations, exits, and fire extinguishers.

Labels:

- Waste containers should be labeled in accordance with Section 3(c)(i).
- Labels on containers of chemicals should contain information on the hazards associated with use of the chemical.
- Peroxide-forming chemicals (ex: Tetrahydrofuran, Diethyl Ether, etc.) shall be labeled with the date that they were opened and tested for peroxide-formation every six months. Results of the peroxide test shall be written on the peroxide test sticker affixed to the bottle when removed from the Chemistry Stockroom.

- Unlabeled bottles of chemicals should not be opened; efforts should be made to determine the contents of the bottle based on generator's knowledge. Outdated materials should be disposed of promptly and appropriately.

xv. Centrifuges



Each operator should be instructed on proper operating procedures prior to using a centrifuge. Instructions should include requirements for balancing loads, using the proper rotor, use of secondary containment and the use of accessory equipment.

Each employee who uses a centrifuge is responsible for the condition of the machine and rotor at the end of the procedure.

OSHA Quick Facts – Laboratory Safety: Centrifuges

c. Waste Disposal

Waste generation should be kept at a minimum. Waste minimization is an action of both local and global significance, and staff are encouraged to share thoughts and ideas concerning waste minimization and prevention.

Illinois State University is committed to managing its wastes in a safe and efficient manner. These procedures govern the management of hazardous and radioactive waste at the University.

Hazardous waste management is governed by increasingly stringent and complex regulations. Management of chemical and hazardous wastes at the University is accomplished by the generator of the waste with the assistance of Environmental Health and Safety (EHS). EHS will assist generators on campus to help assure that wastes are managed in accordance with the regulations. However, the generator is ultimately responsible for assuring that waste generated is managed in a safe and appropriate manner.

Any waste material that may, upon contact, present a hazard to one's health or surrounding environment should be treated as a potentially hazardous waste. This includes spent or unused chemicals, cleaning solutions, oils, etc. If there is any doubt whether a material should be treated as hazardous, contact EHS at 8-8325. Only aqueous/non-hazardous waste may be disposed in the sewer or trash.

EHS will pick up properly documented and packaged wastes and will store them prior to their final disposition. Waste is disposed of by contract and is picked up from the University usually three-four times per year. The hierarchy of disposal methods used for the University's waste is reclamation and residual destruction, high temperature incineration, chemical/physical treatment, and a secure landfill.

i. Labeling Waste Containers

All containers should be labeled with contents including % composition, accumulation date, associated hazards, and generator identification. Manufacturer labels are acceptable for unused or out-of-date chemicals. When container size and configuration allow, the uniform waste label should be used. Labels are available from EHS.

ii. Storing Waste

All waste shall be stored in a safe and secure area. Waste shall remain in such areas until picked up by EHS. Never leave waste in a hallway or other unsecured area where it may be subject to public contact. Wastes should be properly segregated. Halogenated materials should be kept separate from

non-halogenated and solids separated from liquids. Acids shall be stored separate from flammables. Oxidizers must be stored separate from organics and flammables. (Reference RCRA Chemical Waste Compatibility Chart).

Generators are responsible for obtaining necessary storage containers. Containers shall be structurally sound, in good condition, and have a tight fitting screw cap. Stoppered bottles and plastic milk or soda bottles are not acceptable. Waste generators are also required to use a container made of or lined with materials which will not react with, and are otherwise incompatible with, the hazardous waste to be stored. Materials that may generate vapor, such as solvents and other low boiling point materials should be stored in a properly ventilated area. All waste containers should have at least 10-20% headspace left in them to avoid pressure build up that may result from thermal expansion.

iii. Having Waste Picked Up for Disposal

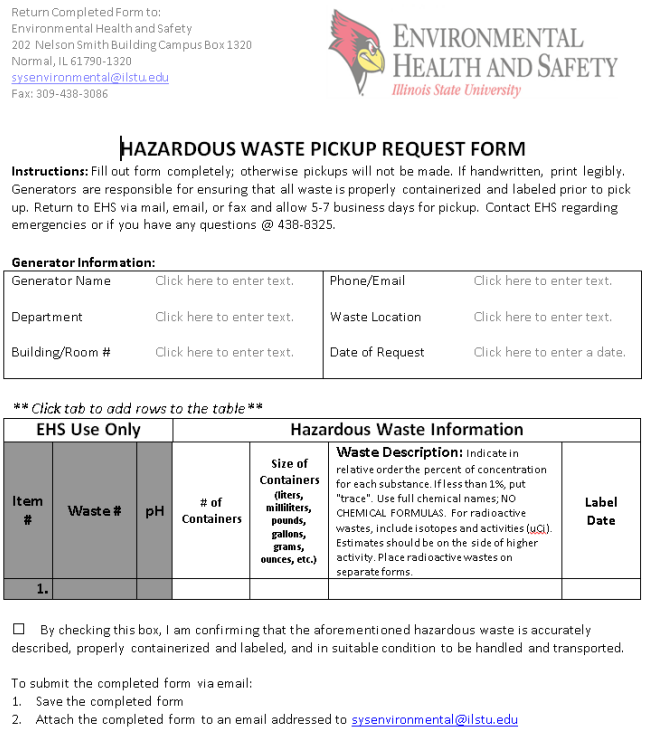
Information must be provided to EHS to adequately characterize and dispose of the waste prior to having it picked up. This information is provided by the generator to EHS by using the Hazardous Waste Pick-Up Request Form. Pickup requests shall be filled out and emailed, mailed, or faxed to EHS. Four to five days should be allowed for pickup.

EHS will evaluate the information and if sufficient, will schedule the material for pickup. If insufficient, EHS will request additional information from the generator. A pickup will not be made until appropriate information is received.

Certain wastes will require the generator to certify the presence or absence of constituents and concentrations. This certification can be based on the generators knowledge, analytic testing, or other scientific data. EHS will notify generators when additional information or certification is necessary.

The generator, defined as Principal Investigator (PI), in making the certification, accepts the associated liability and responsibility for possible misrepresentation of the waste. Penalties for misrepresentation, a violation of state and federal law, can include fines and/or imprisonment.

When the generator does not have sufficient knowledge or information to make the certification, the wastes must be analyzed at the Department's (generator's) expense. The analysis must performed by a laboratory acceptable to EHS and be sufficient to provide necessary data for the generator to certify the waste. EHS can provide guidance on appropriate analyses.



Return Completed Form to:
Environmental Health and Safety
202 Nelson Smith Building Campus Box 1320
Normal, IL 61790-1320
sysenvironmental@ilstu.edu
Fax: 309-438-3086

ENVIRONMENTAL HEALTH AND SAFETY
Illinois State University

HAZARDOUS WASTE PICKUP REQUEST FORM

Instructions: Fill out form completely; otherwise pickups will not be made. If handwritten, print legibly. Generators are responsible for ensuring that all waste is properly containerized and labeled prior to pick up. Return to EHS via mail, email, or fax and allow 5-7 business days for pickup. Contact EHS regarding emergencies or if you have any questions @ 438-8325.

Generator Information:

Generator Name	Click here to enter text.	Phone/Email	Click here to enter text.
Department	Click here to enter text.	Waste Location	Click here to enter text.
Building/Room #	Click here to enter text.	Date of Request	Click here to enter a date.

*** Click tab to add rows to the table ***

EHS Use Only			Hazardous Waste Information			
Item #	Waste #	pH	# of Containers	Size of Containers (liters, milliliters, pounds, gallons, grams, ounces, etc.)	**Waste Description:** Indicate in relative order the percent of concentration for each substance. If less than 1%, put "trace". Use full chemical names; NO CHEMICAL FORMULAS. For radioactive wastes, include isotopes and activities (uCi). Estimates should be on the side of higher activity. Place radioactive wastes on separate forms.	Label Date
1.						

☐ By checking this box, I am confirming that the aforementioned hazardous waste is accurately described, properly containerized and labeled, and in suitable condition to be handled and transported.

To submit the completed form via email:
1. Save the completed form
2. Attach the completed form to an email addressed to sysenvironmental@ilstu.edu

Note: A comprehensive analysis of an unknown waste can cost well over $1,000. It is therefore in the generator's and Department's best interest to maintain meticulous data concerning the waste and strict control over its composition.

iv. Radioactive Waste

Radioactive waste should be stored and labeled separate from other hazardous wastes. However, generators must assure that adequate shielding of the storage area is provided to keep exposure as low as possible. Liquid and solid wastes should always be segregated and collected in separate containers.

The same waste labels and request forms used for other hazardous waste should be used for radioactive waste. The container label must indicate the chemical composition of contents, isotopes used, quantity in microcuries, and associated hazards. This same information must also be provided on the pickup request form.

High-energy beta emitters with half-lives shorter than 60 days can be stored on site for decay. Once 10 half-life decays have passed, with proper documentation, the material can be discarded into the solid waste stream.

Low-energy alpha and beta emitters may be disposed of in the sanitary sewer.

Once material has been used and disposal is complete, the Radioisotope Inventory Form should be returned to EHS.

Radioisotope Inventory Form

v. Minimizing Waste

Waste minimization or prevention can be accomplished many different ways. Generators are strongly encouraged to be alert for alternative procedures or products that will reduce or prevent waste generation.

Laboratory supervisors should be familiar with the nature of the waste they generate, including composition and quantity. Chemicals or other materials which have not been opened or are still in usable form can be saved from becoming waste by offering to other University staff for use.

Waste generated in both teaching and research laboratories have additional reduction options available. These include converting to micro scale experiments and incorporating material neutralization or inactivation into experiment procedures. This promotes environmental and product stewardship and could be a valuable theme in course curriculum.

vi. Using Sink Drains and the Sewer

Sink drains or the sewer should never be used as a means to dispose of hazardous or other chemical waste unless it is known to environmentally compatible. Chemical and waste products should enter the sewer only through actions incidental to the process or experiment, such as container washing and rinsing. Waste material should otherwise be collected for pickup and disposal.

Materials of questionable nature should not be put down the drain without first contacting EHS. Never allow organic liquids, mercury, or extremely toxic substances to enter the sewer.

Note: Low-energy alpha and beta emitters may be disposed of in the sanitary sewer. Sink and drains lines must be labeled with a radioactive label when used for disposal.

d. Special Chemical Safety

i. Corrosive Substances

Corrosives attack human tissue and cause irritation, chemical burns, and in severe cases, tissue destruction. In case of skin or eye contact with corrosives, prompt treatment with a physiologically correct buffered saline is important. Consultation with a medical professional is required. Safety showers and eyewash fountains must be provided for this purpose and must be readily available to all lab occupants. At no point should the storage of material or placement of articles impede access to safety showers and eyewashes.

Types of corrosives and examples of each are:

Acids:

Acids are acidic substances that have a pH below 7. Inorganic or mineral acids include sulfuric, nitric, hydrochloric, phosphoric and hydrofluoric.

Organic acids contain a carboxylic group, (-COOH) and are generally less acidic and corrosive than the mineral acids. Common organic acids include acetic, benzoic, citric, and oxalic.

Bases:

Bases are alkaline substances that have a pH above 7 when dissolved in water. Contact with the skin causes a "slippery" or "soapy" feeling. Examples of common bases include:

Ammonium hydroxide	Calcium hydroxide
Potassium carbonate	Potassium hydroxide
Sodium carbonate	Sodium hydroxide

The eye is especially susceptible to alkalis, so splash goggles or face shields are required whenever there is a possibility of eye contact.

Corrosives shall be stored with compatible materials. Acids should be stored separate from bases, flammables, and oxidizers.

EPA Compatibility Chart or RCRA Compatibility Chart

Halogens:

The elemental halogens (bromine, chlorine, fluorine, and iodine) are all extremely corrosive and especially damaging to the respiratory system. They are also capable of causing the deterioration of equipment components, including gaskets, piping and tubing.

Organic Compounds:

Organics can be as corrosive as the inorganic acids and bases. Examples include phenols, amines and some unsaturated ketones. In addition, many organics can be absorbed through intact skin and produce toxic effects.

List of Common Laboratory Corrosives

ii. Oxidizers

Oxidizers are compounds (solid, liquid, gas) that evolve oxygen or are electron acceptors either at room temperature or upon slight heating. This group includes peroxides, chlorates, perchlorates, nitrates, permanganates, and the elemental halogens. Oxidizers can react vigorously at ambient temperatures when they contact organic material or reducing substances.

List of Typical Oxidizers (NFPA)

iii. Air Reactive and Moisture Sensitive Compounds

Many chemical compounds deteriorate when exposed to air. For most of these, oxidation only causes a decrease in purity. But for a few, extreme reactivity with oxygen leads to other effects. Another group of compounds reacts with atmospheric moisture and causes the release of toxic or flammable gases or vapors or the generation of enough heat to cause fires and explosions. In the following information, the threshold limit value (TLV) is the safe amount to which a person can be exposed to without harm.

Examples:

Compound	Effects
Aluminum Alkyls	React with moisture to generate extremely flammable hydrocarbon vapor.
Dichlorosilane	Forms silicon dioxide and hydrogen chloride on contact with air. Will detonate spontaneously under some conditions.
Phosphides	React with moisture to form highly toxic phosphine (Threshold Limit Value-TLV=0.3 ppm)
Potassium	Reacts with moisture to release hydrogen and when combined with oxygen to cause ignition and explosion.
Selenides	Moisture causes release of the extremely toxic hydrogen selenide (TLV=0.05 ppm)
Sodium	Reacts with moisture to release hydrogen. The heat generated may cause a fire.

Sulfides	Hydrogen sulfide (TLV=10 ppm) formed on contact with moist air.

These substances should be handled in a glove box with an inert atmosphere or in special glassware (Schlenk techniques) to avoid the aforementioned effects during experimental work. Storage in containers with a nitrogen atmosphere is often necessary. Potassium and sodium are usually stored under a non-volatile hydrocarbon liquid to exclude oxygen and moisture.

iv. Pyrophoric Compounds (Liquids and Solids)

Pyrophorics are a special subgroup of air-sensitive compounds. These substances are so reactive that they will ignite spontaneously when exposed to air. Handling requirements for pyrophorics are extremely restrictive.

Examples:

Compound	Effects
Aluminum Alkyls	Ignite spontaneously in air. Also react violently with water and with oxygenated and halogenated solvents.
Bromotrifluoro-	Ignites spontaneously in air to form ethylene hydrogen bromide and hydrogen fluoride which are corrosive and toxic.
Diborane	May ignite spontaneously in air and may detonate under some conditions. Extremely toxic vapor (TLV=0.1 ppm)
Phosphine	Its ability to ignite spontaneously in air may depend on purity. Phosphine gas is highly toxic (TLV=0.3 ppm)
Silane	May detonate violently when released in air, but usually it only ignites.

Pyrophoric Chemical List (Purdue University)

Pyrophoric Liquid Safety Video (UCLA)

v. Peroxide-Forming Compounds

Some organic compounds are unusually susceptible to atmospheric oxidation. They require special storage and handling procedures to minimize the formation of peroxides that may create an explosion hazard. Once formed, peroxides are thermally unstable and may also be shock-sensitive.

The types of organic compounds that are most apt to form peroxides include:

- Aldehydes and ketones
- Ethers-especially those with primary or secondary alkyl groups
- Allylic or benzylic structures
- Vinyl and vinylidine compounds

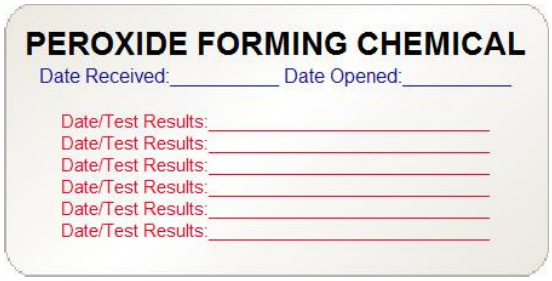
Avoid distilling compounds that may contain peroxides. There are test procedures for detecting peroxide compounds and approved methods are available for destroying them once they have formed.

Peroxide forming compounds must be dated upon receipt. Inhibited ethers can be stored for a maximum of one year. Uninhibited ethers may only be stored for six months. After these dates, peroxide formation may increase, thereby increasing the instability of the material. Disposal of dated peroxide-forming materials is quite dangerous and must be accomplished by specially trained and outfitted personnel.

Workers should be aware that ethers have the greatest ability to form peroxides, but the other classes of compounds should be routinely evaluated by need and age for waste disposal.

1. Labeling Requirements for Peroxide-Formers:

Peroxide-forming chemicals (ex: Tetrahydrofuran, Diethyl Ether, etc.) shall be labeled with the date that they were opened and tested for peroxide-formation every six months. Results of the peroxide test shall be written on the peroxide test sticker affixed to the bottle when removed from the Chemistry Stockroom.



2. Testing for Peroxides:

Peroxide test strips can be obtained from the Chemistry Stockroom. Containers passing the initial screening (above) may be tested for peroxide content. Four peroxide detection methods are commonly used. They include two qualitative variations on the iodine detection method, the qualitative ferrous thiocyanate method, and the use of semi-quantitative redox dip strips.

Dip strips provide the highest sensitivity and the most accurate quantification of peroxide concentration for routine testing. They are easier, faster and safer to use than other methods and detect a wider range of peroxides. However, dip strips are inconvenient to use for testing nonvolatile solvents and have a limited shelf life.

A common test is the EMQuant® Peroxide Test Strip (0-100 ppm range).

< 25 ppm	Considered safe for general use
25-100 ppm	Not recommended for distilling or otherwise concentrating
> 100 ppm	Avoid handling and contact EHS for assistance with safe disposal

Tables of Peroxide-Forming Chemicals

vi. Explosive and Shock-Sensitive Compounds

Shock-sensitive and/or explosive compounds are an obvious safety problem even for laboratory-scale quantities. The first step in safe operations with such substances is recognition of the potential for damage and personal injury. If possible, avoid using explosive or shock-sensitive compounds.

Examples:

Types	Compounds
Azides	Lead azides
Nitro-Compounds	Trinitrotoluene (TNT)
Poly-Nitrates	Nitroglycol and Nitroglycerine
Perchlorates	Perchloric acid and its salts
Picrates	Picric acid and its salts
Peroxides	Benzoyl peroxide or Methylethyl ketone peroxide

Refer to the SDS and other literature to learn about the potential problems and the proper procedures for working safely with these substances. Also be aware of the potential for inadvertent formation of explosive compounds such as heavy metal perchlorates when using perchloric acid to oxidize organic matter in an analytical procedure.

A key to safe operations with explosive or shock sensitive substances is to use very small quantities at any one time or place.

List of Shock Sensitive and Explosive Chemicals

vii. Incompatible Materials

Some materials when mixed together can react violently and/or liberate toxic gas. Groups of materials that do so are termed incompatible. Classic examples of materials that are incompatible are cyanides or sulfides and acid. Mixing acids with either hydrogen cyanide or hydrogen sulfide can result in the evolution of deadly gases. Laboratory staff must be aware of the groups of materials in their labs that could be incompatible. These materials must be physically isolated from their incompatible counterparts. Emergency procedures must also be in place that guides laboratory staff action in the event that materials are inadvertently mixed together.

viii. Formaldehyde

OSHA has singled out formaldehyde for special regulation. This is due, in part, to formaldehyde being implicated as a sensitizer and carcinogen. OSHA's requirement for a formaldehyde exposure monitoring program requires the employer to document exposure levels, provide training, and in some cases, medical monitoring. Staff members who work with formaldehyde should contact EHS to assure they are in compliance with the standard.

OSHA 29CFR1910.1048 Formaldehyde

ix. Mercury

Mercury and mercury compounds can be highly toxic. Mercury compounds, other than metallic mercury, are extremely difficult to dispose of. Staff is therefore encouraged to minimize mercury use and to eliminate it when possible. Mercury waste should be stored in a non-breakable container in the fume hood.

Mercury thermometers are commonly found in research laboratories. Whenever possible, mercury thermometers should be replaced with safer alternatives (i.e. alcohol thermometers).

x. Radioactive Materials

Authorized PI's are responsible for training laboratory workers in the proper use of radioactivity.

Proper personal protective equipment, such as shielding, safety glasses, and disposable gloves, must be worn when handling radioactive materials. Each person working in an area using high energy beta and gamma materials must wear a radiation film badge dosimeter. Film badges are not required for low beta-emitters (^{3}H and ^{14}C).

Glassware and other laboratory equipment used with radioactive materials should be rinsed with an appropriate non-hazardous, biodegradable solvent prior to normal washing. The solvent must be collected and stored in containers used for radioactive waste disposal, unless the levels are <1830 dpm/gm for ^{3}H and ^{14}C or <50 dpm/gm for ^{32}S and ^{32}P. Washing of the glassware and equipment should be done by trained personnel wearing personal protective equipment.

All radioactive material received by staff must be properly labeled with the following information: name of the isotope, quantity, and date on which the last quantity was determined.

All radioactive materials must be stored in in locked, properly labeled cabinets or refrigerators-freezers in designated laboratories which are locked in the absence of experienced lab personnel.

xi. Laser Installations

Lasers produce non-ionizing radiation capable of causing eye injury. Lasers operating outside of the visible light region (ultraviolet or infrared red) are especially hazardous.

Laser dyes are complex fluorescent organic compounds. In solution with organic solvents, these dyes form a lasing medium. Toxicity information on commercially available laser dyes is not extensive. However, the current research has found a number of the dyes to be mutagenic and possibly carcinogenic. The active dyes identified thus far include:

Cresyl Violet 670 Perchlorate	Coumarin 7
Coumarin 102	Coumarin 535
DCM	DODCI
LD 490	Nile Blue 690 Perchlorate
Oxazine 720 Perchlorate	p,p-Diaminoterphenyl
N,N,N'N'-Tetraethyldiaminoterphenyl	Oxazine 170 Perchlorate

Because the toxicological properties of most laser dyes have not been fully investigated, these compounds must be handled with care.

Class 3b and 4 laser installations must be approved by the University Laser Safety Officer. These lasers must be registered with the State of Illinois on an annual basis.

xii. Particularly Hazardous Substances

The **OSHA Laboratory Standard** requires as part of the Chemical Hygiene Plan that provisions for additional employee protection be included for work involving particularly hazardous substances. These substances include "select carcinogens", reproductive toxins, and substances which have a high degree of acute toxicity.

The OSHA Laboratory Standard states for work involving particularly hazardous substances, specific consideration should be given to the following provisions where appropriate:

- Establishment of a designated area.
- Use of containment devices such as fume hoods or glove boxes.
- Procedures for safe removal of contaminated waste.
- Decontamination procedures.

EH&S can assist researchers by providing information on working with particularly hazardous substances. General guidelines and recommendations for the safe handling, use, and control of hazardous chemicals and particularly hazardous substances can be found in **SDSs** and **other references,** such as **Prudent Practices in the Laboratory** and **Safety in Academic Chemistry Laboratories Volumes I and Safety in Academic Chemistry Laboratories Volumes II.** The hazards associated with Particularly Hazardous Substances go beyond what is covered in the ISU comprehensive Chemical Hygiene Plan. Principle Investigators and Laboratory Supervisors that use Particularly Hazardous Substances are required to develop specific Standard Operating Procedures (SOP's)

1. Establishment of a Designated Area

For work involving particularly hazardous substances, laboratories should establish a designated area where particularly hazardous substances can only be used. In some cases, a designated area could be an entire room out of a suite of rooms, or could mean one particular fume hood within a laboratory. The idea is to designate one area that everyone in the laboratory is aware of where the particularly hazardous substances can only be used.

When warranted, Principal Investigators and laboratory supervisors may decide to restrict use of a particularly hazardous substance to a fume hood, glove box or other containment device.

2. Safe Removal of Contaminated Waste Materials

Some particularly hazardous substances may require special procedures for safe disposal of both waste and/or contaminated materials. When in doubt, contact EH&S to determine proper disposal procedures. Once these disposal procedures have been identified, they should be included as part of the laboratory's **SOPs** and everyone working in the lab should be trained on those procedures.

3. Decontamination Procedures

Some particularly hazardous substances may require special decontamination or deactivation procedures for safe handling. Review SDSs and other reference materials when working with particularly hazardous substances to identify if special decontamination procedures are required. If they are required, then this information should be included in the laboratory's SOPs and appropriate training needs to be provided to laboratory personnel who work with these chemicals.

4. Guidelines for Working with Particularly Hazardous Substances

Laboratory workers should always practice good housekeeping, use engineering controls, wear proper PPE, develop and follow SOPs, and receive appropriate training when working with any chemicals. The following special guidelines should be adhered to when working with particularly hazardous substances:

- Substitute less hazardous chemicals if possible to avoid working with particularly hazardous substances and keep exposures to a minimum.

- Plan your experiment out in advance, including layout of apparatus and chemical and waste containers that are necessary.
- Before working with any particularly hazardous substance, review chemical resources for any special decontamination/deactivation procedures and ensure you have the appropriate spill cleanup materials and absorbent on hand.
- Ensure that you have the appropriate PPE, particularly gloves (call EH&S at 438-8325 for assistance).
- Always use the minimum quantities of chemicals necessary for the experiment. If possible, try adding buffer directly to the original container and making dilutions directly.
- If possible, purchase premade solutions to avoid handling powders. If you have to use powders, it is best to weigh them in a fume hood.
- As a measure of coworker protection when weighing out dusty materials or powders, consider waiting until other coworkers have left the room to prevent possible exposure and thoroughly clean up and decontaminate working surfaces.
- Whenever possible, use secondary containment, such as trays, to conduct your experiment in and for storage of particularly hazardous substances.
- Particularly hazardous substances should be stored by themselves in clearly marked trays or containers indicating what the hazard is i.e. "Carcinogens," Reproductive Toxins", etc.
- Always practice good personal hygiene, especially frequent hand washing, even if wearing gloves.
- If it is necessary to use a vacuum for cleaning particularly hazardous substances, only High Efficiency Particulate Air (HEPA) filters are recommended for best capture and protection. Be aware that after cleaning up chemical powders, the vacuum bag and its contents may have to be disposed of as hazardous waste.
- Ensure information related to the experiment is included within any SOPs.

5. Select Carcinogens

A carcinogen is any substance or agent that is capable of causing cancer – the abnormal or uncontrolled growth of new cells in any part of the body in humans or animals. Most carcinogens are chronic toxins with long latency periods that can cause damage after repeated or long duration exposures and often do not have immediate apparent harmful effects.

The OSHA Lab Standard defines a "select carcinogen" as 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)** ; or
- (iii) It is listed under Group 1 ("carcinogenic to humans") by the **International Agency for Research on Cancer Monographs** (IARC); 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.

With regard to mixtures, OSHA requires that a mixture "shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of 0.1% or greater, which is considered to be carcinogenic."

Note that the potential for carcinogens to result in cancer can also be dependent on other "lifestyle" factors such as:

- Cigarette smoking
- Alcohol consumption
- Consumption of high fat diet
- Geographic location – industrial areas and UV light exposure
- Therapeutic drugs
- Inherited conditions

More information on carcinogens, including numerous useful web links such as a listing of OSHA regulated carcinogens, can be found on the **OSHA Safety and Health Topics for Carcinogens webpage**. The State of California has developed an extensive list of "**Carcinogens Known to the State of California through Prop 65**". Please note, this list is being provided as supplemental information to the OSHA, NTP and IARC chemical lists and is not legally mandated by New York State.

6. Reproductive Toxins

The **OSHA Lab Standard** defines a reproductive toxin as a chemical "which affects the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis)". A number of reproductive toxins are chronic toxins that cause damage after repeated or long duration exposures and can have long latency periods. Women of childbearing potential should be especially careful when handling reproductive toxins. Pregnant women and women intending to become pregnant, or men seeking to have children, should seek the advice of their physician before working with known or suspected reproductive toxins.

It is important to be aware of the threats to reproductive health and prevent potential reproductive hazard exposures for male and female employees and students who work with known and suspected reproductive toxins including chemical, biological, radiological, and physical agents. EH&S is available to respond to concerns or questions on reproductive hazards, conduct workplace hazard assessments, and provide recommendations to address or eliminate specific reproductive risks.

More information on reproductive toxins, including numerous useful web links, can be found on the **OSHA Safety and Health Topics for Reproductive Hazards webpage**. The State of California has developed an extensive list of "**Reproductive Toxins Known to the State of California through Prop 65**". Please note, this list is being provided as supplemental information to the OSHA, NTP and IARC chemical lists and is not legally mandated by New York State.

7. Acute Toxins

OSHA defines a chemical as being highly toxic if it falls within any of the following categories:

- (a) A chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- (b) A chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
- (c) A chemical that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Information on determining whether or not a chemical meets one of these definitions can be found in **SDS's** and other chemical references

When working with acute toxins, the following considerations should be assessed:

- Consider storing highly toxic materials in a locked storage cabinet.
- Be aware of any special antidotes that may be required in case of accidental exposure (Hydrofluoric acid and inorganic cyanides for example).
- Give particular attention to the selection of gloves and other personal protective equipment.
- Do not work with highly toxic chemicals outside of a fume hood, glove box or ventilated enclosure.

More information on acute toxins, including numerous useful web links, can be found on the **OSHA Safety and Health Topics for Hazardous and Toxic Substances webpage**.

4. EXPOSURE CONTROL MEASURES

Exposure control measures should be used to reduce the potential for exposure while performing hazardous operations. Listed below are a number of control measures that can be implemented to reduce the potential of exposure. It is very important that personnel be aware of possible symptoms of overexposure, since some individuals may be more sensitive to a particular chemical exposure, even at levels generally held as acceptable.

a. Direct Methods of Control

Direct methods of control are those which involve a change in practice concerning the use of the toxicant. A change may involve use of a smaller amount of toxicant, alternating personnel using the toxicant (there by reducing individual exposure), substitution with a less toxic agent, or perhaps a change in procedure eliminating the need for the toxicant. Direct methods of control shall always be preferred over other methods.

b. Engineering Methods of Control

Engineering control measures such as localized ventilation, chemical hoods, snorkels, etc., generally reduce but do not eliminate the potential for exposure. In this sense, it can be considered an indirect method of control. The use of Personal Protective Equipment is the least preferable option to mitigate exposure. Engineering methods of control include both local and general ventilation, equipment design and use and work area modifications. Ventilation Evaluation

c. Ventilation Evaluation

Local ventilation consists of systems designed to remove the toxicant or contaminant from the point of generation, such as a chemical fume hood. General ventilation serves an entire work area supplying and removing air through diffusers or vents strategically located throughout a room. Applicable design standards should be strictly followed.

The OSHA's Technical Guide recommends a face velocity of 80-120 feet per minute at a sash height of 18 inches for chemical fume hoods. Face velocity indicates the speed with which air moves into the hood interior. Fume hoods should be used for one of two purposes; either procedural use or storage, not both. Hood interiors should be kept free of objects that may impede airflow. Disruption of airflow may reduce the hoods ability to protect personnel. EHS certifies the operation fume hoods and biological safety cabinets annually.

The Guide also recommends that air be supplied to laboratory rooms at a rate of 4 to 12 room changes per hour. General ventilation is important in maintaining employee comfort in the room and for removing low levels of contaminants that would be difficult to contain within a local exhaust hood. Contact EHS if you suspect the general exhaust ventilation is insufficient.

Environmental Health and Safety can offer assistance with ventilation-related questions and concerns.

5. PERSONAL PROTECTIVE EQUIPMENT

a. Respiratory Protection

Respirators, when properly selected and used, can offer protection against a wide variety of airborne contaminants. However, respiratory protection should only be used when other methods of exposure control are not effective or impractical. All respirator use must comply with the ISU's Respiratory Protection Program. Provisions of the program include requirements for initial and annual training, annual fit testing, and medical evaluations. Mandatory use of respirators requires a medical evaluation, annual fit tests, and annual training. Voluntary use of respirators requires a medical evaluation and training and information (Appendix D), but fit tests are not required. More detailed information, including required forms and helpful links, is available on the EHS Respiratory Protection webpage.

Anyone who wishes to use a respirator must contact EHS and comply with all components of the ISU Respiratory Protection Program. EHS will perform a hazard assessment of the operation necessitating the use of the respirator and help determine the proper level of protection.

b. Eye and Face Protection

OSHA requires that employees wear eye or face protection whenever a potential exists for accident or injury. Any use of corrosive materials or fast moving equipment, such as centrifuges, shall constitute such a potential. Face shields shall be used when potential exists for both eye and skin injury. Goggles used shall be resistant to the types of chemicals used. Also, if splashing or vapor penetration is possible, goggles designed for such hazards must be used. Ultraviolet face shields should be available for use with UV lamps and transilluminators.

c. Glove Use

Gloves are the Personal Protective Equipment (PPE) most frequently used by laboratory staff. Like all PPE, gloves must be properly selected for the materials to be worked with. Gloves can be purchased in a variety of materials each offering a limited ability to resist chemical breakthrough. Lab personnel must familiarize themselves with the limitations of the gloves they are using and the compatibility of the glove with the chemicals likely to be encountered. Check glove selection charts for more information.

Although gloves can provide adequate protection against contamination, they are not a suitable alternative to hand washing. It is recommended that laboratory personnel wash their hands thoroughly whenever gloves are removed.

d. Clothing

Protective clothing includes lab coats or other protective garments such as aprons, boots, shoe covers, Tyvek coveralls, and other items that can be used to protect street clothing from biological or chemical contamination and splashes as well as providing additional body protection from some physical hazards.

Principal Investigators and laboratory supervisors are strongly encouraged to require long pants and clothing which effectively covers the torso for all laboratory personnel, including visitors, working in or entering laboratories and laboratory support areas under their supervision. Lab coats are required if shorts or skirts are worn and are not long enough to cover the knee.

The following characteristics should be taken into account when choosing protective clothing:

- The specific hazard(s) and the degree of protection required, including the potential exposure to chemicals, radiation, biological materials, and physical hazards such as heat.
- The type of material the clothing is made of and its resistance to the specific hazard(s) that will be encountered.
- The comfort of the protective clothing, which impacts the acceptance and ease of use by laboratory personnel.
- Whether the clothing is disposable or reusable - which impacts cost, maintenance, and cleaning requirements.
- How quickly the clothing can be removed during an emergency. It is recommended that lab coats use snaps or other easy to remove fasteners instead of buttons.

Laboratory personnel who are planning experiments that may require special protective clothing or have questions regarding the best protective clothing to choose for their experiment(s) should contact EHS for recommendations.

6. INFORMATION AND TRAINING

All individuals who work in laboratories and may be exposed to hazardous chemicals must be apprised of the hazards of chemicals present in their work area. This information and training as outlined below must be provided before initial assignment and before new exposure situations. Equipment necessary for the safe handling of hazardous substances must also be provided. Training specific for the particular lab where an employee is assigned is the responsibility of lab Principle Investigator. The frequency of refresher information and training shall be performed annually by the supervisor.

a. Information

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

- OSHA standard 1910.1450 "Occupational exposure to hazardous chemicals in laboratories".
- The location and availability of the University Chemical Hygiene Plan.
- Permissible exposure limits (PEL's) for OSHA regulated substances, or the recommended exposure limits for other hazardous chemicals or threshold limit values (TLV's) found on SDS's where there is no applicable OSHA standard or PEL.
- Signs and symptoms associated with exposure to the hazardous chemicals found in the lab.
- 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 (SDS) received from the chemical supplier.

i. Safety Data Sheets

Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals an appropriate SDS for each hazardous chemical purchased.

SDS's can be obtained from chemical distributors, on-line references and departmental databases. PI's must inform laboratory personnel how and where to obtain SDS's for chemicals used in their lab.

ii. Health and Safety References

A number of resources are available from EHS for staff to review. They cover a wide variety of topics ranging from specific chemical toxicity to general safe lab practices. Among them are:

- CAMEO Chemicals
- NIOSH Pocket Guide to Chemical Hazards
- Safety Data Sheets (SDS)
- Regulatory Standards (OSHA)
- Consensus Standards, such as National Fire Protection Agency (NFPA) and American Conference of Governmental Industrial Hygienists (ACGIH)

b. Training

It is the responsibility of the Principal Investigator or laboratory supervisor to ensure laboratory staff has received the appropriate training. The training shall include:

- The methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by University personnel, continuous monitoring devices, visual appearance of hazardous chemicals when being released, etc.)
- The contents of the OSHA Laboratory Standard and its appendices.
- The physical and health hazards of chemicals in the work area.
- 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.
- Applicable details of the University's written Chemical Hygiene Plan.

General Laboratory Safety Training (ISU)

7. CLASSES OF HAZARDOUS SUBSTANCES

a. Hazardous Substances

Chemicals for which special precautions are to be taken include carcinogens, reproductive toxins and certain chemicals with a high degree of acute toxicity or reactivity. These materials must always be used in a functioning certified chemical hood or biological safety cabinet. If there is a question whether a hood or cabinet is working properly, EHS should be contacted to perform an evaluation of the equipment prior to using the material.

i. Carcinogens

"Select carcinogens" are defined by the Lab Standard as being any substance which meets one of the following criteria:

- "It is regulated by OSHA as a carcinogen; or
- 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
- It is listed under Group 1 ('carcinogenic to humans') by the International Agency for Research on Cancer Monographs(IARC) (latest edition); or
- 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:
    - After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;
    - After repeated skin application of less than 300 (mg/kg of body weight) per week; or
    - After oral dosages of less than 50 mg/kg of body weight per day."

ii. Reproductive Toxins

Reproductive hazards are defined by the Lab Standard as: "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."

Examples of reproductive toxins include: benzene, mercury, ethylene dibromide, carbon monoxide, anesthetic gases (halothane, methoxyflurane), ionizing radiation, ethylene oxide, ethylene thiourea, glycidyl ethers, lead and 1,2-dibromo-3-chloropropane.

iii. Mutagens

Mutagens are 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.

b. Procedures for Working with Hazardous Substances

Working with volatile chemicals should be performed within a functioning fume hood, ventilated glove box, sealed system, or other system designed to minimize exposure to these substances. In all cases, work with these types of chemicals shall be done in such a manner that the permissible exposure limits or similar standards are not exceeded.

The ventilation efficiency of the designated fume hood, glove box or gas cabinets, and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances should be evaluated periodically according to Section 4(c).

Gloves and other appropriate protective apparel must be worn.

Laboratory workers of child-bearing age should be especially cautious when working with reproductive toxins.

Laboratory workers who are or may be pregnant should take extra precautions when working with reproductive toxins.

c. Health and Physical Hazards

i. Health Hazards

A health hazard is any 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).

ii. Physical Hazards

A physical hazard is any 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 (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; or in contact with water emits flammable gas. The criteria for determining whether a chemical is classified as a physical hazard are in Appendix B of the Hazard Communication Standard (§1910.1200).

iii. Other Chemical Hazards

In addition to health and physical hazards, there are other hazards that may be encountered that are dangerous to life, property, and the environment. These include:

- Asphyxiation, or asphyxia—is a condition where there is not enough oxygen in the air to breathe normally, leading to suffocation. A simple asphyxiant is a chemical that displaces oxygen in the air and causes rapid suffocation. Pure nitrogen is an example of an asphyxiant.
- Pyrophoric gas—is a chemical that catches fire spontaneously if exposed to air.
- Combustible dust—is a chemical in dust form that may form explosive concentrations of dust in the air. In some cases, a chemical is shipped in a form that is not yet dust, but under normal conditions of use or processing, it will form a combustible dust.
- Hazards Not Otherwise Classified—represents a chemical that may have hazardous physical or health effects, but the specific effects have not been identified under the hazard classification process outlined in the hazard communication rule.

Aquatic Toxicity - chemicals that present either acute or chronic aquatic toxicity hazards to aquatic environments. Acute aquatic toxicity means the intrinsic property of a material to cause injury to an aquatic organism in a short-term exposure. Chronic aquatic toxicity means the potential or actual properties of a material to cause adverse effects to aquatic organisms during exposures that are determined in relation to the lifecycle of the organism.

8. EMERGENCY RESPONSE

Departments are required to have specific Emergency Response Procedures that direct individuals what to do in the event of an emergency in their department. All employees must be trained and understand the specifics of their departmental Emergency Response Plan.

a. Chemical Spills

Minor spills can be managed by laboratory personnel familiar with the chemical spilled. Each lab has a spill response kit intended to be used on small spills of known material. Spills involving a large volume of material or acutely hazardous substances should be managed by trained personnel. If you are involved in a spill that meets the following conditions you must immediately contact EHS (438-8325) during regular business hours or ISUPD afterhours (911 from a campus phone or 438-8631 from a personal phone.) If your spill meets any of the following criteria it is considered a large or complex spill:

- A person is injured; or
- The identity of the chemical is unknown; or
- Multiple chemicals are involved; or

- The chemical is highly toxic, flammable or reactive; or
- The spill/leak occurs in a "public space" such as corridors; or
- The spill/leak has the potential to spread to other parts of the building such as through the ventilation system; or
- The clean-up procedures are not known or appropriate materials are not readily available; or
- The cleanup requires a respirator (including cartridge respirators) to be worn and no personnel have been trained and fit-tested in accordance to the campus Respiratory Protection Program; or
- The spill/leak may endanger the environment by reaching waterways or outside ground, or by going down a drain.

b. General and Fire Evacuation Procedures

When an evacuation has been ordered or initiated due to a fire alarm:

1. Evacuate immediately by following the nearest Exit signs.
    a. If you see smoke or fire:
        i. Pull the nearest fire alarm pull station to alert building occupants of the fire.
        ii. Call 911 from a safe place.
        iii. Assist anyone needing help.
        iv. Be alert for smoke as you exit the building - choose a path to avoid the smoke.
        v. Before exiting through a door, check the door and handle. If the door or handle are hot to the touch or smoke is present, do not open the door.
        vi. DO NOT use elevators if evacuating due to a fire or fire alarm.
2. Proceed to the designated emergency assembly area. Once safely out of the building, call 911 to report the situation.
3. After reporting to the designated emergency assembly area, begin the accountability process.
4. Let the police or fire department know if someone is missing or trapped inside and/or is in need of assistance.
5. Stay out of the way of emergency personnel and equipment.
6. Do not enter the building until you are approved to do so by the University Police.

i. If trapped in the building:

- Occupants are to remain in their rooms.
- Try to seal the base of your door (wet towel or cloth if possible) to prevent smoke from entering.
- Call 911 and let them know your situation and location.
- If possible, move to a window and signal for help.

ii. Emergency Assembly Area:

The designated emergency assembly area for {insert name of your building here} is located on the {insert your assembly location here}. As this location may not be the best site based upon the type of emergency (i.e. weather and traffic conditions), individuals need to be prepared to move to another location.

iii. Accounting and Information Procedures

Note: Refer to your departmental Emergency Response Plan to identify accounting and information procedures.

c. Shelter-in-place

When a shelter-in-place order has been issued, it means that conditions are such that is safer to be inside your office / classroom / lab. A shelter-in-place order may be given for a hazardous materials incident or a sustained police action. A shelter-in-place order will be issued by the University Police or other competent authority, based on the nature of the crisis.

Note: Refer to your departmental Emergency Response Plan to identify accounting and information procedures.

d. Tornados

Illinois is located in the area of the United States that has the highest percentage of tornado activity. Illinois is ranked eighth in tornado frequency and first in tornado deaths. For more information on what to do in case of a Tornado Watch or Warning, please visit the EHS website "Tornados".

Note: Refer to your departmental Emergency Response Plan to identify accounting and information procedures.

e. Additional Information

Additional information on procedures and responsibilities can be obtained by contacting EHS.

9. ACCIDENT REPORTING

For any incident resulting in a serious or life threatening injury to an employee, call 911 for emergency medical care.

In the event of a workplace accident causing injury, the injured employee and his/her supervisor should follow this procedure:

The injured employee, if possible, must promptly notify his/her supervisor of the injury. If the injured employee is unable to do so, a co-worker should contact the injured employee's supervisor.

a. Seeking Medical Attention

If the injured employee needs immediate medical attention, the supervisor, or designee in his/her absence, should call 911 and request emergency medical care. If the injury does not warrant immediate care, but medical treatment or evaluation is deemed warranted, the supervisor or designee should arrange transportation via a university vehicle to the designated medical facility. It is necessary to notify the care-givers that it is a work-related injury and to bill directly to the Workers Compensation Section of Human Resources. A Treatment Authorization Form should accompany the employee to the designated medical facility at this time, if possible.

b. Investigate

Immediately after ensuring medical attention, the supervisor should initiate an accident investigation to focus on the cause(s) of the accident and subsequent corrective actions. Assistance with investigations shall be available from EHS if necessary.

c. Report

After completing the investigation, the supervisor shall complete and submit the "Online Injury/Illness Log" and associated Workers Compensation forms required by the State of Illinois Division of Workers Compensation to Human Resources / Workers Compensation Section at ISU.

If there is a witness to the accident, he/she should complete the proper forms supplied by the Supervisor. If the witness refuses to complete this form, he/she should write "Refused" across the form, initial and date it, and forward it to the Human Resources.

d. Follow-up

All bills regarding the work-related injury should be sent directly to the Human Resources Office for processing. If the employee is personally billed or was required to pay at time of service by the medical facility/pharmacy, he/she shall submit their bills, receipts and completed forms to the ISU Workers Compensation Administrator to process for payment in a timely manner.

10. MEDICAL CONSULTATION & EVALUATION

a. Medical Examination

i. Criteria

Medical examinations will be provided to all employees who work with hazardous chemicals, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

- Employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
- 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.
- 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.
- 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.

ii. Information

Employer shall provide the following information to the physician:

- The identity of the hazardous chemical(s) to which the employee may have been exposed.
- A description of the conditions under which the exposure occurred including quantitative exposure data, if available.
- A description of the signs and symptoms of exposure that the employee is experiencing, if any.

b. Physician's Written Opinion

A written opinion from the examining physician shall be obtained and shall include the following:

- Any recommendation for further medical follow-up.
- The results of the medical examination and any associated tests.
- 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.
- 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.

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

11. RECORDKEEPING

a. Medical Records

Medical records shall be maintained by the medical provider for at least the duration of employment plus thirty (30) years, for each employee with occupational exposure, in accordance with 29 CFR 1910.20.

b. Training Records

Training records shall include the dates of the training sessions and contents or a summary of the training and the name of the training provider. At a minimum, training records shall be maintained for three (3) years from the date on which the training occurred.

c. Monitoring Records

EHS shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposure to hazardous chemicals in the laboratory.