

Chemical Hygiene Plan for the University at Buffalo

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Environment, Health & Safety Services

University at Buffalo

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South Campus

716-829-3301

buffalo.edu/ehs

What's New in the 2019 Update

Page	Type of Change
How to Proceed in a Campus Emergency	Updated Contact Information for Emergencies
3-1	Added information on mandatory laboratory safety training.
5-1, 5-2	Added a statement on how to request a lab door sign via the EH&S website. Changed the upper limit for fume hood air velocity from 100 feet per minute (fpm) to 120 fpm
5-4	Updated Contact Information in the In Case of Fire table
10-1, 10-2	Updated Section on Labeling Secondary Containers; added a graphic of a typical GHS label
13-1	Clarified the wording on the introductory paragraph
13-2	Updated Chemical Inventory Requirements
13-3	Added a Risk Assessment Tool topic
14-1	Updated wording to reflect current practices; In the last bullet on the page, changed required training to mandatory training
15-1	Updated Contact Information for Emergencies
A-15	Removed the outdated Select Agents and Toxins table in Appendix G. Readers are now directed to the government website for the most up-to-date information.

Acknowledgements

UB Environment, Health & Safety wishes to acknowledge the following institutions whose websites provided information and resources that were referenced creating this plan:

- Cornell University
- University of Pennsylvania
- Stanford University
- Purdue University
- Harvard University
- Arizona State University
- UCLA

How to Proceed in a Campus Emergency

Contacts for Police, Fire, Suspicious Behavior or Medical Emergencies:	
For North & South Campuses	Call: 645-2222 (UB Police)
For Downtown Campus Including: CBLS CTRC Jacobs School, 955 Main Street	Call: 645-2222 (UB Police)
For All Other Off Campus UB Locations	Call 911

When making an emergency call:

- Give your name, location, and phone number
- Describe what happened
- Do not hang up until asked to do so

Non-emergency hazardous material concerns: 829-3301 (EH&S)

Environment, Health & Safety can assist with:

- Information on biological, chemical, fire, radiation, laser, occupational, laboratory and general campus safety
- Contacting Chemical Hygiene Officer, Chemical Hygiene Plan, OSHA Laboratory Standard
- Safety Training Programs
- Hazardous Waste Disposal

Other Resources:

Poison Control Center of WNY: 878-7654

Building Utilities Emergencies: 645-2025

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1. Introduction

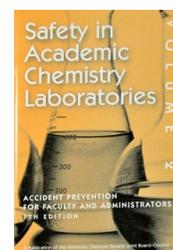
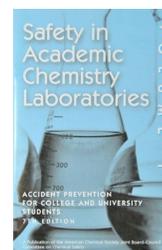
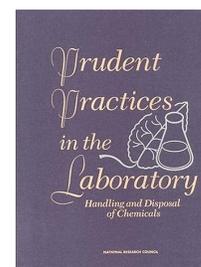
Purpose

Environment, Health and Safety Services (EH&S) at the University at Buffalo (UB) strives to provide a workplace free of recognized hazards. The purpose of this Chemical Hygiene Plan (CHP) is to establish a written program that protects laboratory personnel from the potential hazards associated with the use, storage, and disposal of hazardous chemicals in a laboratory work area. This document meets the requirements of the Occupational Safety Health Administration (OSHA) regulations; Standards for Laboratories listed in 29 CFR 1910.1450 and Standards for Personal Protective Equipment (PPE), listed in 1910.132. Compliance with the guidelines set forth by the CHP should protect laboratory personnel from most potential chemical hazards.

Additional information can be obtained by referring to the publications "Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards" published by the National Research Council and the American Chemical Society's "Safety in Academic Chemistry Laboratories." Both of these publications are excellent resources for guidance and can help strengthen and solidify a culture of safety in academic laboratories. They are available through a number of online sources.

Scope

UB's CHP applies to all University at Buffalo laboratory personnel and campus laboratories as defined in this CHP. It does not apply to hazardous chemicals that are in use in an area not defined as a laboratory; nor does the CHP cover work with radioactive materials or biological agents. Those areas have specific requirements that are addressed in separate documents. Contact the EH&S office at 829-3301 for further information.



2. Positions and Responsibilities

Chemical Hygiene Officer (CHO): The CHO is responsible for providing technical guidance in the development and implementation of the provisions of this chemical hygiene plan. The CHO is a staff member of EH&S.

University at Buffalo Environment, Health and Safety Services (EH&S): EH&S is responsible for institutional oversight of compliance with the OSHA Laboratory Standard as well as the overall campus-wide implementation of this plan. In addition, EH&S will maintain and update the CHP as needed and provide training on its requirements.

Deans and Department Heads/Chairs: The various University Deans as well as individual department heads and chairs are responsible for establishing compliance with the CHP and implementation of the plan within each department. To foster this atmosphere of compliance, a chair may wish to designate a safety officer within the department to ensure compliance. This safety officer must be familiar with the CHP.

Principal Investigator/Laboratory Supervisor/Laboratory Manager: Each Principal Investigator (PI) or lab supervisor must implement and follow this CHP in their respective areas of responsibility. They are also responsible for ensuring individuals under their control obtain the necessary training associated with the CHP. They must develop specific standard operating procedures (SOPs) and policies to make certain the employees are made aware of health hazards associated with chemicals located within the laboratory. These SOPs or policies *must* be placed in and become an addendum to the lab's CHP. The PI or lab supervisor must provide training on all lab specific SOPs. This training must be documented. Guidance on when a SOP may be required can be found in Appendix C.

PIs are responsible for the following:

- Be familiar with the contents of this CHP
- Oversee the selection and use of personal protective equipment (PPE) in the lab. A laboratory policy must be established which outlines when PPE is to be used. EH&S is available for assistance in the selection of proper PPE
- Must provide either a library of Safety Data Sheets (SDS) in their laboratory or have the information readily available via online computer sources per OSHA regulations. Electronic media such as a CD or DVD disk is also acceptable
- Must familiarize themselves with the necessary steps to be taken in the event of an emergency situation

Laboratory worker: Laboratory workers include personnel who conduct their work in a laboratory and are at risk of possible exposure to hazardous chemicals on a regular or periodic basis. These personnel include laboratory technicians, instructors, researchers, visiting researchers, administrative assistants, graduate

assistants, student aides, student employees, and part-time and temporary employees and volunteer appointments. All those working in a lab environment must:

- Be familiar with the hazards associated with working in a laboratory and the proper procedures outlined in this CHP
- Must make themselves available for training as directed by their supervisor
- Wear proper PPE for the task being performed and demonstrate good general lab safety habits
- Inform their supervisor of any unsafe practices, conditions, or general hazards present in their work area
- Familiarize themselves with the steps to be taken in the event of an emergency situation

If you as a lab worker feel the experiment or research you are conducting is not being performed in a safe manner or may cause an injury to you or someone else, it is your responsibility to bring it to your PI or supervisor's attention and if necessary EH&S.

Contractors, Vendors, and Visitors: Each laboratory group is responsible for ensuring contractors, vendors, custodial workers, and visitors are made aware of the hazards associated with the area they are visiting. Any necessary personal protective equipment (PPE) must be worn while in the laboratory space. PPE is to be provided to all visitors by the lab or by contractor agreement. EH&S may be contacted if you have questions about what PPE should be used.

3. Chemical Hygiene Plan General Requirements

Training

The Principal Investigators or lab supervisors shall provide all laboratory workers with the necessary information concerning the hazards of chemicals in his/her lab. Training shall consist of:

- Contents of this Chemical Hygiene Plan
- Potential hazards of common chemicals in the lab
- How to protect yourself from these hazards, covering topics such as safe work practices, proper PPE, emergency procedures, etc.
- How to locate, read and understand a safety data sheet (SDS)

Additionally, each PI will ensure said laboratory worker attends mandatory Laboratory Safety Training sessions provided by EH&S on laboratory "right to know" and hazardous waste management training. Information on dates, times and the location of Laboratory Safety Training can be found on the EH&S website.

Availability of Plan and Frequency of Review

This CHP will be made available to every laboratory space located at the University at Buffalo where chemicals are in use.

The plan shall be reviewed yearly and updated if necessary.

Lab Inspections

Lab inspections are an integral component of a thorough laboratory safety program. Inspections identify and address potential health and safety deficiencies and also are conducted to fulfill regulatory compliance requirements. Each laboratory and/or laboratory group is required to participate in the University's inspection program. Inspections are conducted by EH&S on a regular basis, usually once a year depending on the scope and nature of the hazards associated with that specific lab. Areas of focus may include, but are not limited to: housekeeping, hazardous waste management, reagent and hazardous materials storage, electrical safety, use of PPE, compressed gas safety, etc.

4. Hazardous Chemical Descriptions

Allergens and Sensitizers: This group of chemicals causes exposed persons to develop an allergic reaction in normal tissues after repeated exposures. Exposures to even very small amounts of the same substance can trigger an allergic response.

Persons who have developed an allergy can manifest the allergic response as a skin rash, eye irritation, allergic asthma, or, in severe allergic reactions, anaphylactic shock that can result in death if not treated quickly enough.

Corrosives: Corrosives are chemicals that can attack and chemically destroy exposed body tissue. Damage is possible from the point it comes in contact with skin. Exposure to corrosives can cause damage to the eyes, skin and respiratory tract. A corrosive can be in the form of a liquid, solid or a gas.

Extremely Toxic Chemicals: Toxic chemicals are chemicals that can produce injury or death when inhaled, ingested, or absorbed through the skin. Damage may result from acute or chronic exposures and involve local tissue or internal organs. The extent of the injury depends on the dose administered, duration of the exposure, physical state, solubility, and interaction with other chemicals.

Flammable Liquids: Flammable and combustible liquids are classified according to their flash points with flammable liquids having a flashpoint of <math><100^{\circ}</math> F and combustible liquids a flashpoint between 100-200° F. Both are considered fire hazards; all flames and sparks should be kept away.

Flammable Solid: A solid that is capable of causing a fire through friction, absorption of water, spontaneous chemical change, heat retained from a manufacturing process, or that can be ignited easily and when ignited, burns so vigorously or persistently as to create a serious fire hazard.

Irritants: Irritants are chemicals that can cause inflammation of body tissue by chemical action. There are a wide variety of inorganic and organic chemicals that are considered irritants; skin contact should be avoided. In some cases, the damage caused by exposure to irritants can be reversible.

Nanomaterials: A nanomaterial or nanoparticle (or nanopowder or nanocluster or nanocrystal) is a microscopic particle with at least one dimension less than 100 nm. Engineered nanoparticles are intentionally produced and designed with very specific properties in relation to their size, shape and surface properties. Each nanomaterial has its own unique toxic properties.

Pyrophoric Chemicals: Pyrophoric substances are extremely reactive and can ignite spontaneously when contacted with air even in the absence of heat or fire. Extreme caution must be taken when

working with them. Pyrophoric chemicals can be handled and stored safely so long as exposure to atmospheric oxygen and moisture is avoided.

Reactive Chemicals: Reactive and other unstable chemical compounds are materials which under certain conditions have the potential to vigorously or violently polymerize, decompose, or otherwise become self-reactive. They may react under conditions of shock, pressure, or temperature, or may adversely react with other incompatible materials.

Water Reactive: Water reactive materials can react violently or vigorously in contact with water, wet surfaces, or even the moisture in the air. These chemicals may react to give off a flammable gas (such as hydrogen) or a toxic gas, (such as phosgene) or spontaneously burn or explode.

5. Controls in Place to Reduce Exposures

Administrative Controls

Administrative controls consist of various policies and procedures put into place with the purpose of limiting chemical exposures. They may include safety policies, rules, rotating work schedules, door postings and training. These controls help reduce the duration, frequency, and severity of an exposure to a hazardous chemical. PIs can assist by designing experimental procedures that minimize the probability and degree of exposure.

Lab Door Signs: Laminated lab door signs are required for all laboratories and areas that contain hazardous materials. The signage complies with applicable regulations and provides a consistent look for all campus locations where hazardous materials are in use. Information on the sign can inform staff and emergency responders about the types of hazards that are in the lab and if any precautions are required. The sign also provides contact information of who to notify in case of an emergency in the room or area. Additionally, information concerning the correct personal protective equipment can be accessed prior to entering the lab. Refer to Appendix D for more information on the laboratory door signage program.

The hazard sign can be obtained by completing an on-line form available on the EH&S website. If information contained on the lab sign requires updating (such as adding or deleting hazardous materials, change of emergency contacts, etc.) it is the responsibility of the laboratory personnel to contact EH&S so an updated sign can be created.

Engineering Controls

Engineering controls are those that are put into place to reduce the potential exposure to hazardous materials. Controls may include laboratory chemical fume hoods, glove boxes, biosafety cabinets, etc. This section describes some of the more common engineered controls that are in place at UB.

Laboratory Chemical Hoods (Fume Hoods): Laboratory chemical fume hoods must be used whenever a hazardous chemical or material is in use. The hood sash maximum height **must** be set at or below the certification sticker provided by EH&S. A sash placed at this level provides the minimum protection requirements.

- Laboratory chemical fume hoods should provide 80-120 feet per minute (fpm) of air velocity at the sash height indicated by the EH&S inspection label placed on the unit.
- Keep the sash lowered at all times except to adjust apparatus that is inside the hood.



Example of a UB Laboratory Door Sign



Figure 1 EHS Fume Hood Sticker

- Hood fan must be kept on at all times while chemicals are in use or work is being performed inside.
- Practice good housekeeping: hoods should never be used as storage areas for chemicals, apparatus, or other materials. The rear of the hood (baffle area) should be open and clear of obstruction.
- The face velocity of the fume hood will be checked annually by EH&S. The inspection date as well as the sash height required to deliver the required 80-120 fpm shall be placed on the front on the hood. *If your hood inspection sticker indicates that it has not been inspected within the last 12 months, contact the EH&S office for an evaluation and inspection.*
- Fume hoods found to not provide minimum protection will be tagged out of service and a warning label will be attached to the window sash. *Under no circumstances is a hood to be used if EH&S or UB Facilities tags it out of service.*
- Modifications to any existing chemical fume hood or ventilation system require prior approval by EH&S or UB Facilities.
- If repairs are required, contact Facilities Customer Service at 645-2025.
- For more information on laboratory chemical fume hoods consult the American National Standard for Laboratory Ventilation (ANSI/AIHA Z9.5-2003).

Glove Boxes: A glove box can operate under either negative or positive pressure depending on the specific application. If the material is highly toxic, use of an exhaust system emptying into an adjacent laboratory chemical hood may be required. Regular inspection and maintenance of all components is essential to make certain the glove box is in working order and not leaking. The glove especially should be checked for cracks, splits, cuts, etc. and replaced if necessary.

Biosafety Cabinets: Biosafety cabinets, tissue culture hoods, etc., containing HEPA filters are in use in certain areas of the University. Although they will protect the laboratory worker and the surrounding environment from pathogens, they afford no or little protection from chemical vapors, fumes or mists. These units must be certified yearly and when moved to another location. EH&S does not provide this service. Users must contact an outside vendor and make arrangements for annual certification. A list of vendors is available through the EH&S office. Since this Chemical Hygiene Plan covers chemical hazards only, please contact the EH&S office if you require additional information on the use of biosafety cabinets.

HEPA filters may be used for toxic solids and particulates. However, be aware that air from these devices may be exhausted back into the laboratory atmosphere.

Note: Laminar flow hoods, PCR ductless hoods, and vertical flow clean benches are designed to protect the product/sample and **not** the individual. These devices are **not** considered biosafety

cabinets and are not to be used as a substitute for a biosafety cabinet or a replacement for a fume hood. They can be used for certain clean activities, such as dust-free assembly of sterile equipment or electronic devices. However, they must **never** be used when handling cell culture materials, potentially infectious materials or any other potentially hazardous materials.

Eyewash and Safety Showers: In laboratories where hazardous chemicals are in use, particularly corrosives and flammables, an eyewash station and safety shower must be in close proximity to the work area. Familiarize all laboratory workers with the location of the eyewash station and safety shower in your work area.

- Plumbed eyewash stations must be activated by laboratory personnel on a weekly basis to ensure the valve functions properly. If it does not, contact University Facilities Customer Service at 645-2025 for maintenance. For stations that are located in public hallways, the individual departments will assume responsibility for the weekly testing. For stations that are unplumbed, place a bucket or pail under the drainpipe to capture test water.
- Access to eyewash/showers must not be blocked. There must be a clear path to the eyewash/shower unit with no obstructions that may impede access. Nozzle covers must be kept on the eyewash nozzles at all times. This is to prevent dust from covering the nozzle and possible presence of bacteria that may form on the nozzle after a period of non-use.
- EH&S inspects all eyewash stations on a yearly basis per American National Standards Institute standards (ANSI Z358.1-2004). All units should have a tag attached that lists the inspections dates. If your unit does not have a tag, contact the EH&S office so they may add it to the inspection list.
- In areas where plumbed installation is not possible, a portable wall mounted eyewash station is acceptable. The saline solution contained in them must be monitored to ensure it has not passed its expiration date; it must be replaced when this occurs.

Flammable Cabinets: Flammable liquid storage cabinets are intended for the storage of flammable and combustible liquids and are an important fire prevention and control device within many laboratories. See Chapter 9, "Storage of Chemicals" for additional information on the proper use and requirements of flammable liquid cabinets.

Fire Extinguishers: In all laboratories where combustible and flammable chemicals are in use, an appropriate fire extinguisher must be available. All extinguishers must be wall mounted or in

labeled cabinets. Access to them must be unblocked. Lab workers must familiarize themselves with their location, use and classification.

Laboratory workers are **NOT** required to extinguish a fire but may do so if:

- It's a small fire, typically the size of a trash can or smaller
- You have been trained in the use of an extinguisher
- The area around the fire is safe, e.g. limited quantities of flammables

Fire extinguisher training is available through EH&S offices. Call 829-3301 for further information.

IN CASE OF FIRE	
North or South Campus	Call UB Police at 645-2222
Downtown Campus Including: CBLS CTRC Jacobs School, 955 Main Street	Call UB Police 645-2222
For All Other Off Campus UB Locations	Call 911

6. Personal Protective Equipment (PPE)



An OSHA requires the use of personal protective equipment whenever hazardous materials are present in a laboratory. The use of proper PPE reduces the chance of an injury from or exposure to the hazardous materials. Remember, PPE should be used in conjunction with and not instead of administrative and engineering controls or safe work practices. It is the responsibility of the Principal Investigator or the lab supervisor to ensure lab workers obtain the training on the proper selection and use of PPE.

In order to choose the proper PPE, OSHA requires a safety assessment be made. A safety data sheet (SDS) can provide information on the hazards associated with a specific chemical. Principal Investigators and lab supervisors are required to perform this assessment before work begins. At a minimum, the assessment should include the following:

- A review of the procedure and/or Standard Operating Procedures (SOP)
- The chemicals involved, and their concentrations and quantities
- Type of hazard(s) associated with them
- The risk level of the hazards
- PPE choices that will minimize exposure to the hazards

PPE **must** be worn when laboratory workers are in active use. Active use is defined as any action that involves the movement, transfer, or manipulation of chemicals. Examples include distillation, heating, etc.

Minimum PPE requirements for a lab worker as defined by this plan are as follows, but are not limited to:

- Safety glasses or splash goggles (these must meet the requirements listed in American National Standards Institute standard ANSI Z87.1)
- Long laboratory coat that covers the arms
- Long pants. No shorts or short skirts, (long skirts are acceptable provided legs are not exposed)
- Closed-toe shoes, no sandals
- Nitrile or other suitable gloves, if vessels containing hazardous materials are to be handled

Before you put on PPE, always keep the following in mind:

- Always inspect your PPE for damage. If any rips, tears, holes, etc. are present, discard. If any signs of contamination exist, discard. If there is any doubt, throw it out!
- Reusable PPE should be cleaned immediately after use with the appropriate cleaner.
- Disposable PPE should be worn only once.

- Remove your PPE prior to leaving your lab area. Do **not** wear PPE such as gloves in the hallway, elevators, etc. This will prevent the spread of contamination. If gloves are needed to transport anything, double-glove so clean gloves are always on the outside or wear one glove to handle the transported item. The free hand is then used to touch doorknobs, elevator buttons, etc.
- Become familiar with the proper methods for putting on, taking off, and, when applicable, fit-checking PPE.

Types of PPE

Eye Protection: Eye protection is required at all times when working in a laboratory and especially when handling hazardous materials. There are many types of eye protection available; the choice should be based on the physical hazard associated with the chemical you are working with. All eye protection must meet the requirements of the ANSI Z87.1 standard.



Normal prescription eyewear (street wear), with or without side shields, is not an acceptable substitution for approved safety glasses or goggles. If you obtain prescription safety glasses, they must comply with ANSI Z87.1.

Contact lenses may be worn in the laboratory provided eye protection such as safety glasses or splash goggles are worn over them. However, be aware that if you wear contacts it may be impossible to remove them in the event of a splash incident and they may interfere with emergency flushing procedures.

Additional eye protection requirements:



Face shields are not to be worn independently; they **must** be worn together with safety glasses or safety goggles.

- Safety glasses with hardened lenses and side shields or a wrap around design are acceptable for general laboratory use. However, safety glasses do *not* provide complete protection against splash or spray because they do not fit tightly to your face.
- Splash goggles are necessary for any task that may result in liquid splashes to the eye that might not be prevented by safety glasses, even those with side shields. When worn properly, splash goggles will protect the eyes and surrounding skin from forcefully propelled liquids coming from above, below, beside, or behind the wearer. Indirectly vented or baffled goggles are those that contain hoods or caps over the vent openings to prevent splashes from entering the inside of the goggle and causing injury to the eye.
- Face shields can provide an extra level of safety as they protect the eyes, face, and neck from chemical splashes and spray as well as flying particles. They provide protection when working with hazardous materials where the increased chance of a splash may occur, especially when using corrosives or cryogenics.
- If lasers are being used in the laboratory, laser safety glasses must be worn. The chosen type of protection depends on

the specific light spectrum and power of the laser source. If you have questions about the type of eyewear that must be worn when working with lasers, contact the EH&S Laser Safety Officer at 829-3301.

Gloves: It is important that your hands be protected when working with hazardous materials in the laboratory. The correct type of glove must be worn whenever a potential hazard exists from exposure and there is a chance of a chemical being easily absorbed through the skin. Gloves must be worn when working with particularly hazardous materials, such as carcinogens, reproductive toxins, and highly toxic substances. Care should be taken to ensure that the gloves chosen for a specific application are suitable, properly fitting, and will provide adequate protection. Although this section primarily covers the potential exposure of hands to chemicals and hazardous materials, it must be noted that proper hand protection be considered for other operations that may not be lab related such as grinding, welding, extreme heat, etc.

There is not one type of glove that offers the best protection against all chemicals. The selection of which glove to use depends on several factors such as the type and concentration of the chemical in use, the performance of the glove of choice, duration of use, degradation rate, breakthrough time, etc. You must also consider chemical combinations. When combined, certain chemicals may cause a glove to degrade faster than if they were to be handled separately or they may permeate faster than individual chemicals.

Refer to the glove chart on the next page. It summarizes some of the more common types of gloves that may be used when working with a particular category of chemical. As there are many variables and numerous chemicals and hazardous materials regularly in use here at UB, this information is to be used as a guide only. More detailed information on glove choices can be found on the EH&S website. You can also refer to the specific chemicals safety data sheet (SDS) or by accessing the glove manufacturer's website.

Glove Chart

Type	Advantages	Disadvantages	Chemicals Protected Against
Latex	Low cost, excellent physical properties, dexterity, comfort	Allergy potential, may cut easily, may be dissolved by many organics	Oils, grease
Nitrile	Low cost, excellent physical properties, dexterity, can be cut resistant	DO NOT USE for methylene chloride, certain ketones	Oils, greases, most organics, weak acids and bases
Rubber	Low cost, dexterity	Poor choice for oils, grease, most organics	Bases, alcohols, dilute aqueous solutions
Polyvinyl chloride (PVC)	Low cost, good physical properties, medium chemical resistance	Poor choice for organics, limited physical dexterity, certain organics may dissolve	Strong acids and bases, aqueous solutions, alcohols
Polyvinyl alcohol (PVA)	Good physical properties, highly impermeable to gas,	Expensive, cannot be used in water or water based solutions	Aliphatics, aromatics, chlorinated solvents
Neoprene	Medium cost, medium chemical resistance	Not for some organics	Acid, bases, oils, phenol
Silver Shield	Excellent chemical resistance	Poor fit, not puncture resistant, stiff, poor grip	Metallic mercury, hazmat use

When using gloves in the lab:

- Wear the correct gloves when required.
- Do not use the same disposable gloves longer than one work shift.
- Disposable gloves must be discarded once removed. Do not save for future use.
- Dispose of gloves into the proper waste container. For example, biologically contaminated gloves go into a red biohazard bag and must be treated as Regulated Medical Waste. Gloves grossly contaminated with certain chemicals may, in some cases, be considered hazardous waste. Contact EH&S for further information.

- Wash hands once gloves have been removed.
- Non-disposable/reusable gloves must be washed and dried, as needed, and then inspected for tears and holes prior to reuse.
- Remove gloves before touching personal items, such as phones, computers, pens and one's skin.
- Do not wear gloves out of the lab. If gloves are needed to transport anything, double-glove so clean gloves are always on the outside or wear one glove to handle the transported item. The free hand is then used to touch doorknobs, elevator buttons, etc.
- If for any reason a glove fails, and chemicals come into contact with skin, consider it an exposure and wash under running water for at least 15 minutes, seek medical attention.

If gloves are needed to transport anything, double-glove so clean gloves are always on the outside or wear one glove to handle the transported item. The free hand is then used to touch doorknobs, elevator buttons, etc.

Latex Gloves: Certain types of latex gloves such as the thin disposable type should not be used for handling chemicals. These gloves offer little protection from the hazards associated with most chemicals found in the lab. Additionally, latex gloves can cause an allergic reaction in some people. At times it can be quite severe. Symptoms can include nasal, eye, or sinus irritation, hives, shortness of breath, coughing, wheezing, or unexplained shock. If any of these symptoms become apparent in personnel wearing latex gloves, discontinue using the gloves and seek medical attention immediately.

In most cases, latex gloves are best suited to be used only in the following applications:

- Very dilute aqueous solutions containing <1% of a hazardous chemical or constituent, but never when a known or suspected carcinogen is in use
- Medical use
- Handling most biological materials
- Handling non-hazardous salts or other materials

A note about latex gloves:

Those required to wear latex gloves should receive training on the potential health effects related to the use of latex. Hypoallergenic, non-powdered gloves should be used whenever possible. A general-purpose substitute for disposable latex gloves is disposable nitrile gloves.

Respirators: Although laboratory fume hoods are considered a primary engineering control device, there may be instances where their use for control of chemical vapors and laboratory chemicals may be considered impractical or not feasible. In these cases, the use of a respirator may be allowed. However, you must contact EH&S prior to the use of any respiratory device so that you can be enrolled in the EH&S respiratory protection program. This program meets OSHA regulations that require that all users are provided with a specialized physical, respirator fit test and training before using a respirator.

Lab Coats: Lab personnel must wear lab coats when working in an area where chemicals are being handled. Additionally, no shorts or short skirts are to be worn under the lab coat. If a lab coat becomes grossly contaminated, it should be discarded. "Normal" lab coats usually are made from synthetic blends, such as polyester/cotton, and are suitable for most applications. However, when working with pyrophoric and water reactive material, a flame-resistant lab coat made of 100% cotton is required due to risk of fire. Lab coats made

from synthetic blends can melt when exposed to flames, sticking to and burning your skin. Specialized body coverings such as rubber aprons must be worn when working with large quantities of chemicals, especially acids such as hydrofluoric and nitric.

Lab coats should not be taken home for laundering. Instead, they should be laundered by a uniform service that provides specific service for lab coat laundering.

Footwear

Do not wear open toed footwear such as sandals, flip-flops, footwear with holes, etc. in the laboratory.

Laboratory PPE Training Requirements

OSHA regulations also require that once a safety assessment has been completed and the proper PPE chosen, lab personnel be trained in its use. The training must include selection, proper care, limitations, proper care and maintenance. It is the responsibility of the principal investigator or laboratory supervisor to perform and document this training.

7. General Lab Safety Rules

Pay special attention when working with chemicals and hazardous materials. **EVERYONE** is responsible for lab safety, including PIs, supervisors, students, lab workers, etc. If you see something that may lead to an accident or unsafe act, bring it to your supervisor's attention.

- Avoid working alone in the lab, especially when using hazardous materials or performing a hazardous operation. You may not be able to summon help if an incident occurs while you are working alone. If you must work alone, use the buddy system or contact your principal investigator or supervisor so he/she is made aware you are alone.
- All equipment, instruments, and apparatus should be inspected prior to use. Any concerns must be addressed immediately; an out-of-service tag must be attached if it is deemed non-useable.
- Wear appropriate PPE, including eye protection.
- Keep sources of ignition away from flammable chemicals.
- Read the SDS for the chemical(s) you are working with. An SDS will provide you with a summary the health hazards of the materials and recommended safe work practices.
- No horseplay! It can lead to accidents.
- Do not pipette by mouth. Pipetting by mouth risks ingesting the chemical you are trying to suck into the pipette. Do not attempt!
- Know where the safety equipment, such as: eyewash, safety shower, etc., is located.
- Avoid mixing chemicals that may react in such a way as to cause an adverse reaction.
- Unauthorized or unsafe experiments are prohibited.

Personal Hygiene

- Wash areas promptly whenever skin contact has occurred.
- Don't smell or taste chemicals. For many chemicals, if you can smell them then you are exposing yourself to a dose that can harm you! If the safety information says that a chemical should only be used inside a laboratory chemical hood, then don't use it anywhere else.
- Eating and drinking are prohibited in areas where chemicals are in use.
- Do not store food, beverages or cosmetic products in areas where chemicals are located. Food must be placed in refrigerators and/or freezers that are labeled "for food use only".
- Always wash your hands with soap and water after you remove your gloves and before you leave the lab. Also, wash your hand before consuming food items.



- Never touch items in the lab such as phones, doorknobs, computers, etc. without removing your gloves first, and never leave the lab while still wearing gloves. If you must carry a chemical container outside of the lab, double-glove so clean gloves are always worn on the outside or wear one glove to handle the transported item. The free hand is then used to touch doorknobs, elevator buttons, etc.

Housekeeping

Below are “good housekeeping” practices that should be followed:

- Access to emergency equipment such as eyewash/showers, fire extinguishers, etc. and exits must not be blocked.
- All containers must be labeled. At a minimum the label must identify the contents and potential hazards.
- Keep all work areas, especially lab benches, free and clear of clutter. Put away chemical containers when not in use.
- All chemicals should be placed in their assigned storage areas at the end of each work shift. Chemicals must be stored by compatibility groups and not alphabetically. A list of incompatible chemicals is available on the EH&S website.
- Keep all aisles, hallways and other well-traveled areas clear of all chemicals and clutter. A minimum of 24 inches must be maintained for all emergency egress routes.
- Hazardous chemical wastes must be properly labeled and stored in appropriate containers in a hazardous waste satellite accumulation area (SAA). Grouping by chemical compatibility also applies to the storage of hazardous waste.
- All chemical spills must be promptly cleaned up and the resulting spill residual materials disposed of. Spill kits, along with training in their use, are available through the EH&S office. Use a spill kit only if:
 - You have been trained to do so,
 - Feel comfortable using it, and
 - The amount of chemical spilled is relatively small. Stop work and notify you PI or supervisor.
- In the event of large chemical spill (greater than 1 liter of material), contact UB Police at 645-2222. Larger chemical spills require special procedures to be followed.
- Working surfaces should be cleaned regularly.
- Dispose of any old, unused or unknown chemicals (see Chapter 14, “Managing Hazardous Waste”).

In the event of large chemical spill (greater than 1 liter of material), contact UB Police at 645-2222.

Larger chemical spills require special procedures to be followed.

Prior Approval

Prior approval of a laboratory experiment or task must be obtained from a PI or supervisor whenever:

- A new laboratory procedure, test, or experiment is to be carried out.
- The procedure or experiment presents a personal safety hazard or if an unintended chemical reaction may cause harm.

- It is likely that toxic limit concentrations could be exceeded, or that other harm is likely.
- There is a change in a procedure or experiment even if it is very similar to prior practices. Change in a procedure or test could mean:
 - A 10% or greater increase or decrease in the amount of one or more chemicals.
 - A substitution or deletion of any of the chemicals in a procedure.
 - Any change in other conditions under which the procedure is to be conducted.
- There is a failure of any of the equipment used in the process, especially of safeguards such as laboratory chemical hoods or scientific apparatus.
- There are unexpected results.
- Members of the laboratory group staff become ill, suspect that they or others have been exposed to chemicals used within the lab, or otherwise suspect a failure of any safeguards.

Handling of Chemicals

- **Always wear your PPE!** At a minimum this includes proper eye protection, gloves, lab coats and closed toed shoes.
- When working with flammable chemicals, all sources of ignition must be kept away.
- Label the contents of all secondary containers. When a chemical is transferred to a secondary container from the original container, two items must be transferred to the label of the new container: the name of the chemical and the hazard warning.
- Use a tip resistant shield for protection whenever an explosion or implosion might occur; i.e. vacuum distillations, sublimations, rotary evaporators, and high temperature operations.
- Know the hazards of all chemicals being used, (e.g. corrosivity, flammability, reactivity, toxicity, etc.) Refer to the SDS for the particular chemical for information on the hazards.
- Do not eat or drink in areas where chemicals are being used. A designated area for food consumption may be located in the same room, but not in close proximity to areas where chemicals are located. Contact EH&S for further information.
- Familiarize yourself with the proper procedures for transporting chemicals from bench to bench, from the stockroom to your lab, etc. Thinking ahead will lessen the chance of an accident occurring.
- Know what steps to take in the event of an emergency. Become familiar with the building evacuation routes and emergency contact numbers.
- Know the location of the spill kit in your laboratory and know what steps to take in the event of a spill.

Transporting Chemicals

The transportation and movement of reagent chemicals at UB presents the greatest potential for an accidental release to occur. Exercise caution when transporting chemicals from stockroom to lab, lab to lab, or from any one location to the next. When transporting chemicals:

- Freight elevators must be used whenever possible. Do not use passenger elevators if a freight elevator is available.
- The use of a cart is strongly recommended. The cart must be properly sized and have sides on the shelves. Do not stack containers of hazardous materials on top of one another while transporting them.
- Transport in original packaging whenever possible.
- Containers of flammable liquid, especially smaller containers should be secured in a box or other carrying case.
- Use rubber bucket carriers, non-breakable PVC coated bottles or a wheeled cart with raised edges to serve as secondary containment for acids.
- Care should be taken when transporting incompatible materials. Segregate them in different boxes or containers.
- Specific US Department of Transportation regulatory requirements must be followed when transporting hazardous materials. If you have a hazardous material that must be transported from campus to campus, contact EH&S and we will facilitate the movement of these materials.
- Gas cylinders must be transported properly. Ensure that the cylinder valve is fully closed and the protection cap (where applicable) is secured in place. Always use carts or hand trucks designed for moving cylinders. Never roll cylinders to move them. Never drop cylinders or allow them to strike each other violently. Never lift cylinders by the cap.

Under no circumstances are hazardous materials to be transported between UB campus locations, e.g. South to North, South to Downtown, etc. in private vehicles.

8. Special Provisions for Working with Particularly Hazardous Materials

Definition of Particularly Hazardous Materials

Chemicals are considered particularly hazardous for many reasons. They may cause cancer (**carcinogenic**), birth defects (**teratogenic**), induce genetic damage (**mutagenic**), cause miscarriage, or otherwise interfere with the reproductive process. In addition, they may be an acutely toxic chemical such as a cholinesterase inhibitor, cyanide, or other highly toxic chemical (poison) that, after a comparatively small exposure, can lead to serious injury or even death. Below are definitions of the classes of chemicals that are particularly hazardous materials:

Highly or acutely toxic chemicals: Substances with a high degree of acute toxicity that can cause death, disability, or serious injury after a single, relatively low-level exposure. The following table denotes the OSHA-defined toxicity designations, for various routes of exposures. The criterion for “highly toxic” appears in bold letters.

Acute Toxicity Hazard Designations

OSHA Hazard Designation	Other Toxicity Rating ¹	Oral LD ₅₀ (rats, mg/kg)	Skin Contact LD ₅₀ ² (rabbits, mg/kg)	Inhalation LC ₅₀ ³ (rats, ppm for 1 hr)	Inhalation LC ₅₀ (rats, mg/m ³ for 1 hr)
Highly toxic	Highly toxic	<50	<200	< 200	<2000
Toxic	Moderately toxic	50 to 500	200 to 1000	200 to 2000	2000 to 20,000
	Slightly toxic	500 to 5000	1000 to 5000	2000 to 20,000	20,000 to 200,000

[1] *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*; National Academy Press, Washington, D.C., 1995

[2] LD₅₀- The amount of a chemical that when ingested, injected, or applied to the skin of a test animal under controlled laboratory conditions will kill one-half (50%) of the animals.

[3] LC₅₀- The concentration of the chemical in air that will kill 50% of the test animals exposed to it.

Carcinogens: Chemicals that are strongly implicated as a cause of cancer are termed *carcinogenic*. Substances defined by OSHA as *select carcinogens* fall into one of the categories listed below:

OSHA Carcinogen: a chemical regulated by OSHA as a carcinogen; each has its own standard in subpart 2 of the OSHA General Industry Standards.

Known Human Carcinogen: Classified as “known to be carcinogens”, in the most recent *Annual Report on Carcinogens* issued by the National Toxicology Program (NTP), or listed under Group 1 “carcinogenic to humans” by the International Agency for Research on Cancer (IARC).

Important!

Remember that a chemical's lack of inclusion in one of these lists does not necessarily imply that it is free from carcinogenic activity. Substances such as **ethidium bromide** that are used extensively in research do not have a substantial industrial use and, consequently, have not undergone a rigorous analysis for carcinogenicity. Although ethidium bromide is a well-known, potent **mutagen** it is **not** included in any of the lists. Laboratory workers are reminded to diligently research a chemical's toxicity and hazard potential rather than relying exclusively on its presence in a list.

Potential Human Carcinogen: Listed under IARC Group 2A "probably carcinogenic to humans" or Group 2B "possibly carcinogenic to humans", or classified as "reasonably anticipated to be a carcinogen" by NTP, and causes statistically significant tumor incidence in experimental animals under any of the following dosage criteria:

Inhalation exposure - chronic exposure (for a significant portion of a lifetime); 6-7 hours/day, 5 days/week; dose <10mg/m³

Skin exposure - repeated skin exposure of <300mg/kg body weight per week

Ingestion - daily dose <50mg/kg body weight

Reproductive Toxins: Reproductive toxins are chemicals that can cause problems with male and/or female reproduction. Adverse effects can include: reductions in libido, reduced fertility, embryo lethality, induction of chromosomal damage (mutations), malformations of the developing fetus (teratogenesis), and postnatal functional defects. Some chemicals cause problems for infants if a breast-feeding mother is exposed.

Chemical Sensitizers (Allergens): An allergy develops when the immune system reacts to a substance as if it were infectious, triggering the production of antibodies. Subsequent exposures to even very small amounts of the same substance can trigger the allergic response. The individual who has developed an allergy can manifest the allergic response as a skin rash, eye irritation, allergic asthma, or, in severe allergic reactions, anaphylactic shock that can result in death if not treated quickly enough.

There are several chemicals and classes of chemicals that can be sensitizers. Examples of the more common sensitizer chemicals are: polyisocyanates, latex rubber, certain metals (such as Beryllium, Nickel, etc.), formaldehyde, acid anhydrides, toluene, coal tar volatiles, and some phenol derivatives.

Non-Chemical Particularly Hazardous Materials

Toxins, Biological Toxins & Select Agent Toxins: Toxins are chemicals created by plants, animals or microorganisms that are poisonous to humans. Biological toxins are molecules produced by plants, animals, or microorganisms that are poisonous to animals, including humans. Toxins can be small molecules, peptides, or proteins that are capable of causing disease by contact or absorption through body tissues.

Certain specific toxins have been listed as Select Agent Toxins by the Centers for Disease Control (CDC). The University is required to register these toxins with the CDC and must follow strict procedures for receipt, use, security, and disposal. If you plan to use a Select Agent Toxin, you must first be approved for its use and registered for its possession. See the section "Prior Approval for Restricted Use and Extremely Toxic Chemicals" below for guidance on obtaining

approval for select agent use. The complete list of Select Agent Toxins can be found at the National Select Agent Registry website.

Responsibilities

Principal Investigator

- Assure that the chemicals chosen are the least hazardous for the experiment being performed
- Assure that individuals performing the work are properly trained, and know proper safety measures, including standard operating procedures and emergency procedures
- Assure that the proper PPE and engineering controls are available and being used, and that the chemical is being handled and cleaned up properly
- Assure that Hazardous Waste is properly labeled and disposed of in a timely manner

Individual(s) performing work

- Be properly trained and familiar with the chemicals you will be working with. Ask questions if unclear, and obtain additional training whenever procedures or chemicals change
- Be familiar with emergency procedures. Notify supervisor of any hazardous conditions or unsafe work practices in the area
- Wear proper PPE (safety glasses with side protection, goggles, gloves, lab coats, etc.)
- Follow all proper methods for waste accumulation and disposal. Inspect Satellite Accumulation areas and chemical containers for signs of leaking or deterioration

Environment, Health & Safety Services

- Review and approve SOPs
- Provide consultative support
- Assist in managing unusual or special problems
- Dispose of waste according to local and federal regulations when requested

Hazard Control for Particularly Hazardous Materials

Prudent experimental planning requires not only an accurate assessment of the risks involved, but also selection of appropriate work practices. General laboratory safety practices and procedures are usually sufficient for operations involving hazardous chemicals of mild to moderate risk. However, when highly hazardous chemicals are involved, it may be necessary to take additional steps to adequately reduce risk and protect the health and safety of laboratory workers.

The goal in developing and implementing these special precautions is to set up multiple lines of defense to minimize the risks posed by particularly hazardous materials. Consider each of the following provisions when developing special procedures for highly hazardous

*It is vital that lab staff examine every experiment using particularly hazardous materials to determine if these types of modifications can be implemented as a **first step in risk reduction.***

materials; some or all of them may apply, depending on the particular circumstances in which the substance will be used. In some circumstances, only select precautions may be necessary, such as when the total amount of an acutely toxic substance to be handled is a small fraction of the harmful dose. In other circumstances it may be necessary to implement a full array of precautions.

Substitution & Other Procedural Modifications

The most effective way to minimize the risk posed by particularly hazardous materials is to reduce or eliminate their use, or to alter the procedure in a way that reduces the risk that they pose. Whenever possible replace particularly hazardous materials with less hazardous substitutes. Consult with supervisors, colleagues, and reference documents for assistance in identifying suitable substitutes and other risk reduction strategies.

Standard Operating Procedures (SOPs)

When working with particularly hazardous materials laboratory personnel must develop lab specific standard operating procedures (SOPs) relevant to safety and health considerations. The purpose of the SOP is to outline the risks associated with the highly hazardous chemicals in use as well as to describe the steps that lab staff will take to mitigate those risks. SOPs for particularly hazardous materials can be substance specific or procedure specific, depending on the needs of a particular laboratory. For each experiment using particularly hazardous materials, an SOP must be developed and submitted to EH&S for approval. In general, SOPs are documents designed to minimize risk and should contain the following information:

See Appendix C for more information on Standard Operating Procedures.

- **Working Principles:** Describe the mechanism of action, the anticipated outcome and the specific procedures to be followed during the experiment.
- **Potential Hazards:** Discuss the potential for the material to harm human health. Provide the quantity that constitutes a toxic dose, if known. For hazardous chemicals, include a brief discussion of acute and chronic toxicity and routes of entry. This information may be found on a Safety Data Sheet (SDS).
- **Regulatory Review:** List any Occupational Safety and Health Administration (OSHA) regulations and any occupational exposure limits or special requirements.
- **Controlling Exposure:** Discuss what measures will be put in place to ensure that all personnel in the work area are aware of the potential hazards of this chemical. Discuss training: general and lab-specific. Identify a "Designated Area" for use with carcinogens, reproductive toxins, or chemicals with high degree of acute toxicity. Mention controls to be in place to reduce exposure to lab workers, i.e., chemical fume hoods, personal protective equipment (PPE), and administrative controls. Discuss methods to secure

access to the chemical, i.e., lock boxes, locked doors when lab is unoccupied. Only quantities of hazardous chemicals that will be used during an experiment should be permitted outside of approved storage locations.

- **Spill Control:** Describe procedures for managing spills including the proper PPE to be worn and disposal methods. If a large spill occurs (greater than 1 liter of material), contact UB Police at 645-2222. Notify those affected and evacuate the area. If a small spill occurs and your lab has a spill kit and you are trained to use it, go ahead and clean up the area. If you do not wish to clean up a small spill, contact the EH&S office at 829-3301 for assistance.
- **Waste Disposal:** Describe procedures for following the University at Buffalo Waste Disposal Procedures. List the wording to be written on the container of waste, using the UB "Hazardous Waste" Label. The Chemical Waste Pick-Up Form is available on the EH&S website.
- **Emergency Procedures:** Information concerning emergency procedures for exposure or accidental contact with particularly hazardous materials should be provided on the SDS. List those procedures along with emergency phone numbers. Contact the chemical manufacturer if more information is needed.

Designated Area

Confine operations involving particularly hazardous materials to a designated work area in the laboratory. This designated area can be the entire laboratory, an area of the laboratory, or a device such as a chemical fume hood. Isolate area from food and drink. Refrigerators, freezers, microwaves, ovens, etc. designated for chemical use must be properly labeled as "Chemicals Only". No food or beverages are permitted to be stored in them. Use warning signs to clearly indicate which areas are designated and the nature of the hazard. Use of designated areas need not be restricted to particularly hazardous materials, as long as all lab staff are aware of the nature of the substances being used, and the special precautions, laboratory skills, and safety discipline required to work in the area.

Access Control

Limit access to all laboratories where particularly hazardous materials are in use to appropriately trained and authorized personnel. Depending on the materials and the circumstances of use, access control can be achieved by a combination of administrative procedures (such as prohibiting unauthorized visitors) and/or physical barriers (such as closing laboratory doors while highly hazardous chemicals are in use, or storing highly toxic chemicals in locked cabinets).

SOP Training

After EH&S approves your Standard Operating Procedure, the PI (or lab supervisor) must train each member of the lab on its contents.

A Standard Operating Procedure template and training record are available on the EH&S website.

Experiments conducted with extremely hazardous chemicals may need to be carried out in work areas designed to contain accidental releases. Hood trays and other types of secondary containers should be used to contain inadvertent spills, and careful technique must be observed to minimize the potential for spills and releases.

Containment

Procedures involving extremely toxic chemicals that can generate dust, vapors, or aerosols must be conducted in a hood, glove box, or other suitable containment device. Proper operation should be confirmed prior to conducting experiments with extremely hazardous chemicals. If experiments are to be continuing over a significant period of time, regular checks of hood function, or the installation of a flow-sensing device with an audible or visual indicator of performance should be considered.

Decontamination

Equipment used for the handling of particularly hazardous materials may need to be suitably isolated from the general laboratory environment. Decontamination of equipment should be properly performed when necessary, and should be conducted in a designated chemical fume hood.

Waste Disposal

Wastes of acutely hazardous materials are generally on the EPA P-list, and care must be taken to not exceed the limits that can be accumulated at a satellite accumulation area. The limit for acutely hazardous waste at a satellite accumulation area is one-quart (or quart-size) container. **For proper disposal, follow the procedures outlined in the EH&S Hazardous Waste Management Guidebook.** This guidebook should already be present in your laboratory; additional copies are available from EH&S.

An empty container that has held an acutely hazardous waste must be triple rinsed using a solvent (which might be water) capable of removing the acute hazardous waste prior to disposal of the container as regular trash. Each rinsing should be performed with an amount of solvent equal to approximately 5 percent of the volume of the container. The rinsate must be collected and disposed of as hazardous waste. Remember to deface any chemical or hazardous waste labels prior to disposal as regular trash. Alternately, place a RCRA empty label on the container after the triple rinse. Notify EH&S before triple rinsing any empty containers of acutely hazardous materials.

Prior Approval for Restricted Use & Extremely Toxic Chemicals

Certain select agents, biological toxins and restricted use chemicals have been determined as having the “potential to pose a severe threat to public health and safety.” The OSHA lab standard requires that a chemical hygiene plan include information regarding the circumstances under which prior approval for their use would be necessary.

EH&S can provide assistance in identifying circumstances where prior approval must be obtained before a lab can obtain and begin using such materials in an experiment. However, the ultimate

Approval from EH&S is required prior to the use of select agents noted in Appendix G. Prior approval ensures laboratory workers receive proper training on the hazards of the select agent or restricted chemical and that safety considerations be addressed **prior** to a new experiment taking place.

responsibility of establishing prior approval lies with the Principal Investigator or laboratory supervisor.

A list of the select agents and biological toxins requiring prior approval may be found in Appendix G. If you wish to incorporate use of any of the agents found on this list in your research, please contact the EH&S Biosafety Officer to initiate the prior approval process.

Following are some additional examples of when prior approval must be obtained:

- New equipment is brought into the lab that requires special training be provided to laboratory workers.
- When a laboratory worker plans on working alone while using a highly hazardous chemical or operation.

Principal Investigators should seek prior approval from EH&S when using any agents of high risk that classify as Particularly Hazardous Substances, as described by this section of the CHP.

9. Storage of Chemicals

Storage of Reagent Chemicals

Reagent chemicals must be properly stored and segregated to prevent an unexpected reaction. Do not keep excessive supplies of chemicals in laboratory chemical hoods where they may clutter space, interfere with the hood's airflow, and contribute to the possibility of an accidental release. Do not store excess chemicals on the bench top, as this also increases the risk of an unexpected reaction and leaves them unprotected from ignition sources (low hazard materials such as salts, salt solutions and buffers may be stored on the bench top in higher volumes). For your convenience, a chemical compatibility chart is located as part of this plan in Appendix I (also available on the EH&S website). When in doubt, contact EH&S for guidance.

Consider the following when storing reagent chemicals:

- The proper method to follow when storing reagent chemicals is according to compatibility and not alphabetically. Reagents should only be stored alphabetically if they are in the same compatibility group.
- Compatibility can be determined by referring to the labeling on the reagent bottle or by reviewing the SDS.
- Separate storage areas must be designated for compatibility groups such as oxidizers, reducers, acids, etc. Each area must be labeled accordingly.
- While it is recognized that shelf storage space in most labs is at a premium, it is preferred that chemicals are stored at or below eye level. This prevents an accident that may occur when removing containers from a high shelf. If it is necessary to store reagent chemical containers above eye level, use extra caution when moving them around.
- All containers must be kept sealed and closed except when removing material from them.
- Storage areas should not be exposed to extremes of heat or sunlight.

When storing chemicals in a laboratory, segregate the chemicals into hazard classes:

Dry reagents:

- Oxidizing solids - place a label on the shelf lip identifying it as an area for oxidizers only.
- Flammable solids
- Water-reactive solids
- All other solids

Liquids:

- Acid liquids
- Caustic liquids

- Oxidizing liquids
- Flammable liquids
- All other liquids

The following sections describe the safe storage of certain chemical groups:

Flammable Liquids

Flammable Cabinets: Flammable liquid storage cabinets are intended for the storage of flammable and combustible liquids. Per New York State Fire Code and Office of Fire Prevention and Control policy, flammable cabinets must be used in any laboratory or area where the volume of flammables exceeds certain levels. **Many, but not all, buildings/areas have a 10-gallon limit on the amount of flammables that may be stored outside of an approved cabinet. Certain buildings/areas carry more restrictive storage requirements which must be followed. EH&S can assist you with determining the proper storage of flammables in your building and laboratory.**

Storage of flammable liquids in household grade refrigerators is a fire hazard and is not permitted. If flammable liquids need to be refrigerated, small volumes can be stored in a UL approved refrigerator rated for flammable liquids. This type of unit has no internal switching devices that can arc or spark as a source of ignition. However, these refrigerators are **NOT** considered explosion proof.

Explosion proof refrigerators are designed for use in areas where the air *outside* the unit may be explosive and small volumes of flammable liquids can be stored inside. However, in a typical lab setting, explosion proof refrigerators are usually not necessary. Explosion proof refrigerators are **NOT** considered approved flammable cabinets, and materials stored in them will count toward the maximum amount permitted in a laboratory space (e.g. must be less than 10 gallons in lab space, etc.).

When storing flammables consider:

- Flammables should be placed back in the approved cabinets when not in use.
- Flammable storage cabinets must be UL listed, self-closing, and otherwise meet New York State Fire Code requirements. Be aware that many storage cabinets located under laboratory chemical hoods labeled "Flammables" do not meet these requirements. Although you may use these areas for low volume flammable storage, any amounts exceeding the 10-gallon limit must be stored in an approved cabinet.
- Cabinets are not required to be vented. However, if a lab group requires a cabinet be vented for the purpose of odor control of malodorous material, it shall be done through and with the prior approval of EH&S.
- Approved flammable cabinets are available in many sizes and orientations. EH&S will assist you with choosing the

correct cabinet tailored to your lab's needs. Each PI is responsible for funding the purchase of these cabinets.

- Any cabinet used to store low volumes of flammables must have the words "flammable storage" adhered to the cabinet door.

Pyrophoric and Water-Reactive Substances

Pyrophoric substances are extremely reactive and can ignite spontaneously when contacted with air even in the absence of heat or fire. Extreme caution must be taken when working with them. Pyrophoric chemicals can be handled and stored safely so long as exposure to atmospheric oxygen and moisture is avoided. The choice for appropriate storage should be made prior to obtaining the chemical; it's a good idea to limit quantities to the minimum required so as to minimize the storage and disposal requirements.

Pyrophoric solid and liquid substances should be stored in inert gas filled desiccators or glove boxes. Some are required to be stored under a flammable solvent (such as kerosene), and the use of a lab chemical fume hood is required to prevent the release of flammable vapors into the laboratory. Pyrophoric gases such as silanes are required to be stored in a specialized gas cabinet when the cylinder size exceeds that of a typical lecture bottle. When deciding how to store these materials, refer to the SDS or contact EH&S for guidance. Examples of pyrophoric chemicals include silanes, tert-butyllithium, metal hydrides, finely divided metal powders, nonmetal hydride and alkyl compounds, white phosphorus, alloy of reactive materials and organometallic compounds, including alkyllithiums.

Store water reactive materials in a cool and dry location segregated from all other chemicals in the lab. They are to be stored in such a way as to protect them from water in the event of the sprinkler system activation. Examples of water reactive materials include alkali metals such as sodium and potassium, alkali earth metals, anhydrides, certain carbides, hydrides, sodium hydrosulfite, and similar chemicals.

Oxidizers

Oxidizers should be stored in a cool, dry place and kept apart from flammables, combustibles, organic materials, and reducers. A good practice is to designate a separate area away from the above-mentioned chemicals and label it as an "oxidizer only" area. Examples of oxidizers include certain nitrates, permanganates, chlorates, concentrated nitric acid, etc. An oxidizer can be identified by reading the container label or referring to the SDS.

Peroxide Forming Chemicals

Certain common organic compounds can react with air to form unstable and dangerous peroxide compounds. These peroxides can detonate when subjected to thermal or mechanical shock. The risk

Note:

Any cabinet used to store low volumes of flammable liquids must have the words "Flammable Storage" adhered to the cabinet door.

*Always check for peroxide formation prior to use. If the area of the cap appears to contain salts or if you are unsure whether the chemical contains peroxides, **DO NOT OPEN OR USE** - Contact EH&S immediately.*

of this occurring can increase if the peroxide becomes concentrated by evaporation or distillation. Simply opening the container can initiate peroxide formation, while light and heat act to accelerate the process. Manufacturers may add an inhibitor to prevent peroxide formation, for many peroxide-forming solvents, butylated hydroxy toluene (BHT) is commonly added. Refer to Appendix H for additional information on the handling of peroxide forming chemicals.

When storing and using peroxide forming chemicals:

- Place the date of purchase and the date opened on the container. Discard the entire contents when the recommended storage time period has expired. Contact EH&S for recommended storage times for peroxide forming chemicals.
- Do not purchase these chemicals in quantities greater than can be used within their specified storage time period.
- Certain peroxide-forming solvents such as ethers should be stored in the dark and under nitrogen, if possible.

Corrosives

Corrosive chemicals are defined as either being an acid (pH greater than 4) or a caustic (pH greater than 10). Acids must always be segregated from bases and any other chemicals with which an adverse reaction may occur.

- Never store acids and flammables in the same area unless they are in separate secondary containment bins. It's never a good idea to store acids in an approved flammable storage cabinet as they are incompatible with one another.
- Generally, inorganic and organic acids can be stored in the same cabinet provided they have secondary containment. The cabinet must be labeled with the word "Acids".
- Inorganic and organic bases can also be stored together in the same cabinet. In this case, the cabinet must be labeled with the word "Bases".
- Oxidizing acids such as nitric, perchloric and chromic should be stored in a separate area if organic acids are also present
- Never store corrosives on a shelf that is greater than shoulder height. Storage of corrosives above shoulder height increases the probability of injury if the container falls.

Controlled Substances

Controlled substances used for research require additional security and handling requirements. Security requirements vary depending on the particular schedule and characteristics of the substance. Storage of controlled substances must provide for effective prevention of theft.

The Associate Vice President of Research administers the controlled substance program at UB. Refer to the AVP website for further information on the storage and use of controlled substances.

10. Labeling of Chemicals

Chemicals in the laboratory must be adequately and properly labeled. In the event of an incident such as a personal exposure or a chemical spill or release a properly labeled container will assist in identifying the physical and health hazards associated with that particular chemical.

The following labeling requirements must be followed:

- All containers must be labeled. The label must be in plain English with no chemical structures or abbreviations. If a container arrives without the manufacturer's label, an appropriate label must be affixed to it. Information required to be on the label may be obtained by referring to the SDS.
- Minimum labeling requirements for containers:
 - Label must be in plain English with no chemical structures or abbreviations.
 - Must include a signal word and any appropriate hazard warnings.
 - Must list specific physical/health hazards, including target organs
- Labels that are falling off, torn, unreadable, etc. must be replaced. Otherwise the container contents may become an "unknown" chemical. Determining the contents of an "unknown" chemical is an involved and costly process and also presents unique concerns and hazards for chemical waste handlers, EH&S staff, and to the environment. Please take care to avoid creating "unknown" chemicals in your laboratory.
- Carefully read all the information on each label. If you do not understand something, contact your PI or lab supervisor for an explanation or request to review the SDS.

Labeling Secondary Containers

A secondary container is defined as any container being used beyond the original manufacturer's bottle in which the chemical was shipped in. This may include but is not limited to portable or working containers such as flasks, beakers, small storage bottles, wash bottles, etc. All secondary containers must be properly labeled with the contents. This prevents mishandling, misuse, or accidents as others in the lab must be unaware of the contents. Laboratory workers should not work with a chemical from an unlabeled container when the contents are not known.

In many cases, a Globally Harmonized System (GHS) label is also required. A GHS label is required if the chemical's safety data sheet indicates it is a GHS regulated material. The label must contain the following information:

- The name of the chemical In English without abbreviations.



Example of GHS Label

- Hazard symbols (pictograms) must be prominently displayed.
- Must contain a signal word (warning or danger) and list the applicable warning statements, e.g. "flammable, keep flames away," "causes severe eye damage" etc.
- If it is not practical to label a small container, appropriate information may be placed on a sign or card **next** to the container.
- Chemicals that are time-sensitive or that produce peroxides must be dated indicating the date storage began.
- Reagent squirt bottles must also be properly labeled. Typically, squirt bottles may contain distilled water, acetone, alcohols, etc.
- All containers used for baths, such as mineral oil, alcohol, etc. must be labeled.

UB EH&S has an extensive library of GHS labels for distribution to the campus community. They can be ordered and obtained from EH&S by accessing our website.

If the SDS identifies the chemical as being non-GHS regulated, you can use a suitable label or tape to properly identify the contents.

Occasionally, a GHS regulated chemical will be in a container, flask, beaker, etc., and its contents used up during a single work shift. This is known as a working container; in this case, a GHS label would not be required. However, the contents must still be identified; a label or piece of tape identifying the contents is suitable in this case.

Chemical Substances Developed or Synthesized by Laboratories

Laboratory developed substances, including: buffers, testing and reference samples, chemical intermediates and drugs, and non-commercially procured chemical compounds must be identified and properly labeled.

- If the volume is small, at a minimum, label the container with a notebook page number, so individual constituents may be identified by referring to the procedure.
- For larger volumes, consider assigning an IUPAC name based on guidelines established by the IUPAC convention.
- Additional requirements for the handling of this material can be found in the "Hazard Communication and Identification" section of this CHP.

Special Labeling for Highly Toxic Materials

All containers that hold carcinogens, reproductive toxins, and acutely toxic reagents and chemicals must be properly labeled with the health hazards posed by the chemical.

11. Handling of Compressed Gases

Compressed gas cylinders are vital to research operations of many laboratories on campus. However, they can expose users to both chemical and physical hazards. A compressed gas can be toxic, corrosive, flammable, an oxidizer, etc. or a combination thereof. Since a gas cylinder is pressurized it can quickly contaminate a lab space when released. There are two major types of cylinders in use at UB: refillable and non-refillable. Refillable are those cylinders usually supplied by gas vendors that are generally large. Non-refillable cylinders can be in the form of lecture bottles and other smaller disposable cylinders.

Storage of Compressed Gas Cylinders:

- All gas cylinders including lecture bottles must be secured upright to a stable structure at all times. For larger cylinders, a chain or appropriate strap located above the midpoint but below the shoulder is the best way to achieve this. Smaller cylinders can be secured using approved stands or wall brackets. Lecture bottles can be secured by storing them in boxes upright or by fashioning a stand out of material such as PVC pipe. **NOTE: New York State Fire Code requires all cylinders to be secured regardless of size.**
- Do not store gas cylinders in exit areas or within egress routes.
- Always make sure that the gas regulator and valve fittings are compatible. Some regulators are designed to be used only with specific gases; regulators should not be interchanged.
- Cylinders must be stored in an upright position and capped with the vendor-supplied cap when not in use for an extended period of time.
- Empty gas cylinders must be stored separately from those that are full. Mark empty cylinders "empty" or "MT".
- When using toxic or corrosive gases, set up apparatus in a laboratory fume hood.
- Oxygen cylinders that are considered in storage must be kept at least 20 feet away from all flammable, combustible, or incompatible materials.

Safe Use of Compressed Gas:

- Review Safety Bulletins, SDS sheets, and become familiar with what gases are in use.
- Never string gas lines across the lab and over sprinkler head pipes. Where possible, lines should be secured.
- Some highly toxic or reactive gases require specialized training for their use. Certain actions such as performing a tank change out can be potentially dangerous if not done correctly. Lab specific SOPs detailing these procedures must

be developed and implemented when using these types of gases.

- Always open cylinder valves slowly.
- Cylinders containing flammable gases such as hydrogen or acetylene must not be stored in close proximity to open flames, areas where electrical sparks are generated, or where other sources of ignition may be present.
- Special approval may be required for certain highly toxic, reactive, and pyrophoric gases. Specialized equipment such as gas cabinets may be required. Contact EH&S for further information.
- The correct PPE such as rubber gloves and aprons must be worn when working with corrosive gases.

Transport of Cylinders:

- Remove the regulator and protect the valve by attaching the cap prior to transport.
- Always use a specialized cart when transporting cylinders. They must be secured to the cart with a strap, chain or other suitable restraining material.
- Cylinders must never be dragged, rolled or pulled. Do not use a flat cart to transport; the cylinder can roll off and be damaged or cause injury.
- Move only one cylinder at a time unless a cart specifically designed for 2 cylinders is used.

12. Cryogenic Safety

Cryogenic materials (liquefied gases) are those with extremely low boiling points, typically $<-150^{\circ}\text{F}$. The most common cryogenic at UB is liquid nitrogen. Other cryogenics found here on campus are liquid helium, argon, and methane. Hazards associated with these materials include burns, asphyxiation, fire/explosion and over pressurization. Extreme care must be taken when working with cryogenics such as liquid nitrogen as it can be splashed back onto the skin while dispensing.

Cryogenics require specialized storage devices, more commonly referred to as dewars (container with double walls separated by a vacuum). Dewars used to store laboratory samples are available in a wide variety of sizes depending on the specific needs of the laboratory. Evacuated dewars containing the cryogenic stock material are designed to vent off their contents as part of normal operations. However, if you observe excessive venting or ice build-up on the vessel, this may indicate a more serious problem. If possible, remove the container to a safe, well-ventilated area. The vendor must be contacted immediately so the problem can be fixed. Stock cryogenic dewars are used for filling storage dewars.

Special Precautions for Working with Cryogenics:

- **Burns/Frostbite:** Skin contact with cryogenic materials can cause cold burns and frostbite as they can rapidly freeze human tissue. Eye contact can cause permanent damage. Always wear your PPE including a face shield when working with these materials.
- **Asphyxiation:** All cryogenic liquids produce large volumes of gas when they vaporize and can displace breathable air as they are released into the atmosphere. Always work with cryogenics, including dry ice, in a well-ventilated area; close valves and cap the containers and dewars after use. In some cases where a high volume of liquid nitrogen is in use, an oxygen sensor may be required to alert those in the area that an IDLH (immediately dangerous to life and health) situation may exist.
- **Fire and Explosion Hazard:** Liquid nitrogen and helium are not flammable. However, they can under certain conditions increase the flammability of other materials. Cryogenics are capable of condensing oxygen out of the air creating an oxygen-rich environment and cause nearby flammables to ignite.
- **Property Damage:** Due to the extreme cold, cryogenics can cause damage to equipment and materials that can result in cracking or breaking of equipment and release of materials. Spills can damage furniture, equipment and flooring materials.



Typical Cryogenic Dewar

When handling and/or dispensing cryogenics, follow these safety guidelines:

- Always use a dewar flask for storage of liquid nitrogen. The dispensing process must be performed in a well-ventilated area. Do not overfill containers.
- When dispensing cryogenics, safety glasses and a face shield must be worn to protect the eyes and face from splashing.
- Cold-impervious gloves must be worn. They should have long ribbed cuffs to prevent spillage into the glove or be loose enough to be easily removed.
- Use a cart when possible rather than carrying containers.
- Store containers in a well-ventilated area.
- Do not transport containers in confined spaces such as elevators. If it is necessary to transport a dewar in an elevator, take the following precautions:
 - Use the freight elevator if available, not a passenger elevator.
 - Restrict use of elevator while the dewar is inside. Label or place a sign on the door that notifies people to temporarily not use.
 - Have one person place the dewar in the elevator and another wait for it at its destination.

13. Hazard Communication and Identification

It is important that all hazards that may be present in a laboratory be identified. You have a right to know about the hazards you are exposed to in the workplace. OSHA and New York State regulations require that you be made aware of the hazards of the chemicals used and be provided with information on working safely with these chemicals. With that in mind, there are many sources of information at your disposal including Safety Data Sheets (SDS), safety literature, information on container labels, etc. Identifying the hazards associated with chemicals in your laboratory can help you reduce the risks involved with their use.

Safety Data Sheets (SDS)

A SDS is a formal document designed to provide information on how to handle a specific chemical. It contains specific sections that detail the chemical properties, health, safety and fire hazards, storage and disposal requirements, protective equipment, and spill handling procedures. The OSHA Hazard Communication Standard requires that "anyone who might handle, work with or be exposed to hazardous materials must have access to the Safety Data Sheets." They are intended for lab workers who may be exposed to the chemical as well as emergency personnel such as firefighters who may respond to an incident, such as a spill. When working in a laboratory:

- Be aware of the how to access the SDS library in your work area. Training must include where they are located.
- Maintain SDSs that are received with chemicals that are new to your laboratory. The location of SDS's must be posted and known to all lab members.
- SDSs must be "readily accessible" to all workers. Paper copies in binders or folders are the preferred method but electronic media such as a CD or DVD disk is also acceptable. Internet access is acceptable provided each "link" to a specific SDS is clear. This requirement can be achieved by bookmarking directly to the chemical SDS or your supplier's website.
- Each lab group must assign an individual who is responsible for obtaining and maintaining the SDSs

Chemical Substances Developed by Laboratories

Laboratory developed substances, including: buffers, testing and reference samples, chemical intermediates and drugs, and non-commercially procured chemical compounds must be identified and properly labeled (see Chapter 10, "Labeling of Containers"). For laboratory developed chemical substances where there is no known written hazard information, follow these guidelines:

- If the chemical developed by the laboratory is produced exclusively for the laboratory's use, the laboratory must determine if the substance is a hazardous substance and poses a health risk.
- If the substance is hazardous, then the laboratory must label the containers as such, and indicate those hazards on the label. If the laboratory is unable to determine the hazards, it must label the chemical as if it were hazardous.
- If the chemical developed by the laboratory is produced for use by another laboratory or shipped off campus to an outside entity, the laboratory must develop an SDS for that chemical substance.

Chemical Inventory Requirements

Visit the EH&S website for up-to-date information on how you can keep your chemical inventory online.

An inventory of chemicals that are present in the laboratory must be maintained and updated as they are purchased or removed from service. The principal investigator is ultimately responsible for the maintenance of the inventory. However, if the group has a Safety Officer, that person can be assigned to perform this duty. At a minimum, the inventory is to be updated on a yearly basis. Include all chemicals used or stored in your laboratory.

Benefits of maintaining an up-to-date inventory include:

- Laboratory workers can readily be made aware of what chemicals are present in the workplace inventories. It can be used as an aid for Right-To-Know training that identifies the relative hazards of a particular chemical.
- Provides the ability to identify unneeded or unwanted materials that can be removed from the laboratory and properly disposed by EH&S.
- Duplicate and redundant purchases can be avoided by referring to the inventory beforehand.

The chemical inventory must contain these mandatory items:

- Building and room number where the chemical is used/stored
- Proper name of the chemical (limit the use of abbreviations)
- Number of containers
- Container size
- Physical state

Helpful information but not mandatory

- Date acquired
- CAS number if available

Lab Specific Standard Operating Procedures (SOPs)

Lab specific SOPs must be created when a procedure poses an identified potential risk to the health and safety of the worker and of

others present in the lab. A copy of each SOP must be placed in and become part of this chemical hygiene plan.

Each SOP should include at a minimum:

- An Inventory of specific chemicals to be used in the procedure.
- The hazards associated with their use.
- What measures will be taken to either prevent or control potential exposures.
- The PI or lab supervisor must provide training on all lab specific SOPs. This training must be documented. A training and attendance sheet is available on the EH&S website.
- Refer to Appendix C for specifics on how and when to create a SOP. An example format for a SOP is posted on the EH&S website.

Risk Assessment Tool

EH&S has developed a risk assessment tool to help you determine if your laboratory procedure requires increased safety awareness or a SOP. The tool takes basic information such as the hazardous materials and chemicals you plan to utilize as well as the details of the procedure itself and then calculates a total raw score.

Depending on the raw score, you will receive a recommendation of what actions are to be taken for increased lab safety. Depending on the score, you will be directed to either:

- Perform the procedure with routine precautions.
- Perform the procedure with attention given to specific hazards. Supervision and a Standard Operating Procedure is recommended.
- Procedure may be performed with caution. High level attention must be given to all hazards. High level continuous supervision is mandatory. A Standard Operating Procedure (SOP) is required.
- Procedure must be revised to lower the risk. It cannot be performed in its current form.

The risk assessment form is available on the EH&S website. Questions on how to complete the form can be directed to EH&S.

14. Managing Hazardous Wastes

Hazardous wastes generated in UB labs, shops, studios, etc., must be properly managed. EH&S administers a comprehensive program that ensures the University follows the applicable USEPA and NYSDEC hazardous waste regulations. For a detailed description of the hazardous waste program, refer to the EH&S Hazardous Waste Management Guidebook which is located in this manual.

When managing hazardous wastes:

- Hazardous waste containers must be labeled with the contents as soon as the first drop of waste is added. Labels are available from the EH&S office. Instructions are included on the back. Failure to list the contents can lead to the material becoming an “unknown” hazardous waste. Determining the contents of an “unknown” hazardous waste is an involved and costly process and also presents unique concerns and hazards for chemical waste handlers, EH&S staff, and to the environment. Please take care to avoid creating “unknown” hazardous wastes in your laboratory.
- Wastes must be placed in a satellite accumulation area (SAA) within your lab. Regulations require you keep all hazardous wastes in the same lab in which it was generated. Transfer from lab to lab is not permitted. Refer to the Hazardous Waste Guidebook for instructions on how to set up and manage your SAA.
- Waste containers must be compatible with their contents. Keep them closed except when adding material to them.
- All hazardous wastes must be stored in a secondary containment bin.
- Incompatible wastes must be stored away from one another.
- When it is necessary to dispose of your waste, complete a hazardous waste pickup form (available on the EH&S website) and submit it to EH&S.
- EH&S provides Laboratory Safety Training which includes training on how to manage your hazardous wastes. This training is mandatory for lab workers and principal investigators.

REFER TO LABELING INSTRUCTIONS ON REVERSE SIDE

HAZARDOUS WASTE

FEDERAL AND STATE LAWS PROHIBIT IMPROPER DISPOSAL

Contents: Chemical Name (No Abbreviations or Symbols)	Volume(%)

Physical State: Solid Liquid Gas

Hazard Categories (Check all that apply):

Compressed Gas Flammable Liquid Flammable Solid Oxidizer
 Toxic/Poison Corrosive Pyrophoric Water reactive
 Irritant Other

Container Start Date: _____ DATE WHEN FULL: _____

Generator: _____
 Building: _____ Dept.: _____
 Room: _____ Phone: _____

 IF FOUND, CONTACT EH&S @ (716) 829-3301
 University at Buffalo The State University of New York

EH&S Hazardous Waste
Label

15. Chemical Spills

Spills of toxic and hazardous chemicals require prompt actions by laboratory group members in order to control chemical exposures to personnel and to minimize impacts to the environment and property. Immediate response and quick cleanup are imperative. Spills can be avoided by following these general practices and guidelines:

- Eliminate clutter, practice good housekeeping. Dispose of hazardous wastes and excess chemicals in a timely manner.
- Perform a procedure review. Refer to the SDS and familiarize yourself with the chemical you're working with.
- Store liquid in secondary containment bins and keep containers closed when not in use.
- Use plastic coated or plastic containers whenever possible.

Spill Reporting

All significant (greater than 1 liter of liquid) chemical spills must be reported to EH&S and/or UB Police. EH&S will ensure individual department heads and/or chairs are notified. Small routine spills can be handled by lab personnel provided they have been trained in the use of a spill kit and feel comfortable using one. Never attempt to clean a spill if you feel it is beyond the capability of the spill kit. EH&S offers training on the use of spill kits as part of our Laboratory Safety Training. Spill kits are available for a nominal fee through the EH&S office.

Steps to Take When a Large Spill Occurs (greater than 1 Liter)

- If a large spill occurs, remove people from the area, providing them with assistance if required. If there are any injuries, see to them and provide first aid if you are certified to do so. **Report all significant injuries to the appropriate contact shown in the box to the right.** Contact EH&S for follow-up accident investigation. If anyone has been exposed to the chemical, get him or her immediately to a nearby safety shower or eyewash station.
- As you leave the lab, close the door behind you and direct people to the nearest fire exit. Notify others from adjoining labs and offices of the spill and keep people away from the area.
- **Report the spill to one of the emergency contacts shown in the box to the right** - have someone else do it for you if necessary. Be prepared to give them your name, phone number, location, nature and amount of the spill, injuries, etc.
- Remain in area to direct first responders to the spill.
- If the area of the spill reaches outside your lab and into a public area and vapors from the spilled chemical threaten the safety of others, pull the fire alarm and evacuate the building.

Contacts for Police, Fire, Suspicious Behavior or Medical Emergencies	
For North & South and Downtown Campuses	Call: 645-2222 (UB Police)
For All Other Off Campus UB Locations	Call 911 (Buffalo Police)

Steps to Take When a Small Spill Occurs (less than 1 Liter)

- Remove people from the area providing them with assistance if required. If there are any injuries, see to them and provide first aid if you are certified to do so. **Report any injuries to UB Police immediately!** If anyone has been exposed to the chemical, get him or her immediately to a nearby safety shower or eyewash station.
- As you leave the lab, close the door behind you and direct people to the nearest fire exit. Notify others from adjoining labs and offices of the spill and keep people away from the area.
- If you feel comfortable doing so, proceed to clean up the spill using the spill kit located in your lab. The kit contains:
 - One Tyvek suit and latex booties, neoprene gloves, safety goggles
 - 10 universal spill pads
 - Two empty trash bags, cable ties and hazardous waste labels
- Once you have cleaned up the spill, place all clean up residuals (spill pads, paper towels, PPE, etc.) in the trash bag. Attach a hazardous waste label, and contact EH&S for pickup.
- Inform EH&S about the spill. Provide as much information as you can about the nature of the chemical and how much was spilled, location of the spill, etc.
- EH&S will replace the contents of your spill kit at no charge.

If your lab does not have a Spill Kit or you do not feel comfortable cleaning up a small spill, contact EH&S at 831-3301 for assistance.

Mercury Use and Spill Cleanup

Mercury is found in many areas of the campus in items and devices such as thermometers, manometers, switches, etc. Metallic mercury and mercury compounds are very hazardous; unwanted and spilled materials are regulated as hazardous wastes. Never throw any residual material such as spilled mercury or glass from a broken thermometer or other device into the trash. Metallic mercury must never be poured down the drain. This is against Federal and State environmental regulations. All mercury spills must be cleaned up immediately; most spills do not pose a high risk so long as it can be contained and it has not contaminated anyone.

Mercury can be difficult to handle because it is liquid at room temperature and volatile. It also tends to break up into very small droplets that are difficult to see and pick up. It can remain in cracks and crevices and give off toxic vapors for years until the mercury evaporates.

Mercury spills can be prevented by:

- Avoiding the use of mercury containing devices where practical. Substitute environmentally safe red liquid (alcohol) thermometers for mercury containing thermometers and use electronic devices to measure temperature and pressure. EH&S will collect unwanted mercury thermometers and devices so they may be properly disposed.

- If you must use mercury-containing devices, use basins or other types of secondary containment devices beneath all mercury containing devices to contain any spilled mercury.

Small Mercury Spill

In the case of a small mercury spill, such as the amount present in a standard thermometer, you may, in some cases, be able to clean up the spill yourself. Whether you choose to do this is dependent on how the metallic mercury disperses itself. If it remains in a few larger "blobs" or puddles, then you may proceed. However, if it disperses into many very small droplets or is spilled on to a porous surface like carpeting, do not attempt to clean it up. Contact EH&S immediately so that the proper equipment and expertise is used to completely remove all the mercury from your area.

If you have a small mercury spill AND it has not broken up into many small droplets you may proceed to clean up the spill as follows:

- Move others away from the affected area.
- Do not walk through puddles or droplets. This will only spread the mercury contamination to other areas.
- **Make certain you wear the proper PPE for this procedure.** If you have either a EH&S obtained spill kit or a specialized mercury spill cleanup kit, proceed to clean up the mercury. You may use 3 x 5 cards or scrap cardboard to "herd" the material into a larger blob or bead as necessary. This will make it easier to collect.
- Do not use an ordinary vacuum cleaner to clean up the mercury. These will only put mercury vapor into the air and increase exposure. Specialized commercial HEPA vacuums, which EH&S possesses, are the only ones to be used.
- Once collected, place everything including broken glassware, mercury, cardboard, etc. into a double zip lock bag or sealable container. Place a hazardous waste label on the bag.
- Inform EH&S about the spill. EH&S will determine if any further action is required including monitoring for mercury vapor.
- If anyone has been exposed to the mercury, notify EH&S at once. Any articles of contaminated clothing will be collected and properly disposed by EH&S.

For larger mercury spills or if you do not wish to clean up the spill:

- Move others away from the affected area.
- Do not walk through puddles or droplets. This will only spread the mercury contamination to other areas.
- Contact EH&S. We will respond with a specialized HEPA mercury vacuum to collect all the mercury. Your assistance may be required to identify areas where the spill occurred. Notify EH&S if anyone has been exposed to the mercury.

- Once the cleanup has been completed, EH&S may perform sample monitoring for the presence of mercury vapor in your area.

16. Medical Surveillance, Monitoring and Consultation

The Chemical Hygiene Officer, Principal Investigator or Laboratory Supervisor may request medical exams.

Medical surveillance is required under the following circumstances:

- Anyone using tight-fitting respirators (having a seal) or air purifying, air supplied or self-contained breathing apparatus.
- Anyone working with substances at concentration levels which exceed OSHA action limits and therefore require medical evaluation per OSHA requirements.
- Personnel showing signs or symptoms associated with a hazardous chemical to which they may have been exposed in the laboratory.
- If an event occurs in a work area such as a spill, leak, explosion, or other occurrence resulting in the likelihood of an exposure exceeding the permissible exposure limit (PEL), employees will be provided the opportunity for a medical consultation. This will determine the need for a medical examination.
- A laboratory employee exhibits symptoms of exposure or over-exposure, including headache, rash, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgment, etc.

Definitions

Action Level: A concentration which is designated in health standards for a specific substance, calculated as an 8-hour, time-weighted average, and which initiates certain required activities, such as exposure monitoring and medical surveillance.

Medical Consultation: Consultation with a licensed physician to determine what medical examinations or procedures, if any, are appropriate.

Medical Monitoring: Specific medical procedure(s) performed to detect, diagnose, or evaluate disease, disease processes, susceptibility, and determine a course of treatment.

Medical Surveillance: Early identification of conditions, if any, that could present an increased risk of adverse health effects related to the task being performed. Tasks include use of chemicals, physical agents such as noise and radiation, or animal contact.

Permissible Exposure Limit (PEL): The exposure, inhalation, or skin exposure limit specified in 29CFR Part 1910, Subparts G and Z to which most individuals can be exposed day after day, for an 8-hour day, without adverse effects to their health.

Responsibilities

UB Environment Health & Safety Services (EH&S)

- Ensure that medical surveillance is established if exposure monitoring reveals that a laboratory worker's exposure routinely exceeds the action level or PEL for an OSHA-regulated substance.
- If medical surveillance is required, EH&S will provide information and services. If necessary, EH&S will perform chemical monitoring for laboratory workers so it can be determined at what concentration levels the workers are being exposed.
- Provide guidance and information to reduce exposures to below PELs.

Deans and Chairs

- Provide support for medical surveillance/reporting program.

Principal Investigators

- Ensure that laboratory managers are taking all possible precautions to limit exposures to workers.
- Ensure that individuals who are potentially exposed to chemicals with special requirements and chemicals above the PEL are identified.
- Ensure that exposure incidents are documented and anyone requiring treatment/follow-up receives it, without incurring personal cost.
- Ensure that EH&S is contacted when assistance is needed.

Laboratory Supervisors/Managers

- Provide employees who work with or are exposed to hazardous chemicals the opportunity to receive a medical consultation, including follow-up examinations.
- Ensure that employee has information about the chemical and exposure measurements to take to the physician.
- Ensure that Workers' Compensation contact is made and report completed and filed promptly following an exposure incident. See the UB Human Resources website for more information.
- Take actions to limit future exposures and prevent exposure incidents from happening again.

Laboratory Workers

- Follow all instructions and procedures to minimize exposure to chemicals.
- Report signs and symptoms of exposure to the Laboratory Supervisor.
- Report spills, leaks, or accidents to Laboratory Supervisor as soon as possible and clean up according to your level of training and comfort.
- Seek medical attention as soon as possible following an exposure incident or suspected exposure above the PEL.

UB Human Resources

- Receive any physician's notes or medical opinions regarding time and attendance issues, requested accommodations, and workplace restrictions. Oversee the institutional response to such correspondence.

Medical Exam Criteria and Frequency

- Medical examinations shall be done with no loss of personal accruals and at no cost to the employee.
- Content will be determined by existing federal and state regulations, and supplemented by any additional criteria determined by the licensed physician performing the exam.
- In cases of exposure incidents or suspected exposures above the PEL, exposure assessments will be conducted following medical treatment. Exposure incidents can include:
 - Hazardous chemical leak/spill/cylinder release
 - Direct skin contact with a hazardous chemical
 - Symptoms including headache, rash, nausea, coughing, tearing, irritation or redness of eyes, dizziness, etc. that are felt when working with or near hazardous chemicals.
- For examinations resulting from exposures to OSHA-regulated substances, the exam frequency will be the period specified in the OSHA standard.
- For examinations resulting from potential overexposure to hazardous substances, a licensed physician will determine the examination frequency.

Exam Information and Results

The following information should be supplied to the physician:

- Identity of the hazardous chemical(s) to which employee may have been exposed and the SDS for the chemical(s).
- Conditions under which exposure occurred and any quantitative data available.
- Description of signs and symptoms of exposure, if any.

The physician should supply the following written information:

- Recommendations for a follow-up visit if necessary.
- A record of the examination, any tests conducted, and results of consultation.
- Any medical condition the employee has that places him/her at risk as a result of future exposures to hazardous chemicals.
- A statement that the employee has been informed both of the results of the consultation/examination and of any medical condition that may require further examination or treatment.
- Information regarding diagnoses unrelated to occupational exposure will not be included.

Recordkeeping

All memos, notes and reports related to a complaint of actual or possible exposure to hazardous chemicals are to be maintained as part of the record. These records will be retained for the OSHA-required duration or duration of employment plus 30 years.

Appendices

Appendix A

Definitions

ACGIH - American Conference of Governmental Industrial Hygienists an organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limits (see "TLV") for hundreds of chemical substances and physical agents.

Action Level - A concentration designated in 29 CFR § 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.

Acute - Severe, often dangerous conditions in which relatively rapid changes occur.

Acute Exposure – Acute exposure is a single, brief exposure to toxic substances. Adverse effects on the human body if applicable are evident soon after the exposure and come quickly to a crisis.

Ambient Temperature - Temperature of the immediate surroundings.

Asphyxiant - A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants, such as nitrogen, either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

Aspiration Hazard – Danger of drawing a fluid into the lungs, causing an inflammatory response to occur.

Auto Ignition Temperature - Lowest temperature at which a flammable gas or vapor-air mixture will ignite from its own heat source or other contacted heat source.

Boiling Point - Temperature at which vapor pressure of a liquid equals atmospheric pressure.

C.A.S. Number - The number assigned to chemicals or products by the Chemical Abstracts Service.

Carcinogen - A substance or agent capable of causing or producing cancer.

Catalyst - A substance that changes the speed of a chemical reaction but undergoes no permanent change itself. An example of a catalyst is the platinum used in automotive catalytic converters on the exhaust system.

Chemical Emergency - 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 work place.

Chemical Hygiene Officer - 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 CHP. This definition is not intended to place limitations on the position description or job classification that the designated individual must hold within the employer's organizational structure.

Chemical Hygiene Plan (CHP) - A written program developed and implemented by the employer. It 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) Meet the requirements of CFR 29 1910.1450.

Chronic Effect - An adverse effect on a human or animal in which symptoms develop slowly over a long period of time or recur frequently.

Combustible - A substance capable of fueling a fire. Also a term used to classify certain liquids on the basis of their flashpoints. Also see "flammable".

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

Compressed Gas -

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

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

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

Controlled Substance - Drugs and certain other chemicals, both narcotic and non-narcotic, which come under the jurisdiction of federal DEA and state laws regulating their manufacture, sale, distribution, use and disposal.

Corrosive or Corrosive Material - As defined by the Department of Transportation (DOT), a corrosive material is a liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact or in the cases of leakage from its packaging, a liquid that has a severe corrosion rate on steel.

Cryogenic liquids: Materials with extremely low boiling points (i.e. less than - 150 °F).

Common examples of cryogenic liquids are liquid nitrogen, helium, and argon. Dry ice is the common term for frozen carbon dioxide. One special property of both cryogenic liquids and dry ice is that they undergo substantial volume expansion when converted to a gas phase, which can potentially lead to an oxygen deficient atmosphere when ventilation is limited.

Designated area - 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 or a device such as a laboratory hood.

Emergency - 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 work place.

Employee - An individual employed in a laboratory work place who may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive - A chemical that causes a sudden release of pressure, gas and heat when subjected to shock, pressure, or high temperature.

Exposure Limit - Limit set to minimize occupational exposure to a hazardous substance. Recommended occupational exposure limits used are American Council of Governmental Industrial Hygienists' Threshold Limit Values (TLV's) and Occupational Safety and Health Administration Permissible Exposure Limits (PEL's).

Flammable Limits - The range of a vapor/gas concentration in air that will burn or explode if an ignition source is present.

Flammable - A chemical that falls into one of the following categories:

(i) Aerosol, An aerosol that, when tested by the method described in 18 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.

(ii) Gas, flammable:

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

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

(iii) Liquid, flammable: Any liquid having a flashpoint below 100°F (37.7°C), except any mixture having components with flashpoints of 100°F (37.7°C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

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

Flashpoint - The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100°F (37.8°C), that do not contain suspended solids and do not have a tendency to form a surface film under test or (ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))-for liquids with a viscosity equal to or greater than 45 SUS at 100°F (37.8°C), or that contain suspended solids, or that have a tendency to form a surface film under test or (iii) Setaflash Closed Tester (see American National Standard Method for Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)). Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

General Exhaust - Removal of contaminated air from a large area by an air circulation or exchange system.

Generic Substance - A substance identified by its general chemical name and/or formula.

Hazard Communication Program - The written program employers must develop and use. This program specifies employee training for routine and emergency use of all potentially hazardous chemicals in the workplace. It also specifies details pertaining to chemical labels, chemical storage, MSDS, and the complete list of all hazardous chemicals in the workplace.

Hazardous Chemical - A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems and agents which damage the lungs, skin, eyes, or mucous membranes. Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Hazardous Material - Any substance or compound that has the capability of producing adverse effects on the health and safety of humans.

Health Hazard - Any chemical for which there is at least one scientific study that shows it may cause acute or chronic health symptoms. This includes chemicals which are carcinogens, toxic or highly toxic, irritants, corrosives, sensitizers, or chemicals that effect target organs including the lungs, kidneys, nervous system, pulmonary system, reproductive system, skin and eyes.

Hepatotoxins - Substances that produce liver damage (e.g. nitrosamines, carbon tetrachloride).

Highly Toxic - A chemical that has been found through testing of laboratory animals to cause death when exposed at certain levels:

(i) A chemical is highly toxic to ingest if it has a median lethal dose (LD50) of less than 50 mg/kg. This means that 50 percent of the test animals (rats) died when given an oral dosage of 50 milligrams for each kilogram of body weight.

(ii) A chemical is highly toxic to touch if it has a (LD50) rating of less than 200 mg/kg, meaning that 50 percent of the lab animals (rabbits) die after having continuous skin contact at that dosage for 24 hours or less.

(iii) A chemical is highly toxic to breathe if it has a (LC50) rating of less than 200 PPM for gas or vapor and a 2 mg/m³ for dust, fume, or mist when exposed for an hour or less.

Ignition Source - Anything that provides heat, sparks, or flame sufficient to cause combustion/explosion.

Incompatible - Materials that could cause dangerous reactions from direct contact with one another.

Ingestion - The drawing of a substance into the body (gastrointestinal tract) through the nose, mouth, and breathing passages, in the form of a gas, vapor, fume, mist, or dust.

Inhalation - The drawing of a substance into the body (lungs) through the nose, mouth, and breathing passages, in the form of a gas, vapor, fume, mist, or dust.

Irritant - A substance that will cause an inflammatory response or reaction of the eye, skin, or respiratory system, following single or multiple exposures.

Laboratory - A facility or room where potentially hazardous chemicals, biological agents or sources of energy (i.e. lasers, high voltage, radiation, etc.) are used for scientific experimentation, research, or education.

Laboratory Scale - 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 work places whose function is to produce commercial quantities of materials.

Laboratory Supervisor - The individual in charge of the laboratory. It may be a Principal Investigator (PI), laboratory instructor, or laboratory manager.

Laboratory Startup and Closeout - Process to ensure laboratory operations adhere to Chemical Hygiene program requirements.

Laboratory-type Hood - A device located in a laboratory, enclosed 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.

LC50 - Lethal Concentration 50 the concentration in air that causes the death of 50% of the test animals. The concentration is expressed in mg/liter, mg/m³.

LD50 - Lethal Dose 50 a single dose of material which on the basis of laboratory tests is expected to kill 50% of a group of test animals. The material may be administered by mouth (oral) or applied to the skin (dermal or cutaneous). The dose is expressed in g/kg of body weight.

LEL - (Lower Explosive Limit) LEL is the lowest concentration of a gas or vapor in the air that can produce ignition or explosion.

Local Exhaust - A local exhaust system is used for capturing and exhausting contaminants from the air to a point where the contaminants (gases, particulates) are released. Not to be confused with "general exhaust".

Medical Consultation - 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.

Mechanical Exhaust - Mechanical exhaust systems use a powered device, such as a motor-driven fan or air/street venturi tube, for exhausting contaminants from a workplace, vessel, or enclosure.

Nanoparticle - A collection of tens to thousands of atoms approximately 1 to 100 nanometers in diameter, that may be naturally occurring or engineered. Examples include: carbon buckeyballs or fullerenes; carbon nanotubes; metal oxide nanoparticles (e.g., titanium dioxide); quantum dots, among many others.

Nephrotoxin - Substances causing damage to the kidneys (e.g. certain halogenated hydrocarbons).

Neurotoxin - Substances that produce their primary toxic effects on the nervous system (e.g. mercury, acrylamide, carbon disulfide).

Narcosis - Stupor or unconsciousness caused by exposure to a chemical.

Neutralize - To render chemically neutral or harmless, e.g., neither acidic nor basic, to counteract the activity or effect, the addition of a base (sodium hydroxide) to an acid (hydrochloric acid) results in water and a salt (sodium chloride), thus the acid has been "neutralized" or rendered harmless.

Non-Laboratory Personnel - Laboratory personnel such as administrative staff, plumbers, and heating, ventilation & air conditioning (HVAC) technicians entering research laboratories to perform maintenance, administrative, or other non-research laboratory tasks.

Odor Threshold - An odor threshold is the minimum concentration of an airborne, toxic substance whose odor is detectable to the average individual. Depending on whether it is above or below the substance's TLV, it may be indicative of whether additional ventilation is required.

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

OSHA - Occupational Safety and Health Administration of the U.S. Department of Labor

OSHA is a federal agency with safety and health enforcement authority for most of U.S. industry and business.

Oxidizer - Department of Transportation defines oxidizer or oxidizing material as a substance that yields oxygen readily to stimulate the combustion (oxidation) of organic matter. Chlorate (ClO₃), permanganate (MnO₄) and nitrate (NO₃) compounds are examples of oxidizers.

Particularly Hazardous Substances – These consist of “select carcinogens,” reproductive toxins and substances that have a high degree of acute toxicity (also defined as highly toxic).

PEL - Permissible Exposure Limit is an exposure limit established by OSHA's regulatory authority. PELs may be expressed as either a time weighted average (TWA) limit or a maximum concentration exposure limit.

Physical Hazard - A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, an explosive, a flammable, an organic peroxide, an oxidizer, a pyrophoric, an unstable (reactive) or a water-reactive substance.

Polymerization - A chemical reaction in which a large number of relatively simple molecules combine to form a large chainlike molecule. A hazardous polymerization is a reaction that takes place at a rate which releases large amounts of energy.

PPM - Parts per million a unit for measuring the concentration of a gas or vapor in contaminated air. Ppm is also used to indicate the concentration of a particular substance in a liquid or solid.

Protective Laboratory Practices and Equipment - 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.

Pyrophoric – A chemical that ignites spontaneously with air at 130° F or less.

Respiratory Protection - Devices for use in conditions exceeding set exposure levels when properly selected, maintained and worn by the user will protect the users' respiratory system from exposure to airborne contaminants by inhalation.

Reproductive Toxins - Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

SDS – (Safety Data Sheet) Written or printed material about a chemical that specifies its hazards, safe use and other information. It is prepared by the chemical manufacturer and is required by federal law.

Select Carcinogen - Any substance that 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 editions) 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.

Sensitizer - A substance, which on first exposure, causes little or no reaction in man or test animals, but which on subsequent exposure(s) may cause a marked response not necessarily limited to the

contact site. Skin sensitization is the most common form of the problem in the industrial setting, although respiratory sensitization to a few chemicals has been known to occur.

Solubility in Water - The percentage of a material (by weight) that will dissolve in water at a specific temperature:

NEGLIGIBLE: LESS THAN 0.1%

SLIGHT: 0.1 TO 1.0%

MODERATE: 1 TO 10%

APPRECIABLE: MORE THAN 10%

COMPLETE: SOLUBLE IN ALL PROPORTIONS

Solvents - A substance that dissolves another substance.

Special Ventilation Areas – A special ventilation area is an environmental room, isolation room, cold room, clean room, or incubator.

Specific Gravity - The specific gravity is the ratio of the weight of a volume of material to the weight of an equal volume of water usually at 60°F.

Systemic - Spread throughout the body, affecting many or all body systems or organs, not localized in one spot or area.

TLV - Threshold Limit Value (exposure limit for a specific substance as per ACGIH). TLV is a measure of exposure to inhalation only.

TLV "Skin" - This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes. Thus, the protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.

Target Organ - The specific organs or body systems that sustain hazardous effects from a toxic chemical, either long or short-term. Target organs could be the liver, kidney, central nervous system or skin.

Toxic - A substance which has a median lethal dose (LD50) of 50 to 500 mg/kg for ingestion, from 200 to 1,000 mg/kg within a 24-hour period for contact and from 200 to 2,000 PPM gas or vapor for inhalation.

UEL - Upper Explosive Limit. The highest concentration of a gas or vapor in air that can produce ignition or explosion.

Unstable (Reactive) – An unstable or reactive chemical can go through vigorous polymerization, decomposition or condensation. This process occurs when the chemical undergoes shock or changes in pressure or temperature.

Vapor Density - The ratio of the density of a substance's vapor to the density of another substance's vapor, usually air. A vapor density of greater than one means that the substance is heavier than air.

Vapor Pressure - The pressure exerted by vapor, in confinement, over its liquid as it accumulates at a constant temperature.

Water Reactive - A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Appendix B

Principal Investigator General Responsibilities Related to EH&S Checklist

This checklist is designed to assist Principal Investigators and Lab Supervisors to understand their safety responsibilities and accountability in the laboratory. This checklist should be consulted or completed on a periodic basis to ensure that a strong safety culture is maintained over time. A copy of the checklist is located on the EH&S website.

Example Checklist

Principal Investigator General Responsibilities Related to EH&S

This checklist is designed to assist Principal Investigators and Lab Supervisors to understand their safety responsibilities and accountability in the laboratory. This checklist should be consulted or completed on a periodic basis to ensure that a strong safety culture is maintained over time.

Administrative		
Yes	No	N/A
		Take responsibility for overseeing safety in your lab and enforce the rules
		Provide adequate supervision
		Enact any EHS policies that pertain to the activities in your lab
		Obtain all necessary institutional approvals for experiments when required (IBC, RSC, IACUC, etc.) ¹
		Report all emergencies/accidents/injuries/exposures/significant spills & releases
		Establish a policy for working after hours and working alone
		Inform all students, staff, visitors and collaborators of the laboratory rules
		Conduct regular self inspections to look for hazards and take corrective actions
		Provide and document all applicable training
Chemical Hygiene Plan		
Yes	No	N/A
		Know and understand the contents of the Chemical Hygiene Plan (CHP)
		Implement the CHP in your laboratory
		Develop SOPs for the experiments in your lab
		Train lab staff/students on Standard Operating Procedures (SOPs) and CHP
Personal Protective Equipment		
Yes	No	N/A
		Oversee selection of Personal Protective Equipment (PPE) and provide as necessary
		Establish and enforce a policy on when PPE must be worn in your lab
		Ensure all staff/students are trained on PPE
Hazard Communication		
Yes	No	N/A
		Provide Material Safety Data Sheets (MSDS) for all chemicals stored/used
		Maintain inventory spreadsheet of chemicals stored/used
Hazardous Materials		
Yes	No	N/A
		Ensure that the lab meets the requirements for radioactive materials and radiation producing machines
		Ensure the lab meets requirements for use of potentially hazardous biological materials and blood products
		Properly dispose of all hazardous materials and hazardous waste
		Ensure all requirements are met for hazardous materials to be shipped/transported
		Train staff/students in emergency and spill response
Safety		
Yes	No	N/A
		Ensure physical hazards are adequately controlled (equipment guarding, shielding, laser controls, etc)
		Ensure that staff/students are informed of the location of safety equipment (including eyewash stations, safety showers, fire exits, etc.)
		Maintain all safety equipment
Security		
Yes	No	N/A
		Maintain security of all classes of hazardous materials used in the lab
		Handle/store all "controlled substances" according to regulation

¹ IBC = Institutional Biosafety Committee, RSC = Radiation Safety Committee, IACUC = Institutional Animal Care and Use Committee

Appendix C

Laboratory Specific Standard Operating Procedures

A standard operating procedure (SOP) is a set of written procedures that explain how to work safely with hazardous chemicals in a potentially hazardous environment. They are required to become part of the lab's chemical hygiene plan and a copy must be placed in it.

A lab specific SOP is required:

- When a laboratory engages in an activity or procedure not covered by the chemical hygiene plan.
- Laboratory work involves the use of certain types of hazardous chemicals or physical hazards. Examples may include working with a pyrophoric or reactive chemical, changing a pyrophoric gas cylinder, working with a particularly hazardous material, etc.
- More specific language is required to safely perform a procedure.

Approval and Training:

- Once a SOP is written it must be reviewed and approved by Environment, Health & Safety.
- After approval, all lab workers using that SOP must be trained on its content and the training must be documented. A copy of the training record must be attached to the SOP when placed in the lab copy of the chemical hygiene plan.

Responsibility:

- The PI/Lab Supervisor is responsible for developing written SOPs.
- The PI/Lab Supervisor is responsible for providing training to lab personnel on the SOP.
- Laboratory personnel working autonomously or performing independent research are responsible for developing SOPs appropriate for their own work.

A laboratory SOP form along with a training and attendance record for your use are available on the EH&S website.

Appendix D

Laboratory Door Signage Program

To request a door sign for your lab, visit the EH&S website and fill out the online form. This signage complies with applicable regulations and provides a consistent look for all campus locations where hazardous materials are in use. Information on the sign can inform staff and emergency responders to the types of hazards that are in the lab and if any precautions are required. The sign also provides contact information of who to notify in case of an emergency in the room or area. A sample door sign is show below.

CAUTION

The Following Hazards May be Present

WARNINGS

Authorized Individuals Only - Keep Lab Locked While Unattended

Personnel Protective Equipment Required - Radioactive P-32 in use on benchtops

Class 3B Laser Radiation - Avoid Direct Exposure to Beam

EMERGENCY RESPONSE INFORMATION

Propane tank stored adjacent to building. High voltage shutoff located in Room 101B. chemical waste storage area under hoods. Three flammable storage cabinets located on the left side of the lab next to fume hoods.

104A 250 Winspear Service Center Rancor Research Group
Principal Investigator: Allen Rancor

EMERGENCY CONTACTS

Primary: Allen Rancor	877-1234 x2048	
Alternate: Nelson Clark	877-5555	
Alternate: Laura Carter	716-645-3333	

24 Hour Emergency Lab Contact Number: 716-882-3001

Updated 12/18/2012

If no response from the Emergency Contacts above or after normal business hours, call UB Police at 645-2222

Up to 8 cautionary signs can be displayed along with NFPA Diamond information.

Specific warnings and special instructions can be listed, as well as a description of any items for emergency responders.

Primary emergency contact information along with up to two alternates can be listed on the sign with a place for a 24-hour emergency lab contact number.

Cleaning services can be restricted, if desired.

Appendix E

Compressed Gas Cylinder Safety

Many labs use compressed gas cylinders and they are routinely used without incident. However, their use can be a hazard if not handled properly. For instance, pyrophoric gases require specialized handling such as purging lines when changing cylinders. Contact EH&S for further guidance when working with these types of gases.

Storage of Compressed Gas Cylinders:

- All cylinders including lecture bottles MUST be secured upright at all times. This should be done on the upper third of the cylinder. NYS Fire Code requires all cylinders be secured regardless of size. EH&S can provide guidance on the proper methods to secure a cylinder.
- Always make sure that the regulator and valve fittings are compatible with each other.
- The proper storage for oxygen cylinders requires that a minimum of 20 feet be maintained between flammable gas cylinders and oxygen cylinders or the storage areas be separated, at a minimum, by a fire wall five feet high with a fire rating of 0.5 hours.
- Mark empty cylinders "EMPTY" or "MT" and store them separately from full ones.

Safe Use of Compressed Gas:

- Review Safety Bulletins, SDS sheets, and become familiar with what gases are in use in the lab.
- Leave caps on until gas is ready to be used and replace them if the cylinder will be inactive for period of time.
- Open cylinder valve slowly.
- Never string gas lines across the lab and over sprinkler head pipes.
- Some regulators are only for specific gases; regulators should not be interchanged.
- Cylinders containing flammable gases such as hydrogen or acetylene must not be stored in close proximity to open flames, areas where electrical sparks are generated, or where other sources of ignition may be present.
- Use protective gloves and eye wear when handling cylinders containing cryogenic (super-cold) gases.

Transport of Cylinders

- Remove the regulator and protect the valve by attaching the cap prior to transport.
- Always use a specialized cart when transporting cylinders. They must be secured to the cart with a strap, chain or other suitable restraining material.
- Cylinders must never be dragged, rolled or pulled. Do not use a flat cart to transport; the cylinder can roll off and be damaged or cause injury.
- Only move one cylinder at a time.

Appendix F

Carcinogens and Highly Hazardous Chemicals

Chemicals are considered highly hazardous for many reasons. They may cause cancer, birth defects, induce genetic damage, cause miscarriage, or otherwise interfere with the reproductive process, or they may be a cholinesterase inhibitor, cyanide, or other highly toxic chemical that, after a comparatively small exposure, can lead to serious injury or even death. Working with compounds like these generally necessitates implementation of additional safety precautions. Below are definitions of the classes of chemicals that are considered highly hazardous.

The OSHA Laboratory Standard defines particularly hazardous substances as:

Carcinogens – A carcinogen is a substance capable of causing cancer. Carcinogens are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may become evident only after a long latency period.

A chemical is considered a carcinogen, for the purpose of this Chemical Hygiene Plan, if it is included in any of the following carcinogen lists:

- OSHA-regulated carcinogens as listed in Subpart Z of the OSHA standards. The current list of substances that OSHA regulates as carcinogens or potential carcinogens follows:
 - asbestos
 - 4-Nitrobiphenyl
 - alpha-Naphthylamine
 - Methyl chloromethyl ether
 - 3,3'-Dichlorobenzidine (and its salts)
 - bis-Chloromethyl ether
 - beta-Naphthylamine
 - Benzidine
 - 4-Aminodiphenyl
 - Ethyleneimine
 - beta-Propiolactone
 - 2-Acetylaminofluorene
 - 4-Dimethylaminoazobenzene
 - N-Nitrosodimethylamine
 - Vinyl chloride
 - Inorganic arsenic
 - Cadmium
 - Benzene
 - Coke oven emissions
 - 1,2-dibromo-3-chloropropane
 - Acrylonitrile
 - Ethylene oxide
 - Formaldehyde
 - Methylenedianiline
 - 1,3-Butadiene
 - Methylene chloride
- Under the category "known to be carcinogens" in the latest edition of the *Annual Report of Carcinogens* published by the National Toxicology Program (**NTP**).
- Group 1 ("carcinogenic to humans") of the International Agency for Research on Cancer (**IARC**), latest edition. Chemicals listed in Group 2A or 2B ("reasonably anticipated to be carcinogens") that cause significant tumor incidence in experimental animals under

specified conditions are also considered carcinogens under the OSHA Laboratory Standard.

Reproductive Toxins – Reproductive toxins are substances that have adverse effects on various aspects of reproduction, including fertility, gestation, lactation, and general reproductive performance. When a pregnant woman is exposed to a chemical, the fetus may be exposed as well because the placenta is an extremely poor barrier to chemicals. Reproductive toxins can affect both men and women. Male reproductive toxins can in some cases lead to sterility.

Substances with a High Acute Toxicity – High acute toxicity includes any chemical that falls within any of the following OSHA-defined categories:

- A chemical with a median lethal dose (LD₅₀) of 50 mg or less per kg of body weight when administered orally to certain test populations.
- A chemical with an LD₅₀ of 200 mg less per kg of body weight when administered by continuous contact for 24 hours to certain test populations.
- A chemical with a median lethal concentration (LC₅₀) in air of 200 parts per million (ppm) by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered to certain test populations by continuous inhalation for one hour, provided such concentration and/or condition are likely to be encountered by humans when the chemical is used in any reasonably foreseeable manner.

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. 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.

Appendix G

Select Agents and Toxins List

A select list of biological agents and toxins have been determined to have the potential to pose a severe threat to both human and animal health, to plant health, or to animal and plant products. Certain attenuated strains of select agents or an inactive form of a select toxin may be excluded from the requirements of the Select Agent Regulations. The complete list of excluded agents and toxins can be found at the National Select Agent Registry website.

Information specific to the use of select agents and toxins here at the University at Buffalo can be found on the UB EH&S website.

Questions on the use of select agents and toxins should be directed to the UB EH&S Biosafety Officer at 829-3301.

Appendix H

Management of Peroxide Forming Chemicals

Many laboratories on campus possess chemicals/solvents that are susceptible to peroxide formation. Auto-oxidation may occur under normal storage conditions as these materials typically react with air, moisture, or impurities to produce potentially dangerous peroxide by-products. Peroxides are highly reactive and can explode upon shock, friction, or spark. Since the peroxides are less volatile than the solvent itself, they tend to concentrate. It's important to note that distillation and evaporation increases the danger of peroxide formation.

Considerations when storing and using peroxide forming chemicals:

- Label containers with date received, date first opened and recommended disposal date (based on which group the peroxide is in).
- Keep containers tightly closed.
- Keep opaque containers stored in areas away from light sources.
- Purchase the right size container. This ensures the entire use of the contents within a short period of time.
- Inventory all chemicals in storage at least once a year to eliminate the forgotten items and leaking containers.
- Refrigeration does not retard peroxide formation.
- If possible, purchase only chemicals that contain an additive that retards the formation of peroxides. Generally, the label will note their presence.
- Know the properties and dangers of the chemical you are working with. Read and review the SDS.

Detection of Peroxides

The easiest method to detect peroxide is to use peroxide test strips. These strips are relatively inexpensive and are available through most scientific materials suppliers such as VWR or Fisher Scientific. These strips will change color to indicate the presence of peroxides. When using these test strips, follow the manufacturer instructions.

If there is any question or suspicion that peroxides >100 ppm are present in a container, DO NOT OPEN, USE, OR OTHERWISE DISTURB MATERIAL. Solid crystals may form on the outside of containers especially around the caps. If you see this, place a sheet of paper at or near the container marked "Do Not Use" and contact EH&S as soon as possible. Extreme care must be exercised when handling; EH&S will ensure the material is safely and properly disposed of. Although literature differs on what constitutes a safe level of peroxides, **if you detect greater than 100 ppm peroxides, stop using the materials and contact EH&S for disposal.** If you suspect peroxides may be present but do not possess peroxide test strips, contact EH&S and we will perform the test for you.

Peroxide Action Levels:

<25 ppm	Considered Safe for use
>25 ppm <100 ppm	Safe for use; however, do not distill or concentrate
>100 ppm	Do not use; contact EH&S for disposal

Although the chemical is generally safe to use if the peroxide levels are <100 ppm, EH&S recommends you consider arranging for disposal once peroxides are detected at any level. This will ensure the chemical will not be "forgotten" and pose a more serious safety threat in the future.

If you do not suspect peroxides but the chemical is listed in one of the groups noted below or otherwise known to be a peroxide forming chemical, it should be tested prior to use to ensure no peroxides have formed. Some bottles will have an expiration date, it is important to either dispose of the material once this date is exceeded or test for peroxides before each use.

Common Peroxides Forming Chemicals and Retention Time

Peroxide forming chemicals are categorized into groups depending on peroxide formation susceptibility. *Note: The following lists are not all inclusive!*

Group A: Chemicals that Form Explosive Levels of Peroxides without Concentration

These present a severe peroxide hazard after prolonged storage, especially after exposure to air. Test for peroxide formation before using or discard after 3 months:

- Divinyl acetylene
- Divinyl ether
- Isopropyl ether
- Potassium metal
- Sodium amide
- Vinylidene chloride

Group B: Chemicals that Form Peroxide Hazards on Concentration

Test for peroxide formation before distillation or evaporation. Also test for peroxide or discard after one year:

- Acetyl
- Acetaldehyde
- Benzyl alcohol
- 2-Butanol
- Chlorofluoroethylene
- Cumene (isopropylbenzene)
- Decahydronaphthalene (decalin)
- Diacetylene (butadiyne)
- Dicyclopentadiene
- Diglyme
- Diethyl ether (ethyl ether)
- Ethylene glycol ether acetates
- Furan
- 4-Heptanol
- 2-Hexanol
- Methyl Acetylene
- 4-methyl-2-pentanol
- 3-methyl-1-butanol
- Methyl-isobutyl-ketone
- 2-Pentanol
- 4-penten-1-01
- 1-Phenylethanol
- Tetrahydrofuran
- Tetrahydronaphthalene
- Vinyl ethers
- Sec. alcohols

Group C: Chemicals that are Hazardous Due to Peroxide Initiation of Polymerization

Discard after one year:

- Acrylic acid
- Acrylonitrile
- Butadiene
- Chlorprene
- Chlorotrifluoroethylene
- Methyl methacrylate
- Styrene
- Tetrafluoroethylene
- Vinyl acetylene
- Vinyl acetate
- Vinyl chloride
- Vinyl pyridine

Labeling Peroxide Forming Bottles/Containers

Upon receipt, label the container with the date received, date first opened, and recommended disposal date. A label example is noted below and can be obtained through EH&S. If it is necessary to perform a peroxide test, note the results in the appropriate space.

<p>Caution: Peroxide Forming Chemical</p> <p>Date Received: ____/____/____</p> <p>Date Opened: ____/____/____</p> <p>Date Expires: ____/____/____</p> <p>Limited shelf life. Store tightly closed and away from light and heat.</p> <p>Contact EH&S at 829-3301 for more information</p> <p>Test Date: ____ Peroxide: ____ Tester: ____</p> <p>Test Date: ____ Peroxide: ____ Tester: ____</p> <p>Test Date: ____ Peroxide: ____ Tester: ____</p>
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Appendix I

Chemical Compatibility Chart

Certain chemicals should not be stored in proximity to one another as reactions caused by incompatibility may occur. The following list provides guidance on how to properly store certain chemical groups. This list should not to be considered complete and should be used as a reference only. Always refer to the SDS for information specific to an individual chemical. **If you have a question concerning the proper way to safely store a specific chemical in your area, contact EH&S at 829-3301.**

Chemical Group	Incompatible With:
Flammable solvents (xylene, toluene, benzene, ethyl benzene, etc)	Caustics, acids (with the exception of acetic acid which should be stored along with flammables), oxidizers
Inorganic acids, non-oxidizing (sulfuric, hydrochloric, phosphoric acids, etc.)	Caustics, flammables, cyanides, sulfides, most halogenated and non-halogenated organics, reducing compounds, peroxides
Inorganic acids, oxidizing (nitric, chromic acids, etc.)	Organic acids, flammables, caustics, cyanides, sulfides, most halogenated and non-halogenated organics, reducing compounds, peroxides
Organic acids (formic acid, etc.)	Inorganic acids (oxidizing), flammables, cyanides, sulfides, caustics, most non-halogenated and halogenated organics
Oxidizers (sodium nitrate, potassium nitrate, etc.)	Organics, inorganic acids, organic acids, reducers
Caustics (Sodium Hydroxide, potassium hydroxide)	Inorganic and organic acids, flammables
Water reactives (sodium metal, lithium, etc)	Water reactives should be stored separately from all other chemicals
Cyanide and sulfide compounds	Inorganic and organic acids
Ammonia	Bleach, acids, organics
Halogenated solvents (chloroform, carbon tetrachloride, trichloroethylene, etc.)	Acids, caustics, oxidizers

Appendix J

Acute Toxicity Hazard Designations

Substances with a high degree of acute toxicity are those that can cause death, disability, or serious injury after a single, relatively low-level exposure. The following table denotes the OSHA-defined toxicity designations, for various routes of exposures. The criteria for "highly toxic" appears in bold letters.

<u><i>Acute Toxicity Hazard Designations</i></u> OSHA Hazard Designation	Other Toxicity Rating ¹	Oral LD ₅₀ (rats, mg/kg)	Skin Contact LD ₅₀ ² (rabbits, mg/kg)	Inhalation LC ₅₀ ³ (rats, ppm for 1 hr)	Inhalation LC ₅₀ ³ (rats, mg/m ³ for 1 hr)
Highly toxic	Highly toxic	<50	<200	< 200	<2000
Toxic	Moderately toxic	50 to 500	200 to 1000	200 to 2000	2000 to 20,000
	Slightly Toxic	500-5000	1000-5000	2000-20,000	20,000-200,000

[1] Prudent Practices in the Laboratory: Handling and Disposal of Chemicals; National Academy Press, Washington, D.C., 1995

[2] LD₅₀- The amount of a chemical that when ingested, injected, or applied to the skin of a test animal under controlled laboratory conditions will kill one-half (50%) of the animals.

[3] LC₅₀- The concentration of the chemical in air that will kill 50% of the test animals exposed to it.

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