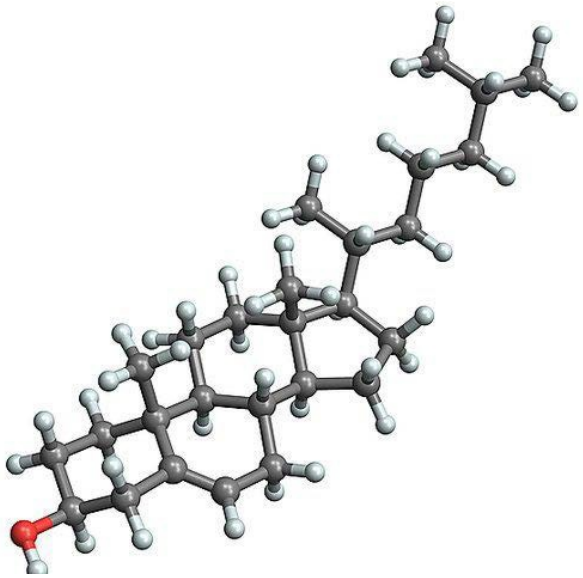
UIC UNIVERSITY OF ILLINOIS AT CHICAGO ENVIRONMENTAL HEALTH AND SAFETY OFFICE

Laboratory Safety Plan



Principal Investigator Name:_____

Chemical Hygiene Officer (CHO): _____

Laboratory Building & Room Number:_____

2012

Emergency Phone Numbers (area code 312, unless specified)		
Health and Safety Section	Normal Business Hours	996-7411
	24 Hours/Day	996-7233 (6-SAFE)
Radiation Safety Section	Normal Business Hours	996-7429
	After Business Hours	996-7233 (6-SAFE)
Emergency- Police / Fire	24 Hours/Day	355-5555
UICMC (Hospital) Emergency Service	24 Hours/Day	996-7297
UIC Health Service	Normal Business Hours	996-7420
MSDS Backup Service, ChemTel Inc.	24 Hours/Day	1-800-255-3924
Illinois Poison Center	24 Hours/Day	1-800-942-5969 1-800-222-1222
Eye and Ear Infirmary	Normal Business Hours	996-6562
Facilities Emergency Services	24 Hours/Day	996-7511
Your Department Office Telephone	FILL IN →	
Your Building Number	FILL IN →	

Richard D. Anderson, Interim Director, Environmental Health & Safety	413-2140
Heather Jackson, Assistant Director, Chemical Safety	413-9706
Leo Njongmeta, PhD Senior Biological Safety Specialist, RO	413-5986
Allan Jackimek, Health Physicist, Radiation Safety Officer (RSO)	996-8776
Dennis Terpin, Industrial Hygienist	413-3706
Kevin Cisner, Laboratory Compliance Coordinator/TSCA Coordinator	413-3387
Jerome Sides, Lab Safety Advisor/ Asbestos Coordinator	413-3704
David Wilson, Laser Safety / Fire Safety	413-3706
Scott Dubick, Laser Safety Officer (LSO) / Lab Safety Advisor	996-1638
Tom Johnson, Hazardous Waste Compliance Manager	413-2436
Becky Oberjat, Industrial Hygienist	413-3707
Lisa Sanzenbacher, Lab Sustainability Analyst	413-3702

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Chapter 1: LABORATORY STANDARD COMPLIANCE

Introduction:

Occupational Safety and Health Administration (OSHA) finalized a safety and health standard entitled "Occupational Exposure to Hazardous Chemicals in Laboratories". It was written into Title 29 of the Code of Federal Regulations Part 1910.1450. The basis for this Standard was that chemical use in research laboratories differs from industry in quantity and hazard potential. The Standard became effective in May 1990 and a compliance date of January 31, 1991 was set. The Illinois Department of Labor (IDOL) administers this standard in State of Illinois facilities. The standard is available in **Appendix C** of this document and at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106,

Purpose of the Plan:

This manual serves as the Laboratory Safety Plan (LSP) for the University of Illinois at Chicago. The (LSP) is designed to be an intuitive flowing document to help any employee who works in a laboratory to recognize what federal, state, and local laws apply to their work, and to be able to recognize the hazards associated with the laboratory environment. After reading this plan any person should be able to identify, recognize, prevent, respond, and report any exposure to hazardous chemicals in a laboratory. The following are objectives of the Laboratory Safety Plan:

- To ensure that the health and physical hazards of chemicals used in UIC laboratories are evaluated, addressed, and conveyed to employees
- To provide guidance for preventing exposure to hazardous chemicals through safe work practices.
- To ensure UIC complies with OSHA's requirements for air concentration limits. (OSHA currently regulates exposure to approximately 400 substances.)
- To serve as documentation of UIC's laboratory Right To Know Program and Chemical Hygiene Plan, as required by OSHA.

Federal, State, and Local Regulatory Agencies

Occupational Safety and Health Administration (OSHA)

This Laboratory Safety Plan (LSP) is intended to safely limit laboratory workers' exposure to OSHA regulated substances. Laboratory workers must not be exposed to substances in excess of the permissible exposure limits (PEL) specified in OSHA rule 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances. PELs for regulated substances are provided in Appendix D. PELs refer to airborne concentrations of substances and are averaged over an eight-hour day. A few substances also have "action levels". Action levels are air concentrations below the PEL which nevertheless require that certain actions such as medical surveillance and workplace monitoring take place. An employee's workplace exposure to any regulated substance must be monitored if there is reason to believe that the exposure will exceed an action level or a PEL. If exposures to any regulated substance routinely exceed an action level or permissible exposure level there must also be employee medical exposure surveillance.

Illinois Department of Labor (IDOL)

The Illinois Department of Labor requires employers to evaluate their workplaces for the presence of hazardous substances, harmful physical agents, and infectious agents and to provide training to employees concerning those substances or agents to which employees may be exposed. Written

information on agents must be readily accessible to employees or their representatives. Employees have a conditional right to refuse to work if assigned to work in an unsafe or unhealthy manner with a hazardous substance, harmful physical agent or infectious agent.

Drug Enforcement Administration (DEA)
Any researcher who would like to work with Controlled Substances must be registered with the Drug Enforcement Administration (DEA). If you would like to work with controlled substances at UIC you must contact the Safety Office at 3-3387 or 6-9706 for more information. For a number of reasons pertaining to Federal and State law, there are many different research protocols that require different registration and license types. In addition, one registration type may not cover two different research projects, such as research with controlled substances and dispensing of controlled substances. The required forms and detailed instructions are available on the DEA website: http://www.deadiversion.usdoj.gov/drugreg/reg_apps/index.html

Toxic Substances Control Act (TSCA)
The Toxic Substances Control Act (TSCA) requires that prudent laboratory practices be developed and documented for research involving new chemicals that have not had their health and environmental hazards fully characterized. Laboratories engaged in research must consider the applicability of the Toxic Substances Control Act (TSCA) on their operation. TSCA, administered by the U.S. Environmental Protection Agency (EPA) under the New Chemicals Program [http://www.epa.gov/oppt/newchems/], is intended to ensure that the human health and environmental effects of chemical substances are identified and adequately addressed prior to commercial use or transport of those substances. A new chemical is defined by the EPA as a chemical substance that is produced or imported and not yet listed on the TSCA Chemical Substance Inventory. Each laboratory or research group that synthesizes new chemicals or imports chemicals from another country should contact EHSO for further guidance.

Department of Transportation (DOT) and International Air Transport Association (IATA)
Hazardous materials packages are regulated through all stages of transport; from the time the package is taken from the shipper to the delivery of the package to the recipient. For all domestic ground transport, the U.S. Department of Transportation (DOT) creates and enforces the regulations one must follow when shipping a hazardous material package. Anyone who may ship or accept a package of hazardous materials is required to take the *Introduction to Shipping and Receiving* course located online at www.uictraining.org.

Packages that ship internationally or domestically by aircraft are the most regulated. Air shipments that contain Dry Ice or infectious substances, for example, require more detailed training. Any who ships packages like these needs International Air Transport Association (IATA) training. Those that believe they need IATA training should contact either the Senior Biological Safety Specialist or the Hazardous Waste Compliance Manager (see p. 2 for the EHSO directory). This training is given in a classroom setting.

Chemical Facility Anti-Terrorism Standards
In 2007, the Department of Homeland Security (DHS) issued a list of "Chemicals of Interest." These are chemicals which pose a risk to homeland security. Any facility which has one of these "Chemicals of Interest" above the specified thresholds determined by the Department of Homeland Security must complete a "Top Screen" which allows DHS to assess the chemical security threat the facility poses. Some of the "Chemicals of Interest" are commonly used in laboratories and have very low thresholds.

UIC is responsible for monitoring the quantities of these "Chemicals of Interest" we have on campus. If UIC exceeds the thresholds for any "Chemical of Interest", it must submit a completed "Top Screen" to the Department of Homeland Security. UIC would then be told be DHS what additional security requirements we must implement. **It is vital laboratories maintain an accurate chemical inventory** so EHSO can monitor the quantities of "Chemicals of Interest" on campus. Please see appendix I for the list of regulated chemicals.

UIC Chemicals of Concern
Because there are so many regulations that affect chemicals in your laboratory, UIC created a list entitled "UIC Chemicals of Concern." This table found in **Appendix B** lists all chemicals likely to be found in laboratories that meet the following criteria:

- Extremely Hazardous Substances
- Pose a threat to Homeland Security
- Shock Sensitive
- Pyrophoric
- Class A Peroxides
- Class B Peroxides
- OSHA Carcinogens
- Toxic Substances Regulated by OSHA
- Toxic Gases

This list is very useful because it shows some chemicals may fall into two or more of these categories. A chemical that falls into two or more of these high hazard categories requires the highest level of attention.

Emergency Planning and Community Right-to-Know Act (EPCRA)
The Emergency Planning and Community Right-to-Know Act of 1986 is a U.S federal law concerned with emergency response preparedness. Its purpose is to encourage emergency planning efforts and to provide the public and local governments with information concerning potential chemical hazards present in their communities. EPCRA established a list of Extremely Hazardous Substances (EHS). EHS are chemicals considered extremely hazardous due to their acute toxicity.

For each EHS, there is a number called a threshold planning quantity (TPQ). If a facility has within its boundaries an amount of an extremely hazardous substance equal to or in excess of its threshold planning quantity, the facility is subject to the EPCRA emergency planning requirements and must notify both the State Emergency Response Committee, the Local Emergency Planning Committees (LEPCs), and the local fire department of the presence of the substance, quantity, and location. **It is critical researchers keep an accurate chemical inventory** so UIC can notify all the appropriate agencies of the presence of extremely hazardous substances at the facility.

Resource Conservations and Recovery Act (RCRA)
Hazardous waste regulations in the U.S. began with the Resource Conservation and Recovery Act (RCRA) which was enacted in 1976. RCRA created a "cradle to grave" system of management for hazardous wastes. This means UIC is responsible for any hazardous waste generated even after it leaves the campus for disposal. Hazardous wastes must be tracked from the time they are generated until their final disposition. UIC is a "Large Quantity Generator" of hazardous waste and is subject to the most

stringent regulation. There are several RCRA requirements that pertain to the management of hazardous waste in the laboratory discussed in detail in Chapter 8.

Responsibilities:

The following individuals have responsibility for implementing the Laboratory Safety Plan:

Deans, Directors and Department Heads:

Have the primary responsibility for ensuring that this document is followed by all of their employees who have access to laboratories, work in laboratories, or assign people to work in laboratories. Their responsibilities are as follows:

- Actively supporting this Plan to ensure the health and safety of the UIC employees and students
- Collaborating with faculty and staff to implement the LSP
- Budgeting for health and safety needs
- Actively supporting compliance with EHSO safety audit findings, recommendations and regulatory agency requirements
- Ensuring all employees complete UIC's orientation to laboratory safety training before beginning any work inside a laboratory
- Ensuring all employees complete UIC's online laboratory and hazardous waste safety training every year

Environmental Health and Safety Office (EHSO)

EHSO provides UIC with environmental compliance, laboratory safety, fire safety, health and safety, radiation safety and hazardous waste disposal programs and services.

EHSO responsibilities:

- Revising and distributing the master UIC LSP and related policies and procedures
- Providing expertise and resources on environmental health and safety issues
- Providing current information on regulatory requirements applicable to UIC
- Providing waste management services for the entire University
- Conducting routine industrial hygiene exposure assessments and laboratory safety audits
- Testing and inspecting chemical fume hoods and coordinating ventilation system maintenance
- Evaluating complaints of odors and possible chemical overexposures
- Providing seminars, web-based training, and training resources such as a lesson plan
- Providing support services during incidents and other emergencies in laboratories
- Reviewing new construction and renovation projects for health and safety concerns

Principal Investigators (PIs) and Laboratory Directors

Academic and professional staffs, which are assigned laboratory spaces, shall be referred to as Principal Investigators (PIs) throughout this LSP.

PI and Lab Director Responsibilities:

- Ensuring that a safe and healthy laboratory environment is maintained by implementing the Laboratory Safety Plan
- Routinely surveying the laboratory for potential health and safety hazards

- Enforcing the use of appropriate personal protective equipment
- Ensuring funding for safety equipment (chemical storage cabinets, shielding, spill kits, emergency shower/eyewash) and its maintenance in grant proposals
- Ensuring that all personnel are trained in safe operating procedures and chemical safety through safety lectures, workshops and web-based training. Maintain training records for all laboratory employees. EHSO sponsored training announcements are posted at the EHSO website www.uic.edu/depts/envh .
- Seeking EHSO advice on environmental health and safety issues (6-7411)
- Seeking advice on occupational illness from the UIC Employee Health Service (6-7420)
- Including safety and environmental performance as a significant factor in employee performance reviews and/or graduate degree fulfillment
- Conducting incident investigations in accordance with UIC Policies and Procedures
- Follow all UIC guidance document on proper chemical waste disposal

To ensure the safety of visitors in lab areas, the PI and CHO are responsible for:

- Scheduling work when a responsible laboratory employee is present
- Providing briefings on the operations in the area
- Providing training on protective equipment to be used in the area
- Ensuring equipment and affected areas have been decontaminated
- Training and educating personnel on laboratory safety

Chemical Hygiene Officer

The Chemical Hygiene Officer **(CHO)** is an individual designated by the Principal Investigator (PI) or Laboratory Director, qualified by training and experience to provide technical guidance in the implementation of this Plan at a specific UIC laboratory location. If the (PI) does not designate a (CHO) the PI will assume the responsibilities of the CHO for his or her laboratories. CHO training is provided by the Environmental Health and Safety Office (EHSO). See www.uic.edu/depts/envh for dates of live sessions and links to online training.

CHO responsibilities:

- Reviewing new chemical purchases to ensure appropriate engineering and administrative controls are implemented and personal protective equipment is available and worn
- Assuring technical information is available on appropriate storage, handling, and disposal of potentially hazardous chemicals
- Arranging for prompt repairs of control devices such as safety showers and other emergency equipment, chemical fume hoods, and Biosafety cabinets
- Reviewing requests for new equipment and the installation.
- Performing chemical hygiene and housekeeping inspections at least two times/year, using the CHO Laboratory Self-Audit Checklist (www.uic.edu/depts/envh/HSS/Documents/CHOChecklist.pdf)
- Ensuring an accurate chemical inventory is conducted annually.
- Ensuring that a possible chemical exposure is referred for medical consultation with the UIC Health Services (6-7420), UIC Emergency Department, or personal healthcare provider
- Assessing chemical inventory and new chemical purchases for carcinogens and particularly hazardous substances and ensuring appropriate work practices are in place
- Ensuring the safety of other laboratory personnel by educating and training the staff

Laboratory Employees
All people who work inside a laboratory regardless of title as graduate and undergraduate students, researchers and/or staff are consider laboratory employees. When assistance is required to evaluate issues of chemical hygiene, they are to consult with the CHO or PI and EHSO.
Responsibilities include:

- Completing safety training (www.uictraining.org) before working in the laboratory and at least annually thereafter.
- Planning and conducting laboratory activities in compliance with this Plan.
- Performing work with volatile, corrosive, or toxic chemicals in a chemical fume hood and not on the bench
- Wearing appropriate personal protective equipment, i.e. gloves, eye protection and protective clothing.
- Obtaining information and training when unfamiliar with the hazards of a chemical or procedure before proceeding.
- Consulting with the PI or CHO before altering an experiment or substituting a chemical.
- Refraining from operating equipment or instrumentation without proper instruction and authorization.
- Reporting potentially unsafe practices or conditions promptly to the lab supervisor, CHO or EHSO.
- Reporting incidents and near misses.
- Recognizing emergency conditions and understanding the appropriate actions to take.

Facilities Management and Outside Contractors
Non-laboratory personnel such as Facilities Management employees and outside contractors shall be referred to as non-lab personnel in this LSP.
Responsibilities include:

- Non-lab personnel should try to minimize their presence in the lab areas.
- Non-lab personnel shall refrain from handling chemical containers and laboratory equipment without prior approval from responsible laboratory personnel.

Chapter 2: Training Requirements

Training

Laboratory safety training is required by federal law for all laboratory employees before they work inside a laboratory. All laboratory employees must complete one live general lab safety course offered in the Fall and Spring semester and complete the web-based laboratory safety training thereafter for their annual refresher training.

It is extremely important that laboratory personnel familiarize themselves with OSHA's laboratory standard, EPA's RCRA, EPCRA, and TSCA regulations, the Department of Homeland Security's Chemical Facility Anti-Terrorism Standards, along with pertinent state and local fire codes. All of these topics are covered in the UIC web-based training courses and EHSO's General Laboratory Safety Training Course, formally known as the Chemical Hygiene Officer Training Seminar. In addition, EHSO will provide special safety lectures to all researchers on campus as requested. All inquiries should be emailed to kcisne1@uic.edu

General Laboratory Safety Live Training

- ***General Laboratory Safety:*** *Offered quarterly for new researchers on campus: New means within the last six months or lacks any safety training to date. Check EHSO website* www.uic.edu/depts/envh *for current times.*

- ***Advanced Chemical Hygiene Officer Training*****:** *Offered once a year for all designated Chemical Hygiene Officers for laboratory groups on campus. Requires attendance at the general laboratory safety training, as well as two years' experience in UIC research laboratories.*

Web-based safety training is available through the UIC EHSO website http://www.uic.edu/depts/envh/Training/CHOTrainLk.html . Contact health-safety@uic.edu for any questions related to these safety training courses.

- ***Initial Training*****:** Before beginning any work in a laboratory, new employees must complete the course "Orientation to Laboratory Safety" and the "Hazardous Waste" course.
- ***Annual Refresher*****:** Complete both Laboratory Safety and Hazardous Waste Training Courses.

Laboratory Specific Training must be provided by the PI or other personnel familiar with the potentially hazardous materials, their operations and their safe use.

- Initial training: New employees must be fully informed of potential chemical, electrical and equipment hazards in the lab spaces.
- Subsequent training: The lab group must be informed when the hazard changes or a new hazard is introduced into the work area.
- CHO training: Chemical Hygiene Officers must attend a live session their first year of assignment and every two years after the initial training.
- Regular safety meetings conducted by the PI should be conducted to review the information presented in this training.

- Hydrofluoric Acid Training is available online under “Chemical Safety Training: Hydrofluoric Acid.

Documentation

Training documentation must be saved and readily accessible by the laboratory supervisor. It can be saved electronically or with a hard copy. It is a good practice to have two copies; one digital and one physical. A certificate is issued when a passing test score is achieved in the web based training. Also, EHSO provides training certificates for live sessions.

Chapter 3: General Guidelines for Room Signage

Hazard Signage and Entrances

Posting hazard signs is an important first step all researchers must complete when starting up laboratory work. All entrances ways into laboratories at UIC must post two signs at each door. The first sign is a laboratory identification sign and the second is hazard placard identifying chemical, biological and radioactive hazards. In addition, all laboratories must be closed at the entrance way when conducting laboratory work.

Entrance Ways

Signage at doorways to laboratory spaces must be posted and updated each year or when information changes.

Electronic Lab ID Data Card:

- UIC has a two step process for filling out laboratory cards. The first step starts with the Departmental Gatekeeper, who is an employee designated by the Department Head to enter all wet and dry laboratory space to a particular PI; usually the person who conducts research in the space.
- The next step issues an automated email message to the PI that states his/her name has been entered into a Facilities Information Management (FIM) database. There the PI can enter the relevant information for their laboratories.
- An example link is shown below where the person will enter lab ID card information electronically and print locally by using the link. Before clicking on the link notice the "netid" portion of the Hyperlink, this needs to be replaced with the PI's netid; https://fimweb.fim.uic.edu/EHSO/labdetail.asp?netid=email-id
- For example, if your email is safe@uic.edu, insert this netid into the above link as shown below) https://fimweb.fim.uic.edu/EHSO/labdetail.asp?netid=safe@uic.edu
- It is critical that Lab ID Data cards be kept up to date, they must be updated annually.

Hazard Signs:

- Are provided by EHSO to all laboratories as well as the acrylic holders.
- The blank space is reserved for special hazards such as carcinogens, biological hazards, radioactive hazards, poison inhalation hazards, explosives, pyrophorics, etc.
- Hazard symbol cards (8"X10") are affixed below the Laboratory ID Data cards; you need to review the chemicals in your laboratory to see which of the hazard classes on the card apply to your laboratory.
- When working with extremely toxic, carcinogenic or mutagenic compounds, additional signage must list the compound, its hazards and state "Restricted Access". This is to prevent any unauthorized user from working with the compound.

Chapter 4: General Guidelines for Labels

Labels

Posting labels is one of the easiest and most important steps a researcher can make to ensure a safe laboratory setting. Although understanding what types of labels and symbols to post on chemical containers, cabinets, and refrigerators is not always understood correctly, hopefully this chapter will present a useful guide. One of the most critical steps before ordering or placing signs is identifying the locations where signs need to be placed.

- Labels are needed on all chemical containers, chemical storage areas (cabinets, refrigerators), and chemical waste areas.

Labels required on laboratory furnishings containing chemicals.

They are many different types of refrigerators designed for storing chemicals. They vary by manufacturers, purpose of Chemicals (explosive, corrosive, flammable, etc.), warranty, size, and types of temperatures. Some refrigerators such as explosion proof and flammable material refrigerators have been meticulously designed to ensure the user's safety when storing these types of materials. This is why it is important to only store explosive chemicals inside an explosion proof refrigerator and to only store flammable materials in an approved flammable storage refrigerator.

Cabinets and refrigerators containing biohazards, cancer-suspect agents, corrosives, oxidizers, poisons, toxic gases, and water-reactive compounds must have the appropriate hazard label posted. A general description of contents in refrigerators and freezers, including nonhazardous materials should be posted on the outside of the refrigerator. Store only flammable chemicals inside an approved flammable materials refrigerator at all times. UIC only allows the stored of explosive chemicals inside an approved explosive refrigerator, after a written permit request has been reviewed by EHSO. Approval to work with explosive materials is needed by the safety office before work begins. Please contact the safety office at 3-3387 for assistance with handling explosive materials.

Labels on chemical containers

Stock bottles must bear original labels with date received and date opened. If a label is missing, obscured, or illegible, generate a new label with chemical name in English, concentration, and a pictorial symbol using the globally harmonized symbols available at EHSO website www.uic.edu/depts/envh . Unlabeled bottles can lead to accidents and eventually end up costing hundreds to thousands of dollars to test and properly dispose.
Reagent bottles must bear content, concentration, hazard class and date prepared.
Sample bottles and flasks must list content, concentration, and hazard class.
Label peroxide formers with date received and date tested for peroxides.

Globally Harmonized System (GHS) for Classification and Labeling of Chemicals

The Globally Harmonized System (GHS) of Classification and Labeling of Chemicals is a worldwide initiative to promote standard criteria for classifying chemicals according to their health, physical and environmental hazards. It uses pictograms, hazard statements, and the signal words "Danger" and

"Warning" to communicate hazard information on product labels and safety data sheets in a logical and comprehensive way. The primary goal of GHS is better protection of human health and the environment by providing chemical users and handlers with enhanced and consistent information on chemical hazards.
Specifically, these hazards include:

- Physical hazards, such as flammability
- Health hazards: Acute toxicity/lethality (based on LD50 or LC50 values for dermal, oral, and inhalation routes of exposure, LD50 stands for the dose required to kill half the members of a tested population, LC50 is the lethal dose from exposure to kill half the population)
- Skin sensitization, skin corrosion/irritation, serious (permanent) eye damage/irritation
- Acute aquatic toxicity

Oxidizer **Explosive** **Corrosive** **Acute Toxic** **Irritant** **Flammable**

For more information on Hazard classification please contact EHSO at 1-312-413-3387

Labels for Lasers

A quick guide on labels for lasers starts with a few laser classifications:

- Class 3b Lasers should have a label stating "Laser radiation –avoid exposure to beam and Class 3b Laser."
- Class 4 lasers should have a label stating, "Laser radiation- avoid eye or skin exposure to direct or scattered radiation and Class 4 Laser."
- Please see the UIC Laser Policy for more information on laser safety at www.uic.edu/depts/envh Appendix E of the policy has examples of pictorial signs.

Labels for Radioactive Materials

- Only the Radiation Safety Section and the Radiation Safety Committee (RSC) many authorize personnel or laboratories to work with radioactive materials. A quick guide to labels for radioactive materials is below:
- All Entrances to laboratories must post a sign stating, "Caution Radioactive Materials"
- All containers must bear a "Caution Radioactive Materials" label, in addition to radionuclide, estimated activity, and date for which the activity is estimated.
- All equipment and storage cabinets must have a sign stating, "Caution Radioactive Materials."
- For more information on radiation safety please see the "radiation safety manual.

Chapter 5: Material Safety Data Sheets (MSDS)

Material Safety Data Sheets (MSDS)

Material Safety Data Sheets (MSDS) must be readily available in all laboratories on campus. The OSHA Hazard Communication standard (29 CFR 1910.1200) requires manufacturers to provide MSDSs at no cost to users. All MSDS are broken down into ten sections that provide details on the manufacturer of the chemical, physical properties, disposal requirements, PPE requirements, known health hazards, and etc. Review both the appropriate Standard Operating Procedure and the MSDS when working with a chemical for the first time or when training staff. Electronic access is encouraged by bookmarking the manufacturer website. MSDS are available by request through the Environmental Health and Safety Office.

Laboratory Requirements

EHSO requires that each lab bookmark electronic copies of their MSDS for their employees. Make hard copies available upon request by any UIC employee who may perform work inside your lab. This includes researchers, faculty, facility workers, lab visitors, and emergency responders.

UIC's official MSDS backup plan for a network computing system failure is to use ChemTel Inc., where any employee can call from UIC to obtain an MSDS over the telephone.

ChemTel Inc. 24/7 1-888-2555-3924

The Ten Sections are usually divided in this order but may vary by manufacturer.

Section I of the MSDS lists information identifying the manufacturer of the product.

- Chemical name and synonyms
- Trade name and synonyms
- Chemical family and formula
- Chemical Abstract Service (CAS) number that is a unique identification number for chemical reagents.

Section II describes the various hazardous ingredient(s) contained in the product and the percentages of ingredient(s). This will include all hazardous chemicals that comprise 1% or greater of the mixture will be identified. Carcinogens must be listed if the concentrations are 0.1% or greater.

Section III describes the physical properties of the material. Physical properties include:

- boiling point
- specific gravity
- vapor pressure
- percent volatile
- vapor density
- evaporation rate
- solubility in water
- appearance and odor

Section IV describes the fire and explosion hazard data for the material and other fire and explosion data. The appropriate extinguishing agent for fires involving the material will be listed.

Special fire fighting procedures may also be listed.

Section V describes the known health hazard data for the material and exposure limits.

Section VI describes reactivity data; that is, the material's ability to react and release energy or heat under special conditions or when it comes in contact with certain substances.

Section VII gives instructions for the steps to be taken in case of an accidental release or spill.

Section VIII describes the protective equipment for the individual who might have to work with the substance. Always review the appropriate Standard Operating Procedure. Equipment may include:

- respiratory equipment
- ventilation
- protective gloves
- eye protection
- Other protective equipment (i.e., special clothing).

Section IX describes handling and storage procedures to be taken with the material.

Section X describes any special precautions or miscellaneous information regarding the material.

Chapter 6: Medical Program and Exposure Control Measures

Employee Hazardous Exposure Determination

Hazardous exposure to chemicals can be measured through industrial hygiene monitoring. Monitoring assesses the effectiveness of procedures and equipment used to prevent chemical exposures. A workplace monitoring program is conducted by EHSO to provide objective data of potential hazardous exposure or the degree of contamination in a laboratory area. Monitoring may be performed when there is a possibility personal exposure levels exceed the relevant health standards or in cases where employees exhibit signs or symptoms of an overexposure to a chemical.

Definitions for relevant health standard exposure levels include:

OSHA Permissible Exposure Limits (PEL's) are regulatory limits on the amount or concentration of a substance in the air. They may also contain a skin designation. PELs are enforceable by Federal and State Law. OSHA PELs are based on an 8-hour time weighted average (TWA) exposure.

Threshold limit values (TLV's) is the airborne concentrations of chemical substances representing conditions under which it is believed that *nearly all* workers may be repeatedly exposed, day after day, over a working lifetime, without adverse effects.

TLV-Time Weighted Average (TWA) is the concentration for a conventional 8-hour workday, 40-hour workweek, to which it is believed *nearly all* workers may be repeatedly exposed, day after day, for a working lifetime without adverse effects.

TLV-Ceiling (C) is the concentration that should not be exceeded during any part of the working exposure.

Short Term Exposure Limits (STEL's) is the level an employee can be exposed to over 15-30 minutes during a single work shift. Situations when a personal exposure level may exceed the standard: Performing repetitive work with significant quantities of easily volatilized chemicals, a chemical incident, or performing work without the proper engineering controls (E.g. laboratory fume hood).

Please see **Appendix D** for a list of chemicals which have OSHA Permissible Exposure limits of Action Levels. Industrial hygienists conduct monitoring of the following environmental hazards:

- arsenic, asbestos, carbon monoxide, combustion products, lead, mercury, nitrogen oxides, organic vapors, volatile organic solvents, humidity, ionizing radiation from radioactive materials or radiation producing machines, non-ionizing radiation, lasers, noise, radio frequency energy, spores and molds.

Medical Evaluation

Contact University Health Services for a medical evaluation when any of these circumstances arise while working with hazardous chemicals.

- Experience signs or symptoms associated either with a chemical exposure or significant changes in health.
- Routine EHSO monitoring reveals an exposure above the PEL or action level.
- A spill, leak, explosion or other incident occurs where an acute exposure may be likely.
- If you plan to work with OSHA regulated substances or activities, such as highly toxic carcinogens and reproductive toxins please contact EHSO and University Health Services.
- The CHO shall call EHSO when they and the employee suspect that they could be exposed to hazardous substances or work processes.

Exposure monitoring:
All monitoring is conducted under the supervision of EHSO by a Certified Industrial Hygienist or Occupational Safety and Health Technologist certified by the American Conference of Governmental Industrial Hygienists (ACGIH). Call our Industrial Hygienist at 3-5657 to schedule an assessment.

- ***Initial monitoring***. Shall be performed for any substance regulated by a standard which requires monitoring if there is reason to believe that the exposure levels routinely exceed the action level or the PEL.
- ***Periodic monitoring***. If the initial monitoring results are over the action level or PEL, a routine monitoring program shall be set up. In the meantime, measures must be taken to decrease or eliminate the exposure level.
- ***Termination of monitoring***. Monitoring may be terminated when the exposure level is initially found to be below the action level or, if it had been above after two subsequent monitoring results below the action level.
- ***Notification of monitoring results***. The employee shall receive, in writing, the monitoring results within 15 working days after the University receives the results. Monitoring samples are analyzed by independent laboratories approved using OSHA and NIOSH-approved analytical methods.

Medical examinations and consultations are typically performed by a licensed physician or under a physician's direct supervision. Such services are provided without cost to the employee, without loss of pay, at the University Health Services. The employee must provide the physician with the following required information:

- Identity and characteristics of the chemicals they may have been exposed (e.g., MSDS or other reference material).
- Conditions under which there is a potential for exposure to occur.
- Description of the signs and symptoms of exposure, if any.

Your Right to Industrial Hygiene and Medical Records

- Employees and their representatives have the right to access occupational health exposure and medical records.
- Exposure records include: area and personal sampling data, Material Safety Data Sheets, and industrial hygiene analyses.
- Medical records include: physical examinations, biological monitoring, diagnoses, x-ray and laboratory reports.

- Information requests shall be in writing to the EHSO, M/C 645 or University Health Service, M/C 684.
- A copy of the OSHA Standard (29 CFR 1910.1200) pertaining to employee access to Exposure and Medical Records is also available through EHSO or the OSHA website, http://www.osha.gov.

General Guidelines for Injuries

When severely injured on campus, seek medical assistance at the UIC Hospital Emergency Room, 1740 W. Taylor. The following work day report to the University Health Service (6-7420), for a follow-up visit.

- If this is a chemical injury bring the MSDS. Enlist another lab employee to help so you can focus on getting medical assistance.
- When the trauma is life threatening or an ambulance is required, call UIC Police at 5-5555 to arrange for emergency assistance and transportation to the University Illinois Medical Hospital at 1740 w. Taylor St. Chicago, IL.
- All incidents, no matter how minor, must be promptly reported to the lab supervisor and to EHSO at 6-7233 or at (6-SAFE).
- The supervisor must complete an "Employee's Injury Report" http://www.legal.uillinois.edu/wc/AccidentReportNew92001uicRevised.pdf .
- The advice and/or orders given by trained emergency response personnel (physicians, nurses, paramedics, firefighters and police officers) must be followed.

Chemicals splashed in the Eyes

- Take victim immediately to the nearest eyewash station.
- Flush the eyes for at least 15 minutes.
- Hold eyelids open while victim rolls the eyeballs around for optimum flushing.
- Immediately after, seek medical attention during normal business hours at University Health Services and if severely injured go to University of Illinois Hospital (UIH) Emergency Services.

Ingestion of Chemicals

- Call the Poison Control Hotline at 1-800-222-1222 or 1-800-942-5969 for advice on first aid.
- Seek immediate medical attention at University of Illinois Hospital.
- Do not induce vomiting unless specifically instructed to do so.
- Promptly seek medical attention at UIH Emergency Services.

Chemicals splashed on Skin over a Large Part of the Body

- Help the injured person to the safety shower, and flush for at least 15 minutes.
- Remove all layers of contaminated clothing, shoes and jewelry.
- If leather articles have been contaminated with a strong acid, discard.
- If clothing or jewelry adheres to a chemically-burned area of skin; do not pull it away.
- Seek medical attention at UIH Emergency Services immediately.

Inhalation of Chemical Vapors or Smoke

- Relocate to an area of fresh uncontaminated air.

- Remember: hot gases rise, but most chemical vapors are heavier than air so the vapor could be near the ground level.
- Seek medical attention at UIH Emergency Services.

Signs and Symptoms of Overexposure to Hazardous Chemicals

The large number of potentially hazardous chemicals on campus precludes an exhaustive list of the symptoms of overexposure. Certain signs and symptoms may also be associated with conditions not even related to contact with chemicals. Thus, the presence of a given sign or symptom need not indicate overexposure to a chemical. Conversely, the absence of a particular sign or symptom may not be meaningful since individuals react differently to toxins. Accurate diagnosis must be left to trained medical personnel.

- Consult the MSDS for signs and symptoms of overexposure before working with a compound.
- Any deviation from an individual's normal state of health, especially if an employee suspects or knows of chemical overexposure, must be reported immediately to a supervisor and attending physician.

Some examples of scenarios which can result in over exposure to hazardous chemicals are:

- Not wearing gloves when continually handling carcinogens
- Ingesting toxic chemicals on a regular basis for the thrill of it
- Working with hazardous solvents inside a non-working fume hood
- Tasting poisonous chemicals for purity

Chapter 7: Chemical Procurement, Handling and Storage

Chemical Storage and Chemical Hazards

This chapter starts with tips on the best practices for safely storing chemicals and reviews specific high hazard chemical groups. This chapter covers the most pertinent chemical hazards groups from oxidizers to water-reactives that are most often used in laboratories. Understanding the dangers with each group, the special precautions needed for working with these chemicals, and reviewing their storage requirements will provide each individual with the knowledge to safely store and work with these compounds. The following general guidelines should be followed when storing chemicals on campus.

General Guidelines:

- No more than 10 gallons (37 L) of flammable or corrosive liquids may be left outside of a Flammable or Corrosive Liquid Cabinet.
- Separate inorganic acids from bases, flammable materials, and combustible materials.
- Place inorganic acids in acid-resistant trays with absorbent or in corrosives cabinet.
- Store amines away from oxidizers. If amines contact oxidizers toxic gases can be generated such as NOx.
- Storing Ammonium Hydroxide by hypochlorites can produce toxic chlorine gas
- When flammable or oxidizing chemicals must be stored on wooden shelving, ensure the shelving is fire-protected by coats of intumescent paint or similar flame shield.
- Separate acid-sensitive materials such as bases from active metals such as sodium, potassium, magnesium.
- Separate cyanides and sulfides from acids.
- Examine chemicals at least every ***six*** months for signs of deterioration, polymerization, container integrity, and readable labels. Polymerized, unstable or old chemicals must be removed for disposal as potentially hazardous waste.
- Store lachrymators (a tear-producing substance), toxic gases, and corrosive gases in vented cabinets.

Do not store:

Corrosive liquids above eye level; reserve upper shelves for nonhazardous solids or unbreakable labware. This is to provide additional protection for the eyes. Hazardous chemicals should not be stored on the floor where they can be easily knocked over and spilled. Chemicals in chemical fume hoods, they can prevent the fume hood ventilation from properly working

Segregate chemicals by their physical state and hazard class:

Before storing chemicals, refer to Appendix A: the incompatible chemicals list for guidance on incompatibilities and the Material Safety Data Sheet for specific incompatibilities. One easy way to remember hazard classes is to think of the “Big Five”: Flammables, Oxidizers, Water-reactives, Corrosives (Acids and Bases), and Toxic chemicals. These are the most frequently seen chemicals on campus. Below you’ll find a more in-depth categorization of hazard classes:

Solids:

Flammable
Water reactive
Oxidizers
Acids
Bases
Toxics

Liquids:

Flammable
Oxidizers
Perchloric Acid
Acids
Bases
Toxics

Once separated into hazard classes, chemicals may be stored alphabetically. Separate each hazard class by a barrier, such as a cabinet, shelf or tray. Many chemicals have multiple hazard classes; please call EHSO at 3-2436 for more information. Refer to Appendix A for additional incompatibility information.

Special flammable liquid storage requirements

A flammable liquid is defined as any liquid having a flash point below 100F (37.8 C), while a combustible material is defined as any liquid having a flash point at or above 100F (37.8 C). Never store flammable compressed gases or flammable liquids in basement/below grade spaces overnight, in accordance with the Office of the Illinois State Fire Marshall and the Municipal Code of Chicago. The National Fire Protection Agency, (NFPA) has subdivided flammable materials into sub-classes based on the flash points and boiling points of the materials. The following table identifies the classifications of flammable and combustible materials by container size, flash point, and boiling point:

Table of Maximum Allowable Container Sizes of Flammable and Combustible Liquids:

Container Flash Point	**Class IA** (<73 F)(22.8C)	**Class IB** (<73 F)(22.8C)	**Class IC** (73 -100 F)	**Class II** (100-140F)	**Class III** (140F<)
Boiling Point	(<100 F)	(100F<)	(100 F<)	(100F<)	(100F<)
Glass	500 ml/1 pt	1 L/1 qt	4L/1 gal	4L/1 gal	20L/5 gals
Safety Cans	10L/2.6 gal	20L/5 gals	20L/5 gals	20L/5 gals	20L/5 gals
Metal Drums (DOT spec.)	Not Allowed	20L/5 gals	20L/5 gals	227L/60 gals	227L/60 gals
Polyethylene (DOTspec)	4L/1 gal	20L/5 gals	20L/5 gals	227L/60 gals	227L/60 gals

Metal (non-DOT) or approved Plastic	4L/1 gal	20L/5 gals	20L/5 gals	20L/5 gals	20L/5 gals

NFPA 30, Flammable and Combustible Liquids

Limit quantities of flammable and combustible liquids to: One (1) gallon of Class I liquids in containers other than safety cans. Safety cans must have a self-closing spigot, pressure relief cap and flame arrester that protects the contents from an external ignition source. A Fire Area is an area physically separated from other areas by space, barriers, walls, or other means to contain fire within the area. Connect flammable liquids storage cabinet to a building ground if intending to dispense from a container in the cabinet.

- The maximum number of Flammable Safety Cabinets in a Fire Area is three. If more are needed please call EHSO.
- Sixty (60) gallons, or approximately 225 liters, is the maximum load limit for a flammable liquid storage cabinet in a typical laboratory.
- Venting the bungs of Flammable Safety Cabinets is not required, nor recommended, but acceptable with odorous chemicals, provided the integrity is maintained. If you choose to vent please use chemical exhaust ducts when extremely volatile chemicals are stored.
- Do not store flammable liquids in cardboard boxes. Store excess in approved flammable storage rooms or flammable cabinets. Do not store more than 9 gallons (34 L) of solvents outside of an approved flammable storage cabinet.

Laboratory Flammable Storage Limits

The need for a Flammable Storage Cabinet is driven by the class of flammable or combustible liquid present as well as the total quantity and location of these liquids. The total amount of flammable and combustible liquids allowed shall be in accordance with the amount shown:

This amount must be stored in the following manner:

- Not more than 10 gallons located outside a flammable storage cabinet.
- Not more than 60 gallons in a flammable storage cabinet.
- Not more than 3 flammable storage cabinets per fire area

References:
National Fire Protection Association (1996), NFPA 30: Flammable and Combustible Liquid Code. Batterymarch, PA: NFPA
National Fire Protection Association (1996), NFPA 45: Fire Protection for Laboratories Using Chemicals. Batterymarch, PA: NFPA
Occupational Safety and Health Administration (1996). General Industry Safety and Health Standards 29CFR 1910.106. Washington, DC: Bureau of National Affairs, Inc.

Design Requirements for a Flammable Liquids Room:
The Environmental Health and Safety Office (EHSO) and UIC Office of Capital Programs can make recommendations for designing laboratories to comply with fire codes. Among the requirements for such rooms:

- Six inch (6") door sills designed to prevent the flow of liquid from the room.
- Explosion-proof wiring.
- Automatic fire suppression systems and no floor drains.

Transporting Chemicals
Transport chemicals through halls or between buildings in secondary containment such as a bottle carrier, bucket, high density polyethylene tray, tote or cart.




When a cart is used, place chemicals in a secondary container, such as a high density polyethylene tote, unless the cart has a sealed rim (e.g. Rubbermaid™). If a bottle would fall and break in the hall, the hazardous vapors would be re-circulated throughout the building because the air in the hallways and offices is re-circulated, unlike air in laboratories and chemical storage rooms, which is normally vented to the outside. When transporting between buildings, keep a spill kit on the cart.

Specific High Hazard Chemical Groups

Flammable and Combustible Substances
Flammables are indicated by a 3 or 4 in the red section of hazard rating systems. Most non-halogenated solvents are flammable liquids. The vapors of flammable substances will ignite when 3 conditions are met:

- When they are at a temperature which forms sufficient vapors
- A spark (e.g. from an electrical switch) is close enough to ignite the vapors
- Sufficient oxygen is available to feed the fire.

Flammable Solids
Many flammable solids are pure high-grade metals such as sodium, magnesium, potassium, phosphorus. High-grade metals can react with air or water and explode. High grade metals are also classified as water-reactive. Because of the risk of violent explosions and exothermic reactions, it is critical you follow the following guidelines when working with these metals.

- Metal chunks should be submersed in mineral oil, to limit exposure to moisture in air to prevent spontaneous combustion.
- Cover spill with Calcium carbonate ($CaCO_3$) or use yellow Class D fire extinguisher

Special Precautions for Flammable liquids and Solids

- Keep 10 feet away from source of ignition: flames, localized heat, or sparks.
- Instead of open sources use steam baths, water baths, oil baths, heating mantles, or hot air baths for heating sources.
- Only approved flammable or explosion proof refrigerators are safe for refrigerating flammables.

Grounding and Bonding:

- Static electricity may be produced by the free fall and turbulence of liquid being poured from a 5-gallon or larger container. Diminish static with grounding and bonding system or use manual dispensing pump.
- Ground container to a building ground with wire clips
- Attach a bonding wire from the dispensing container to the fill container or safety can.
- Pour as slowly as possible and use a grounded nozzle extension that allows filling the container from the bottom, such as a rotary pump.
- Static hazards may also exist in non-metallic plastic or glass containers so pour slowly.
- Because solvent vapors are easily absorbed through the lungs and can cause liver, kidney or reproductive damage, work in the fume hood.
- Wear impermeable gloves because flammable liquids dry out the skin and can be toxic when absorbed through the skin.

Oxidizers

Oxidizers can react vigorously at ambient temperatures when they contact organic material or reducing substances such as peroxides, chlorates, perchlorates, nitrates, permanganates, and the elemental halogens. Some useful storage tips and precautions for oxidizers are:

- Store oxidizers at low temperatures and protected from light with brown or opaque containers
- Do not store oxidizers on uncoated wooden shelves; coat with intumescent paint.
- Treat oxidizers as a flammable substance and do not use near ignition sources.

Peroxide Forming Compounds

Materials that are susceptible to the formation of peroxide crystals usually react with air or moisture to produce a change in their normal chemical composition. The double oxygen bond created is highly unstable and particular **dangerous do to explosion hazards**. You can avoid the creation of peroxides by testing the chemical with a peroxide strip every three 3 months for Class A peroxides and every six months for Class B peroxides. Below are some of the most common peroxide groups found inside laboratories. We have a more complete list of peroxides available in **Appendix E.**

Compounds unusually susceptible to oxidation:

- Aldehydes
- Ethers - especially cyclic ethers and those derived from primary and secondary alcohol groups
- Compounds containing benzylic hydrogen atoms

- Compounds containing the allelic structure including most alkenes, vinyl and vinylidine compounds

Special Precautions for Peroxides:

- Crystals tend to form around the cap and detonate when a static spark is produced while turning the cap. Please contact EHSO immediately at 6-SAFE if you suspect peroxides crystal are present on any container or object inside your laboratory.
    - Test compounds for peroxides annually before concentrating, distilling, or evaporating.
    - Simple Testing Procedure for Peroxides:
        - colorimetric test using 10% ethanol KI solution
        - add 1 ml KI solution to test tube
        - add 1ml peroxide forming solvent,
        - Yellow to brown color change indicates increased peroxide concentration.
    - Ready-to-use KI peroxide test strips are available from distributors, e.g. Fisher or Lab Safety.
- If a chemical is found to contain peroxides contact EHSO for consultation on hazardous waste disposal.
- When unsure of the age or condition of a peroxide forming substance: **DO NOT USE; DO NOT TOUCH CONTAINER! AN EXPLOSION IS POSSIBLE!**
- Do not distill peroxide forming compounds to dryness. Add a high-boiling non-reactive diluent or "chaser" if it is necessary to recover the maximum amount of distilled product.
- Do not purchase containers larger than one gallon. This prevents the risk of creating peroxide crystals by ensuring that the material is used before expiration.
- Date containers with date received, opened and when tested for peroxides.
- Store according to self- accelerating decomposition requirements (SADT). This means to store the compound at a lower temperature than the SADT temperature found labeled on the chemical container.
- Additional information in Fact Sheet: “Chemical Safety Training: Peroxidizable Chemicals” under “Training” at www.uic.edu/depts/envh .

Highly Reactive Chemicals

Unstable (reactive) chemicals are those that in the pure state, or as commercially produced, vigorously polymerize, decompose, condense or become self-reactive under conditions of shock, certain pressure or temperature. If less hazardous alternatives are not available, do not heat to dryness and work in a glove box.

Compounds containing the following functional groups tend to be sensitive to heat and shock: acetylide, diazo, nitroso, peroxide, azide, halogenated amines, and ozonide.
Compounds containing nitro groups may be highly reactive, especially if other substituent such as halogens are present.
Treat the following groups with respect, especially at higher temperatures: perchlorates, nitrates, chlorites, chlorates, bromates, iodates.

Please see our Appendix F for Shock Sensitive Chemicals.

Air and Moisture Sensitive and Water Reactive Compounds

Many compounds deteriorate when exposed to air, mostly causing a decrease in purity. But for a few, oxidation causes extreme reactivity. Another group reacts with atmospheric moisture and causes the release of toxic or flammable gases or vapors or the generation of enough heat to cause fires and explosions. Active metals such as sodium, magnesium, lithium, and potassium are a serious fire and explosion risk because of their reactivity with water, alcohols, and other compounds containing acidic –OH groups.

Special Precautions for Air, Moisture, and Water Reactive Compounds

- Only handle in a glove box with an inert atmosphere and store in special containers with a nitrogen atmosphere.
- Potassium and sodium are usually stored under mineral oil to exclude oxygen and moisture.

Pyrophoric Compounds

The classes of chemicals listed below will readily oxidize and ignite spontaneously in air. Therefore, users must demonstrate to the department that they have the appropriate laboratory equipment, information, knowledge and training to use these compounds safely.

- Grignard reagents, RMgX
- Metal alkyls and aryls, such as RLi, RNa, R_3Al, R_2Zn
- Metal carbonyls such as $Ni(CO)_4$, $Fe(CO)_5$, $Co_2(CO)_8$
- Alkali metals such as Na, K
- Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr
- Metal hydrides such as NaH, $LiAlH_4$
- Nonmetal hydrides, such as B_2H_6 and other boranes, PH_3, AsH_3
- Nonmetal alkyls, such as R_3B, R_3P, R_3As
- Phosphorus (white)

Please See Appendix H for a list of Pyrophoric Chemicals.

Toxic Substances

Toxic agents are chemicals which are lethal when the human body is exposed to a significant quantity. Exposure to only a small quantity of a highly toxic agent such as hydrogen cyanide can be deadly in a matter of minutes. Even if the effect of a single exposure to a toxic agent is not immediate, it may still be felt within a matter of hours and can be deadly. An example would be exposure to carbon monoxide. Have a scrubber prepared with an appropriate neutralizer for proper disposal or in the event of a leak.

Determinants of Toxic Effects:

Route of Exposure:

In occupational settings, the major exposure routes of concern are inhalation, ingestion, injection and skin/eye contact. Although, the skin may be affected by contact, it does provide a somewhat effective barrier against many toxic chemicals, particularly those that are water soluble. A rule of thumb: the greater the fat solubility of a chemical, the greater the possibility that the chemical

will be absorbed through the layers of the skin and reach the blood stream. Contact of the eyes with chemicals is of particular concern because the eyes are so sensitive to irritants and corrosives.

Frequency and Duration of Exposure:
The frequency and duration of exposure to toxic chemicals play an important role in the ensuing toxic effects. For many chemicals, the adverse health effects associated with a single exposure are different than those for repeated exposures. For example, a single exposure to a high concentration of benzene may cause central nervous system depression, while many repeated low level exposures may cause leukemia. Decreasing the duration of exposure and increasing the time between exposures may reduce toxicity because of the ability of the body to detoxify and/or discharge foreign substances. When the frequency or duration of exposure is too great, these defensive mechanisms may be overwhelmed. Duration of exposure is also important for substances such as corrosives, where the severity of the injury is a function of the time of contact.

Magnitude of Exposure:
Exposure magnitude is determined by the duration and intensity of exposure. For inhalation exposures, intensity is measured by the concentration of the toxic substance present in air (e.g., milligrams per cubic meter in air). For skin contact, intensity is determined by the concentration of the substance in solution (e.g., parts per million (ppm) in water). Exposure magnitude is the main determinant of toxic responses which form a spectrum ranging from no detectable effects, through perceptible injury, to death.

Target Organs:
Skin:
Toxic skin response reactions may appear as irritation or allergic reactions**.**

Eyes:
Chemical contact of the eye is very serious because of its extreme sensitivity to almost all chemicals. Most substances cause irritation and pain when they come in contact with the eye. A considerable number of substances are capable of causing damage to the cornea and loss of vision.

Liver:
Chemicals that cause liver injury are called hepatotoxins. The liver is a frequent target organ because many chemicals are metabolized or chemically converted by it. Some forms of liver injury have been found to be reversible, while others are permanent. Chemicals causing liver injury include solvents, carbon tetrachloride, chloroform, nitrosamines and beryllium.

Kidney:
Chemicals causing kidney injury are called nephrotoxins. The kidney is a target organ because it provides the major route of excretion for many chemicals or their metabolic products. The kidney has a very high blood flow and as a result, any chemical in the blood will be delivered in high amounts to this organ. Toxic chemicals may also be concentrated in the kidney. Most heavy metals (mercury, chromium, lead, cadmium, and others) are potent nephrotoxins. Nephrotoxicity has been observed following the absorption of chlorinated hydrocarbons such as carbon tetrachloride, chloroform and trichloroethane.

Respiratory System:
Chemicals can enter the respiratory tract as gases and vapors, or as solid or liquid aerosols. Respirable chemical agents need not be absorbed to produce disease, as exemplified by minerals such as asbestos and silica, which produce pulmonary fibrosis. Some types of respiratory system injury and their causative agents are below**.**

Ammonia, Sulfur dioxide, Chlorine	Nose/Throat Irritation
Nitrogen dioxide, Ozone, Phosgene	Damage to lower airways
Toluene, diisocyanate (TDI)	Allergic response
Polycyclic aromatics, Nickel compounds	Lung tumors

Nervous System:
Some chemicals have an effect on the peripheral nerves and the brain. Examples include mercury, lead, carbon disulfide, aromatic hydrocarbons and some organophosphorus compounds.

Blood:
In addition to chemicals that act directly on the blood and blood-forming organs, this category also includes chemicals which decrease hemoglobin function or decrease the ability of cells to utilize oxygen. Carbon monoxide forms carboxyhemoglobin which decreases the oxygen transport capability of the blood. Sodium nitrite, aniline and some aminophenols produce methemoglobin, which also decreases the availability of oxygen from the blood. Cyanides affect enzyme systems that reduce the ability of cells to utilize oxygen. Benzene can cause anemia, as well as leukemia.

Carcinogens and other Hazardous Drug
Emergencies involving exposure to carcinogens and the facts obtainable at that time shall be reported immediately to EHSO. EHSO will then file a formal report with regulatory authorities.
Special Precautions for working with Carcinogens

- If you work with any of the OSHA regulated carcinogens, contact EHSO immediately at 6-SAFE or Kcisne1@uic.edu .

The 13 carcinogens can be found on OSHA's website in Table Z and are listed below.
www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10007&p_table=STANDARDS

- 4-Nitrobiphenyl, Chemical Abstracts Service Register Number (CAS No.) 92933
- alpha-Naphthylamine, CAS No. 134327
- methyl chloromethyl ether, CAS No. 107302
- 3,3'-Dichlorobenzidine (and its salts) CAS No. 91941
- bis-Chloromethyl ether, CAS No. 542881
- beta-Naphthylamine, CAS No. 91598
- Benzidine, CAS No. 92875
- 4-Aminodiphenyl, CAS No. 92671
- Ethyleneimine, CAS No. 151564
- beta-Propiolactone, CAS No. 57578

- 2-Acetylaminofluorene, CAS No. 53963
- 4-Dimethylaminoazo-benzene, CAS No. 60117
- N-Nitrosodimethylamine, CAS No. 62759

When working with any type of carcinogens please take the necessary steps below to ensure the highest level of safety.

- OSHA regulations require a "Designated Area" be established to work with carcinogens. Signs stating "**Carcinogen use area; authorized personnel only" must be posted at the entrance to these areas**.
- The "Designated Area" for carcinogen use may be an entire laboratory, part of a laboratory, or a containment device such as a fume hood or glove box.
- Store carcinogens and transport in a sealed outer container that provides physical and leak protection. The outer container should contain an absorbent.
- Post a running inventory record showing additions and withdrawals on the cabinet or refrigerating and warning sign: **"CAUTION – POTENTIAL CANCER HAZARD"** and name.
- For occasional use or exploratory operations carcinogens, an inflatable glove chamber may be satisfactory if approved by the CHO. Replace when contaminated.
- Work on a disposable, plastic-backed absorbent pad placed in a shallow tray. Dispose of pad at the end of the day or when a spill occurs, into a bag for disposal by INCINERATION ONLY through the biohazardous waste program.
- Perform a Trial Run with a low toxicity surrogate that approximates the physical properties of the compound to demonstrate the operability of equipment and effectiveness of control measures. Fluorescein can be used to detect aerosol sprays or spills.

Toxic and Corrosive gases

Purchase specialty gases in returnable mini-cylinders such as the 6AL; Lecture bottles are expensive to dispose and departments must pay for their disposal. See "Chemical Waste Fact Sheet: Disposal Options for Lecture Bottles" http://www.uic.edu/depts/envh/HSS/Documents/fctDOL.pdf and "Chemical Waste Fact Sheet: Gas Cylinder Returns" http://www.uic.edu/depts/envh/HSS/Documents/fctGCR.pdf .

Please see Appendix G for a list of Toxic Gases

Corrosive gases:

Can chemically attack and eat away various materials, including fire-resistant clothing. Some gases are not corrosive in their pure form, but can become extremely destructive if a small amount of moisture is added. Corrosive gases can cause rapid destruction of skin tissue and mucous membranes. For these gases, at minimum to detect any leaks, suspend a pH strip in the cabinet, as well as on the outside of the cabinet or closet. If any leaks are detected please contact EHSO immediately at 6-SAFE

Toxic gases:
Even in very small concentrations, brief exposure can result in serious poisoning. Symptoms of exposure may be delayed. Before beginning experiments, prepare a neutralizing scrubber in the event of a leak. When not in use, store gas cylinders securely fastened in a ventilated cabinet; do not stack on a shelf. Include detection equipment to monitor leaks for acutely toxic gases. Before use, secure smaller sized cylinders to a stable fixture in the fume hood.

- Do not work with a specialty gas unless you are familiar with its proper handling procedures and its toxic or corrosive effects.
- In cases where an inhalation hazard is present, contact EHSO if you think you need a respirator.

Acids
Acids must be added to water to avoid local boiling. If not cooled quickly enough, an explosion can occur.

- **Sulfuric acid** (H_2SO_4) when concentrated has a very strong affinity for water and has a strong exothermic reaction when being diluted. For this reason, add acid to water-never the reverse. Concentrated H_2SO_4 can form a violent reaction with oxidizing and reducing agents, organic chemicals, especially those soluble in water.
- **Hydrochloric acid** (HCl) on exposure to air liberates choking fumes of hydrogen chloride which irritate the eyes, nose and throat.
- **Perchloric acid** solutions above 72% in concentration are unstable and may decompose explosively. Try only using concentrations below this threshold.
- **Hydrofluoric acid** (HF) can penetrate and destroy the skin and soft tissue, causing destruction and intense pain. If you work with HF, be sure to keep Calcium Gluconate gel in your laboratory at all times. Calcium Gluconate is the antidote for HF.
- Concentrations of HF below 20% as a more gradual and have a cumulative effect; so symptoms may be delayed for up to 24 hours.
- **HF First-Aid**-After flushing with water for 5 minutes, dry area and apply the calcium gluconate gel with a gloved hand, while proceeding to the UIC Hospital Emergency Room for treatment.

Bases
Bases are any chemical with a high pH that in water solution is irritating or caustic to the skin. Bases with a pH>12 are considered corrosive. Those with a pH of 9-12 are irritants

- After contact with the skin, skin feels "slippery" or "soapy" as it disintegrates
- The eye is especially susceptible to alkalies because they attach and destroy nerve endings. Splash goggles or face shields are recommended whenever there is a possibility of eye contact.

Cryogenic Liquids
Cryogenic liquids exist at very low temperatures, for example argon is a liquid at –302°F. Cryogenic liquids produce large volumes of gas when they vaporize. The expansion ratio of argon is 847:1. If cryogenic liquids were to vaporize in a sealed container, the vessel could rupture. Most metals become stronger upon exposure to cold temperatures, but materials such as carbon steel, vinyl flooring, plastics, and rubber become brittle or even fracture under stress at these temperatures. Both cryogenic liquids and the "boil-off' vapor can rapidly freeze human tissue, causing extensive tissue damage. Always wear a face shield and cryogenic gloves when working with cryogenic liquids.

- If these liquids are vaporized in a sealed container they can produce enormous pressures which could rupture the vessel. For this reason pressurized cryogenic containers are usually protected with multiple pressure relief devices. They usually have a pressure relief valve for primary protection and a frangible disc for secondary protection. Do not tamper with these devices.
- Vaporization of liquid oxygen in an enclosed work area can cause an oxygen enriched atmosphere, which could saturate a worker's clothing. Although oxygen is not flammable, it will vigorously support and/or accelerate the combustion of other materials. There are well documented cases of clothing catching on fire after being sprayed with oxygen and coming in contact with an ignition source.
- Vaporization of liquid hydrogen in an enclosed work area can cause a flammable or explosive mixture in air.
- Most cryogenic liquids are odorless, colorless, and tasteless when vaporized to the gaseous state. Most have no color as a liquid although liquid oxygen is light blue in color.
- The extremely cold liquid and vapor have a warning property that appears whenever they are exposed to the atmosphere. The cold "boil-off" gases condense the moisture in the air, creating a dense visible fog. The fog normally extends over a larger area than the vaporizing liquid.

Storage Precautions

Cryogenic liquid cylinders are insulated, vacuum-jacketed pressure vessels which operate at pressures up to 350 psig and hold 80 to 450 liters of liquid. They are equipped with pressure relief devices to control internal pressure. Under normal conditions, they periodically vent, producing a hissing sound. Do not plug, remove, or tamper with these devices.

Laboratory Guidelines for Asbestos

Asbestos is a common name given to a group of naturally occurring mineral fibers that have been incorporated into a variety of construction products such as wall plaster, floor tile, pipe insulation and asphalt roofing. The presence of asbestos-containing building materials is not uncommon. In fact, the Environmental Protection Agency (EPA) estimates that approximately 90% of commercial buildings constructed before 1980 contain some asbestos. Therefore it would not be uncommon for asbestos to be found in your lab in some form.

Health Hazards Associated with Asbestos

Asbestos materials pose little or no risk to health unless they are disturbed in such a way that asbestos fibers become airborne and are inhaled and deposited within the lungs. Increased incidence of several illnesses including asbestosis, lung cancer and mesothelioma have been observed in individuals who were persistently exposed to high levels of airborne asbestos in work environments such as mining, milling, shipbuilding, construction and manufacturing.

Asbestos Surveillance at UIC

EHSO conducts on-going building surveys to identify and safely manage previously installed asbestos-containing products. Furthermore, all renovation of campus buildings must be reviewed in advance by EHSO to ensure that no Asbestos-Containing Materials are disturbed without proper safeguards. Work that requires removal or repair of Asbestos-Containing Materials is restricted to trained and qualified persons only.

How to Handle Asbestos Containing Materials in your Laboratory

In order to ensure the safe management of Asbestos-Containing Materials within our facilities, it is important that all lab occupants abide by the following requirements:

- Presume all building materials contain asbestos until determined otherwise by the EHSO Asbestos Program Coordinator and or representative from EHSO.
- Do not remove, cut, drill, sand, grind or otherwise disturb any material that may contain asbestos.
- Do not go above ceilings, behind walls or into building spaces such as attics and crawlspaces unless these areas have been inspected and cleared by the EHSO Asbestos Program Coordinator.
- Do not install screws, pins, nails or hangers into asbestos ceiling or wall plasters.
- Be careful not to damage walls, ceilings or floors when moving furniture or equipment.
- Do not brush, sweep, or vacuum textured asbestos ceiling plaster or plaster debris.

How to Respond To Suspected Damaged Asbestos in your Laboratory

- Do not ever ignore any material you suspect could be Asbestos. Remember, asbestos is a carcinogen.
- Immediately report any observed damage or deterioration of suspect asbestos materials to your supervisor, the EHSO Asbestos Coordinator at (312) 413-3704, or EHSO's 24 Hour Safety Phone at (312) 996-7233.

For More Information

Asbestos survey results listing specific locations where Asbestos-Containing Materials may be encountered within your building, detailed procedures for working with asbestos and bulk and air monitoring sample analysis results are available for review. If you have specific questions related to this information, or would like the EHSO Asbestos Program Coordinator to review the above information with you, please contact him at (312) 413-3704 or jvsides@uic.edu.

Chapter 8: Planning Laboratory Experiments: *Engineering Controls, Personal Protective Equipment, and Standard Laboratory Equipment*

Controlling Exposure to Hazards:

Controlling exposures to hazards in the workplace is the fundamental base of laboratory safety. Using Safety's Hierarchy of Controls: Elimination & Substitution, Engineering Controls, Administrative Controls, and PPE, it is possible to eliminate potential hazards by following this sequential order. The top of list has the potential to be more effective and protective than those at the bottom. Following these steps will create a safer system for laboratory employees and the general public within UIC buildings.

The first two steps**, Elimination and Substitution**, are intended to remove the hazard or reduce the hazard in scope to the employee. They are followed by **Engineering Controls**, which eliminates hazards through mechanical means of a barrier, while **Administrative Controls** and **Personal Protective Equipment (PPE)** are the last steps used to eliminate these hazards. Prior to using PPE one should always use the best administrative practices when reviewing equipment purchases, addressing labeling and signs, chemical storage requirements, and laboratory work practices before beginning research. EHSO provides a Laboratory Hazard Assessment Tool to assist researchers in creating and implementing administrative controls.

Planning Chemical Laboratory Experiments:

Advance planning is necessary to control and avoid potential accidents inside a laboratory. All Principle Investigators should perform a site-specific **Hazard Review.** At the University we have develop a Laboratory Hazard Assessment Tool in a PDF document to assist researchers with this process**.** Using this document along with Material Safety Data Sheet and other safety information for special hazards and protection requirements, every PI should be able to understand the necessary steps to ensure a safe laboratory. Please check Appendix A for the chemical incompatibility chart and if possible Bretherick's *Handbook of Reactive Chemical Hazards*. List the possible reactions, including side-reactions, during the planning the process.
For each reactant, intermediate or product, review the MSDS and determine:

- the flash point, flammability range, auto-ignition point, vapor pressure and vapor density
- explosively or rate of decomposition and decomposition products
- stability and storage requirements
- incompatibilities
- toxicity and route of exposure, i.e. inhalation, ingestion, skin or mucous membrane contact
- required protective measures
- recommended first aid treatment for each route of exposure

Before altering a process, check for potential adverse effects with the National Oceanic and Atmospheric Administration's database, NOAA's Chemical Reactivity Worksheet or online database of hazardous materials (http://cameochemicals.noaa.gov). This interactive web application will allow a user to theoretically perform reactions and help determine the following characteristics of the reaction:

- How violent will it be?
- What is the effect of catalysts or inhibitors?
- Does water or air affect the reaction?
- Rate of evolution of, heat and gases released during the reaction.

In an unknown reaction, start with small quantities and carefully observe reaction characteristics, such as temperature, color, viscosity, and physical state. Provide adequate cooling, ventilation, pressure relief and gas purging. Inspect the equipment frequently.

Avoid accidental chemical ingestion.

- Do not mouth pipette; use suction bulbs.
- Do not eat, drink (including coffee), or apply cosmetics in laboratories.
- Do not store food or beverages in refrigerators used for chemical storage.

Avoid inhaling chemicals.

- Keep chemical containers and chemical waste containers closed when not in immediate use.
- Do not sniff chemicals.
- Transfer volatile or toxic compounds and perform experiments that may form vapors in the chemical fume hood.
- Work at least 6 inches from the edge of the fume hood to efficiently contain vapors.
- Ensure that the chemical fume hood is turned on and operating properly. If the fume hood is not equipped with an air monitor, tape a Kimwipe™ to the bottom of the sash to detect direction of airflow.
- Notify EHSO if chemical vapors are being generated that are not being contained by chemical fume hood.

Substances Developed in the Laboratory

General Considerations:

- When the composition of the substance produced exclusively for the laboratory's use is known, it is the responsibility of the person who created the compound to notify EHSO at 3-3387 failure to notify EHSO can result in criminal and liability issues.
- Consider the compound extremely hazardous and implement highest level of appropriate safeguards. For consultation please call EHSO at 6-SAFE.
- When the chemical substance is produced for a user outside of the laboratory, the creator must contact EHSO due to severe legal implications for non-compliance with TSCA. Please contact the TSCA coordinator at 3-3387.
- If you plan on shipping any chemicals off campus contact EHSO for DOT and IATA training or you will be held liable for breaking the law.

Avoid underestimating a risk associated with them:

- Assume that substances of unknown toxicity are toxic.
- Minimize exposure to substances of unknown hazards that does not have an MSDS.
- Assume any mixture will be more toxic than its most toxic component.

Standard Operating Procedures (SOPs) for High Hazard Chemicals and Procedures

Before beginning an experiment, the PI must approve a written SOP for work involving:

- Extremely hazardous chemicals i.e. (pyrophorics, peroxide formers, explosives, toxic hazards.)
- Extremely hazardous lab operations i.e. (nanotechnology, high pressure operations, carcinogen work, laser operations, metal cutting)
- High Voltage
- Mixing Incompatible Chemicals.

SOP's should include:

- Normal or expected operating conditions of an experiment and how to recognize when the experiment is going wrong.
- How to eliminate the risk of chemical exposure or physical harm through PPE and engineering controls.
- Proper waste disposal practices.
- Emergency action steps.

Chemical Procurement

Submit requests for new chemical purchases to the PI and CHO for approval. Note that the University does not permit purchasing chemicals with a P-card.

- Avoid bulk purchases that may not be consumed.
- Re-design experiments to reduce chemical use and save on purchase and disposal cost.
- Use the least hazardous chemicals. For suggestions, refer to the MIT Green Chemical Alternatives Wizard (http://web.mit.edu/environment/academic/purchasing.html)
- Consider pre-packed mini-chromatography columns.
- Re-distill solvent waste for re-use in extractions.
- When ordering a new potentially hazardous substance, share proper handling, storage, and disposal information with lab personnel.
- When receiving chemical shipments, do not accept unlabeled, damaged, or leaking containers.

Working Alone

Always have a telephone available when working alone. The PI must approve an employee to work alone, but only when they will perform a low-risk laboratory operation with little potential for serious injury. Examples:

- Work with dilute acids or bases.
- Work where potentially hazardous equipment is not in operation or is in standby.
- Blending, mixing or filtering chemicals with no reaction, a low corrosivity, and toxicity and below their flashpoints.
- Potential injuries would not hinder ability to call for help.

Unattended Operations (experiments left running while the researcher leaves to class, lunch or off campus). Before deciding to leave, conduct a Hazard Review and implement recommendations. Before leaving an automated or routine process, perform the following:

- Label power controls and utility feeds,
- Post emergency instructions by the process,
- Fill in unattended operation section on the back side of lab ID Data card,

- Ensure the lab is visible through the door window.

High Risk situations that may never be left unattended:

- use of exothermic, flammable or a particularly hazardous substances
- a laboratory procedure that had never been conducted by the researcher
- Blending or mixing chemicals that involve a reaction.

Other considerations

- Break areas for eating and drinking must be located outside the laboratory but in close proximity to the work stations.

Good Housekeeping

- Never block access to emergency equipment such as showers, eyewashes, fire equipment and exits, not even by a temporarily parked cart.
- Keep work areas clear of equipment and glassware that is not in immediate use.
- Keep aisles, hallways, stairs and areas under stairwells clear; do not use as storage spaces.
- Have floors cleaned regularly

To prevent spills and to promote good housekeeping at the end of each workday:

- Return chemicals to their cabinets.
- Transfer the contents of beakers, cylinders and flasks to labeled sealable containers;
- Dispose of bench protectors; if contaminated with an extremely toxic chemical, i.e. carcinogen, reproductive toxin, acute toxin (LD50 <50mg/kg rat), store in plastic bag and dispose.
- Clean work surfaces.

If there is a small accident on a bench top please clean up the spill on the benches and remove protectors promptly and dispose of the cleanup materials appropriately. Do not wipe solvent or acid spills with paper towels.

Engineering Control Measures

Equipment Approval

Prior to purchasing or installing the following equipment, acquire the PI and CHO approval and consult with EHSO:

- chemical storage cabinets
- refrigeration units
- compressed gas cabinets and distribution systems, including monitoring devices
- chemical fume hoods and other ventilation equipment
- furnaces, ovens, process reactors
- emergency eyewashes/showers
- personal protective equipment (eye and face shielding, gloves, protective clothing, respiratory protection)

Radioactive materials or ionizing radiation-producing equipment must be approved by the Radiation Safety Officer (RSO) of the EHSO.UIC Radiation Safety Committee must approve: The use of large quantities of radioactive material, human uses of radioactive material. Please see the Radiation Safety Manual at www.uic.edu/depts/envh. Lasers must be approved by the Laser Safety Officer. Please see the Laser Safety Policy at www.uic.edu/depts/envh

General Room Ventilation
General room ventilation controls small scattered low toxicity air contaminants by diluting them to an acceptably low concentration. General room ventilation may be sufficient if all chemical containers are kept closed. Laboratories should have 8-12 air exchanges per hour.

- General room ventilation shall not be relied upon when working directly with a toxin.

Local Exhaust Ventilation (such as flexible exhaust duct (snorkel) or canopy hood)

- May be used to contain air contaminants when experiment setups are too large for a fume hood.
- Are most useful where the contaminant releases are localized, such as the exhaust from an instrument pump.
- Must be installed by a qualified engineer and may have to include a fan
- A hose placed into the fume hood is insufficient because: the airflow is too low to capture and draw in contaminants, the velocity of the exhaust drops with increased distance and may be insufficient to be properly exhausted. The maximum effective reach of a snorkel is several inches.

Laminar Flow Hood (clean air bench)
Laminar flow hoods provide product protection and must not be used when working with a biological or chemical hazard. Working with a biological or chemical hazard can expose the researcher to aerosols of allergenic or infectious materials when used for cell culture.

Biological Safety Cabinet (BSC)

Biological Safety Cabinets provides personnel, environmental and product protection from biological hazards. Biological Safety Cabinets must be used to protect against infectious agents.

- Limited chemical manipulations may be performed in a BSC if it is vented to the outside.
- Contract a certified agent to perform annual testing and certification.
- Refer to Appendix D of the Biological Safety Manual for details on the types of BSCs (http://www.uic.edu/depts/envh/HSS/Documents/BSM2004.pdf).
- Refer to the Biosafety Cabinet Policy for maintenance information: (http://www.uic.edu/depts/envh/Departmental/Documents/Final%20BSCPolicyt2.pdf).

Chemical Fume Hood

- **Always keep fume hood running in the ON position**. Fume hoods are often inter-connected with other hoods. When one hood is turned off it can create a negative pressure and draw toxins from the other hoods.

- It may be the only means of exhaust in a lab which must maintain negative pressure.
- Do not locate work areas where researchers will spend much of their day, such as desks or microscopes, across or adjacent to fume hoods. Be sure to keep exhaust slots free of obstructions. Keep only equipment that is in immediate use in the fume hood; excess equipment disrupts the air flow.
- Work at least 6" from the edge.
- Carefully remove content from fume hood to prevent contaminant spillover.
- Use a clean-wipe tissue as a primitive air flow indicator by placing it on the edge of the fume hood slashes.
- Routinely check the monitor or strips of tissue paper to verify air flow.
- Do not disable alarms that indicate inadequate air flow; contact FM Routing for repairs at 6-7511.
- Keep the hood sash opened up to the colored dot placed during testing; this is the optimum sash height for that hood and it part of the laboratory ventilation.
- Only store hazardous waste in the fume hood if sufficient space is available for performing routine lab operations.

Walk-in hoods must have adjustable sashes:

- Adjust sashes so that the airflow and the exhaust are not compromised
- Do not work inside the enclosure during the release of airborne hazardous chemicals.

Fume Hood Maintenance

- Face velocity testing is performed annually by EHSO. A sheet with the results is posted on the fume hood. If an acceptable range is not reached, EHSO shall inform the laboratory occupants not to use the fume hood until it is repaired.
- If testing is overdue, contact the EHSO Industrial Hygienist.
- Motors, belts and duct work should be inspected by Facilities Management annually and when problems arise. Call Facility Management Routing at 6-7511 when fume hoods do not appear to be working properly.

Glove Box is a device that operates in two types of manners, either by operating at positive pressure protecting the product from oxygen or moisture, or in at negative pressure protecting personnel by preventing chemical gases or vapors from exiting the box.

- Select glove material compatible with the chemicals to be used.
- Routinely inspect glove material for signs of deterioration.
- For exploratory work or very occasional operations, use a transparent glove bag.

Guides to Standard Laboratory Equipment

Glassware:

- Use only for its intended purpose.
- Inspect before use and replace or repair as necessary.
- Dispose of broken, cracked or chipped glassware in cardboard boxes labeled "BROKEN GLASS". When full, seal with tape for removal by housekeeping.

Vacuum and Pressure Operations:

- Inspect glassware for hairline cracks and flaws to prevent implosion or explosion.
- Check for leaks, pulsation, vibration, and over pressurization of high pressure systems.
- Calibrate pressure gauges regularly.
- Use a shield, dewars flask or taped vessel with operations under vacuum to confine glass and chemicals in the event of an implosion.
- Trap hazardous materials from house vacuum system or a vacuum pump with dual aspirator flasks with a neutralizer.

Laboratory Sinks:

- Line sinks with rubber or plastic mats to prevent glassware breaks.
- Pour a gallon of water monthly into infrequently used sinks and floor drains to prevent drying out of the drain trap and exposure to vapors in the drain. To retard evaporation, top off with mineral oil or seal drain shut.
- Many sinks contain eyewashes keep them free from obstructions. You should maintain at least a 6" clearance around emergency eyewashes at sinks.eep the area around a swing-arm eyewash unit clear of labware.

Cold Rooms:

- When storing human or animal parts or compounds which are unstable at ambient temperature, an alarm system or chart monitor must be installed to warn of malfunction.

Refrigerators:

- Purchase or share an explosion proof or flammable materials refrigerator for flammable or unstable chemicals.
- Store explosive liquid and solid chemicals inside an explosion proof refrigerator.
- Store Class IA flammables inside an approved flammable materials refrigerator.
- Modified domestic refrigerators are not safe.
- Flammable liquids in cold rooms must be stored in a UL listed flammable storage refrigerator or cabinet.
- Unplug malfunctioning refrigeration units and attach DO NOT USE sign until repaired.

Centrifuges

Prior to using a centrifuge please read the manufacturer's manual. Centrifuges have the ability to deteriorate without proper maintenance and the rotor has limited life span. Please use the manufacturer's log for recording time in service, speed, and rotor change-outs for centrifuges including ultracentrifuges, high speed centrifuges and high speed bench top. This will provide necessary safety information to service the device. Microcentrifuges and other low speed centrifuges do not require logs.

- Do not locate centrifuges near areas containing flammable reagents or combustible fluids, or where vibration will cause items to fall off shelves.
- Materials capable of producing flammable or explosive vapors or exothermic reactions should only be spun in centrifuges and support equipment designed for that purpose.
- Inspect the inter-lock system to ensure the cover cannot be opened while the rotor is spinning.
- Do not interchange parts from different centrifuges.
- Balance metal tubes evenly inside the centrifuge to prevent possible accidents.

- Clean and disinfect rotors and sample cavities or cups after each use with noncorrosive solutions.
- Only use only correctly fitting tubes designed for the centrifuge.
- Plastic tubes should be discarded after one cycle of ultracentrifuging; used tubes have a high failure rate.
- When using radioactive, toxic, or pathogenic materials, be aware of potential leaks and exposure to aerosols; prevent exposure with controlled ventilation or sealable caps.
- Do not leave the centrifuge until full operating speed is attained, and it appears to be running normally without vibration.
- If it begins to vibrate, stop the run immediately; wait until the rotor stops, and re-balance.
- In case of a power failure, do not try to open the lid for at least one hour; with rotor is stopped, follow manufacturer instructions for sample recovery.
- Never exceed the maximum rotor speed.
- When a centrifuge is experiencing problems or maintenance is required, immediately disconnect and mark DO NOT USE, name, date, and reason.
- Inspect rotors for corrosion or cracking before use; report problems to CHO or PI.

Bunsen burners

- Notify others in the lab that the burner will be in use so that flammable liquids are confined to fume hoods at least 10 feet away. Do not connect to the gas source with rubber or tygon tubing. Use a flexible metal hose manufactured specifically for this purpose.
- Inspect hose for cracks, holes, pinched points, or other defect and ensure it fits securely on the gas outlet and Bunsen burner to prevent possible explosions.
- Place away from overhead shelving, equipment, light fixtures, remove papers, notebooks, combustible materials and excess chemicals from the area.
- Use a sparker / lighter with extended nozzle to ignite Bunsen burner. Never use matches.
- Adjust the flame by turning the collar to regulate air flow and produce an appropriate flame for the experiment (typically a medium blue flame).
- DO NOT leave open flames unattended and never leave laboratory while burner is on.
- SHUT-OFF gas valve when finished an allow burner to cool before handling.

Electrical Safety

- Routinely check power cords for cracks, fraying and exposed wiring. Remove from service equipment with damaged electrical cords until the cords are replaced.
- **Do Not Use Electrical Tape to repair frayed or cracked cords!**
- Shut off, unplug and remove improperly operating electrical equipment and attach DO NOT USE sign until repaired.
- Most outlets are 15A or 20A do not overload them with equipment or power strips.
- Power strips are only for computerized equipment.
- Restrict extension cords to 6-foot length and only for temporary operations.
- Maintain secure cover plates on electrical outlets to prevent electrocution from exposed wire. When cover plates are missing or cracked, submit a non-billable service repair

through Facilities Management online service:
http://fmweb.fm.uic.edu:8888/famis/uicfm/main/services.jsp

- Maintain easy access to electrical panels in case of an emergency:
    - do not obstruct by refrigerators or other equipment
    - keep unlocked or have readily accessible key
    - Identify circuit breakers with labels of locations and equipment powered.

Keep belts and other moving machine parts covered with a fitting guard to prevent catching hair or clothing.

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Personal Protective Equipment (PPE)

Acceptable Conditions

When engineering controls and administrative controls are inadequate due to the specific hazards of chemicals, reaction products or the increased chance of exposure from non-routine operations such as equipment cleaning or maintenance, additional PPE may be necessary.

- Do not use PPE in lieu of engineering and administrative controls.
- PPE includes respiratory protection, eye protection, face protection, chemical protective gloves and clothing.

Respiratory Protection

Laboratory workers typically do not require respirators however; there are unique situations where employees may need to wear a respirator. Any employee may voluntarily use a respirator. There are many factors determining correct respirator usage include respirator type, face shape, work practices and effort levels, and workplace conditions such as temperature and humidity. Please contact EHSO at 3-3707 for the respirator assistance before buying or using a respirator.

The ***OSHA Respiratory Protection Standard (29 CFR 1910.134)*** requires that lab personnel who are required or choose to wear respirators and masks must first receive:

- Medical clearance (from the University Health Services), to determine physiological ability to use a respirator since it restricts air flow, limiting breathing capacity.
- Training in care and use of respirator (provided by EHSO) 3-3707
- Fit-testing (by EHSO or EHSO-approved personnel) to select the correct size and style. Studies have indicated that 10 micron sized particles can penetrate the face seal; showing importance of a proper fit. Fit tests are to be performed: initially, when determining to wear a respirator, whenever a different respirator face piece (size, style, model or make) is use and at least annually thereafter.

Eye and Face Protection

At minimum, safety glasses with brow bar and side shields must be worn when performing, observing, or supervising operations where there is a reasonable possibility of physical injury to the eyes. Street safety glasses are not acceptable. Select safety glasses for wearing over prescription glasses that will fit closely around the eyes, such as the OTS by Pyramex. When purchasing prescription safety glasses you should select glasses with side shields and brow bar. Most providers of prescription eyewear can order safety glasses.

Splash Goggles
All goggles should be worn when performing, observing, or supervising work where there is a possibility of chemical splashes or sprays or when wearing contact lenses in the lab.

- Wear face shields in addition to safety glasses or goggles when face protection is required, i.e. working with extremely toxic or corrosives.
- Wear face shields and/or use explosion shields if the possibility of implosion or explosion exists (e.g., rotavapping outside of a fume hood).
- Clean goggles and face shields with mild detergent and water after use.
- Do not wear contact lenses in a dusty environment. Dust particles can become lodged behind a contact lens and irritate or scratch the cornea.

Chemical Protective Gloves:
Research indicates that glove thickness is more important than material, since all materials tested have been found to be permeable to some chemicals and hazardous drugs. Unless the chemical manufacturer specifically stipulates another glove material, wear thicker, longer gloves that cover the lab coat or gown cuff. Please refer to EHSO chemical resistance chart for glove information available in **Appendix M.**

- Select powder less gloves since the powder may absorb contamination.
- Due to the variability in permeability within and between glove lots, double glove if it does not interfere with the technique.
- Wear outer glove over the lab coat or gown cuff and inner glove under the cuff.
- Remove inner glove after removing lab coat or gown.
- Because gloves are permeable to some extent and the permeability increases with time, change regularly (hourly) or immediately if gloves are torn, punctured, or contaminated with a spill.
- Always wear gloves when handling all chemicals.
- No one glove material is effective for use with all chemicals.
- ***DO NOT WEAR LATEX EXAM GLOVES FOR CHEMICAL WORK.***
- Wear nitrile rubber gloves, at least 3.5mil thickness, while performing most laboratory experiments where incidental splashes may occur.
- Double glove when working with extremely toxic or corrosive chemicals; one pair under the sleeves, second pair over the sleeves.
- Do not touch door handles and telephones with contaminated gloves, to prevent the spread of contamination.
- Wash hands with soap after removing gloves and before leaving the laboratory.
- After use, wash reusable gloves, rinse inside and out, and turn inside out to dry.
- To remove gloves without contaminating yourself:

1 Strip off one glove from the wrist, turning it inside out so the clean side is outside.



2. Place that glove in the other hand and strip off the glove on that hand, turning it inside out.


3. Dispose of gloves in a waste container.
4. Wash hands with soap and water.

Laboratory Attire

- Wear protective clothing (lab coat, tyvek suit or apron with Tyvek sleeves) when working with chemicals. Wear pants or skirts that cover the legs.
- Do not wear sandals or open-toed shoes to prevent injuries from falling glass and equipment.
- Do not wear canvas or other cloth shoes that spilled chemicals will easily penetrate.
- Wear caps or hair fasteners to prevent long hair from entangling in experiments.
- Do not wear over-sized clothing; excess material can contribute to spills or become entangled in mechanical apparatus.
- Do not wear nylon hosiery; chemical spills or splashes can fuse it onto skin.
- Do not wear shorts, miniskirts or tops with exposed midriffs.
- Remove protective clothing when leaving the laboratory facility and launder work clothes often.
- Wash promptly if skin is splashed with a chemical, regardless of corrosivity.
- Immediately remove protective clothing when significantly contaminated.
- When clothing has been splashed with a chemical, remove it while under the emergency shower.

Chapter 9: Hazardous Waste Management in UIC Laboratories

The University is required to manage hazardous wastes in a safe and environmentally sound manner according to federal and state regulations. As a generator of hazardous waste, you are responsible for ensuring that you and your employees follow University guidelines concerning management and disposal of hazardous waste within your laboratory.

What is Hazardous Waste?

Solid, liquid, and gaseous materials can all be hazardous wastes. If a chemical you no longer want may be hazardous, it is your responsibility to complete a waste removal form. Wastes are defined as hazardous by EPA if they are specifically named on EPA's lists of hazardous wastes (listed wastes) or if they exhibit one of four characteristics (characteristic waste). Each of these types of waste is discussed in more detail below:

Listed Wastes:

Wastes are listed by EPA as hazardous because they are known to be harmful to human health and the environment. A discussion of the three hazardous waste lists that affect UIC is below. All of these lists are in Appendix J.

F-List Wastes – Non-Specific Source Wastes

F-List Wastes are generated by a wide range of facilities. Many solvents commonly used in laboratories at UIC are listed on the "F" list as hazardous waste. For example, spent toluene, Xylene, and acetone are all considered hazardous waste because they are on the "F" waste list. See Appendix J for the "F" list of hazardous wastes.

P-List Wastes – Acutely Hazardous Chemical Products

Chemicals on the "P" list are acutely hazardous due to their toxicity. If you want to get rid of an off-specification, out-of-date, or simply unwanted chemical that is on the "P" list, the chemical is considered hazardous waste. Chemicals can only be P-listed wastes if they were never used. For example, if a researcher wants to dispose of an old half-full container of pesticide with aldrin as the sole active ingredient, it would need to be treated as a hazardous waste because the chemical aldrin is on the P-waste list. See Appendix J for the "P" list of hazardous wastes.

U-List Wastes – Hazardous Chemical Products

Chemicals on the "U" list are hazardous due to their toxicity. If you want to get rid of an off-specification, out-of-date, or simply unwanted chemical that is on the "U" list, the chemical is considered hazardous waste. The U-waste codes are for chemicals that were never used. The

difference between the P and U list is P-list chemicals are considered more acutely hazardous than U-list chemicals. For example, if a researcher wants to discard of some old Xylene, it would need to be treated as hazardous waste with the U239 waste code, because the chemical Xylene is on the U-waste list. *Note: that if the Xylene was actually used to perform a laboratory analysis, the Xylene would receive the F003 waste code, because the waste is spent, not used. Spent waste is waste that has been previously used in your experiment.* See **Appendix J** for the "U" list of hazardous wastes.

Characteristic Wastes D-List
Even if a waste does not appear on one of the EPA P or U hazardous waste lists, it still is regulated as a hazardous waste if it exhibits one or more of the characteristics below.

Ignitability D001
Ignitable wastes have a flash point less than 140°F. A majority of the solvent waste generated in UIC laboratories is flammable.

Corrosivity D002
Corrosive wastes are acids and bases that are capable of corroding metal as well as human skin. Corrosive wastes have a pH less than 2 or greater than 12.5. Spent acids and bases are often corrosive wastes.

ReactivityD003
Reactive wastes are unstable under normal conditions. They can cause explosions or release toxic fumes, gases, or vapors when mixed with water or air. Examples of reactive waste are ethers, perchloric acid, nitrocellulose, potassium, sodium sulfide, and picric acid <30% water.

Toxicity D004 thru D044
Toxic wastes are harmful or fatal when ingested. When disposal of toxic wastes occurs on land, contaminated liquid may leach from the waste and pollute groundwater. Forty chemicals are listed in the toxic category. A waste is toxic if it contains one of the listed chemicals in concentrations over the threshold specified by EPA. Toxic wastes commonly generated at UIC include mercury, suspect carcinogens, chromium compounds, and cyanide compounds.

<u>Compliance with Environmental Regulations:</u>

Do Not Dispose of Hazardous Waste by Evaporation, Sewer, or Trash!

Caution: Never throw hazardous materials into the trash, down sinks, toilets, floor drains, etc! You can be held criminally liable for purposely misrepresenting the contents and improperly disposing of your wastes! No matter how "harmless" the chemical NEVER throw chemicals down the drain, out in the trash, or out in the environment without the approval of the Hazardous Waste Compliance Manager (for contact information, see page 2, "Non-Emergency Telephone Numbers"). Remember, you will be held liable.

Illegal Hazardous Waste Disposal
It is illegal to dispose of hazardous chemicals in any of the following ways:

- Disposal down the drain.
- Intentional evaporation in a fume hood.
- Disposal in the regular trash.

Guidelines for Your Laboratory:

How to Set Up Your "Unwanted Chemical Area"

RCRA allows hazardous waste generators to accumulate up to 55 gallons of hazardous waste (or 1 quart of acute hazardous waste) in your laboratory. This means UIC laboratories- including teaching and research labs, art studios, photo labs, field labs, diagnostic labs in teaching hospitals, and areas that support labs like chemical stockrooms and prep rooms- may accumulate up to 55 gallons of hazardous waste or one quart of "P" listed hazardous waste in containers in the lab. However, for safety reasons, UIC does not want researchers to accumulate more than 20 gallons of waste in a laboratory.

Every lab should establish an **"**Unwanted Chemical Area" for chemicals that are no longer needed or wanted. Please contact the Hazardous Waste Compliance Manager to ensure your "Unwanted Chemical Area" is set up correctly and follow the guidelines below:

- Do not let excessive waste collect in the "Unwanted Chemical Area". RCRA does not allow more than one quart of P-listed waste to be stored in a laboratory.
- The area should be marked with a sign reading "Unwanted Chemical Area." A template for your "Unwanted Chemical Area" sign is provided on the EHSO website.

How to Properly Manage Waste Containers in your "Unwanted Chemical Area"

Laboratories must assure that their unwanted chemicals are accumulated in safe, transportable containers and are stored properly to prevent human exposure or environmental release. Follow the guidelines below in managing your waste containers.

Never overfill waste containers. Expansion and excess weight can lead to spills and explosions**.**

- Containers must not be filled beyond their weight and volume capacity.
- Jugs and bottles should not be filled above the shoulder of the container.
- Chemicals should be labeled "Unwanted Chemical," have the name of the chemical, percentages of each constituent if the chemical is a mixture, and the hazard of the chemical (i.e. flammable, corrosive). A template for the "Unwanted Chemical" label is provided on the EHSO website.
- If you routinely generate waste such as solvents which have been determined by EHSO to be hazardous, you may use a "Hazardous Waste" label. Be sure to include the name of the chemical, percentages of each constituent if the chemical is a mixture, and the hazard of the chemical (i.e. flammable, corrosive).

Keep waste in compatible containers. For example, use polyethylene for organic solvents and glass jugs for strong caustic solutions. Make sure the containers and caps will not react with your waste! You can check RTP Company's website to see chemical resistance of certain plastics at http://www.rtpcompany.com/info/guide/resistance.htm.

Keep waste containers closed at all times except when adding, bulking, or removing waste. There are a couple exceptions to the general rule that all waste containers must be kept closed:

Containers may be opened when venting is necessary such as for operation of equipment like HPLCs or to avoid pressure build-up.

A working container that is less than 2 gallons may also be opened until the end of a procedure or shift, whichever is first.

Caution: Do not leave a solvent bottle, drum, or any bottle of waste open with a funnel in it for the sake of convenience! This behavior can result in a large EPA fines. This is one of the most common violations found in laboratories.

Use secondary containment for liquid waste. Use containment trays or safety cabinets to store the waste containers. This way, if the waste container breaks or leaks, the spill is enclosed in a back-up container.

Containers must be in good condition (i.e. not apt to leak/fail - no rusting, cracks, dents, etc.).

Be sure the following groups of chemicals are segregated from one another:

Halogenated solvents (i.e. chlorinated solvents)
Non-halogenated solvents (Xylene, acetone, toluene, etc)
Acids (inorganic or organic)
Bases (inorganic or organic)
Heavy metals (silver, cadmium, lead, mercury, etc.)
Toxins (inorganic or organic)
Reactive (cyanides, sulfides, water reactive chemicals, peroxides, etc.)

Different classes of hazardous chemical waste must not to be co-mingled in the same waste container.

Do not combine inorganic heavy metal compounds and organic waste solvents.
Do not combine non-hazardous waste (e.g., a mixture of water, dilute acetic acid, and sodium bicarbonate) with hazardous chemical waste, since this then requires that the entire container of otherwise non-hazardous waste be treated as hazardous waste.

What to Do with Empty Chemical Containers

Empty chemical containers may be reused or disposed with other non-hazardous trash, provided that the following requirements are satisfied. EPA regulations stipulate that **an empty chemical container** must:

- not contain free liquid or solid residue,
- have the label removed or defaced,

- have the lid or cap removed

It is not necessary to break empty glass containers when placing them in a dumpster or trash container.

Requesting Waste Collection

The ability of EHSO to make an appropriate waste determination completely depends on the accuracy of the information supplied by the researcher on the waste removal request form. EHSO needs to know the process generating the waste, complete chemical name, percentages of all the chemical constituents in the waste, and the pH of the waste.

If you want waste removed, please fill out the waste removal form completely. An example waste removal form is included in Appendix K for your reference. It is found online at http://www.uic.edu/depts/envh/HSS/ChemWaste.html
E-mail the completed form to chemwaste@uic.edu

The hazardous waste removals service will not pickup containers with improper caps, leaks, outside contamination, or improper labeling. If the waste is unsuitable for pick-up, you will be left a "trouble report", which states why the waste could not be picked up.

Most Common Hazardous Waste Regulatory Violations Found in Laboratories

The following list shows hazardous waste violations which are most commonly cited by regulators. Please review this information and correct any problems in your area. Failure to periodically review your compliance efforts can cause health and safety violation as well as fines from state and federal inspectors. Fines are the responsibility of the department that incurs them.

Problem	Solution
Waste Labeled Improperly	Waste containers must have: • the words "Unwanted Chemicals" • A description of the waste (i.e. spent Xylene) • The hazards associated with the waste (i.e. flammable) • Name of person responsible
Waste containers not closed	Keep containers closed except for the exceptions discussed in previous section
Waste not contained properly	Containers of liquid waste need secondary containment. Bottles of waste should be kept in chemically resistant trays and separated by hazard class
Lab personnel not aware of proper response in event of chemical spill, fire, explosion, or injury	Be sure to complete the site-specific emergency plan for your laboratory and communicate it with other employees. Lab workers, including students, must be trained prior to working with hazardous waste and must receive periodic refresher training. See "Chapter 2-Training" of this Lab Safety Plan.
Chemicals disposed of improperly	1. Do not dispose of chemicals in the sewer or the trash without approval of the Hazardous Waste Compliance Manager.

	2. Do not evaporate residual solvents in fume hoods. 3. Use condensers on all distillation and concentration procedures.
Waste not compatible with the storage container used	Use containers and lids that are compatible with the waste stored in them.
No aisle space maintained around hazardous waste	Keep the "Unwanted Chemical Area" in your lab clear so fire and spill control equipment can get to the waste in an emergency.

Reducing Waste Generated in Your Lab

Your research dollars fund disposal and management of hazardous waste at UIC. Hazardous chemicals can be treated to reduce the hazard or the quantity of waste in the laboratory *if the treatment procedure is included in the experimental protocol*. Below are some techniques to reduce the amount of waste you generate. Please check the Waste Minimization Plan for more details in reducing hazardous waste in the laboratory.

1. Use microscale techniques, chemical substitutes, or process modification to reduce the amount of waste generated. Refer to the EPA's Green Chemistry page for ideas. http://www.epa.gov/gcc/pubs/about_gc.html

2. Refer to MIT's Green Chemical List to find nonhazardous chemicals you can substitute for hazardous chemicals you currently use in your experiments. Refer to the MIT Green Chemical Alternatives Wizard (http://web.mit.edu/environment/academic/purchasing.html)

3. Neutralize corrosives- If the waste is only corrosive and has no other hazardous waste characteristics, neutralize it so it does not need to be disposed as hazardous waste. See Princeton's EHS website for neutralization tips and techniques. http://web.princeton.edu/sites/ehs/chemwaste/elementaryneutralization.htm

4. Use specialty detergents (e.g., potassium hydroxide or sonic baths instead of chromic acid solutions) to clean glassware

40 % of hazardous wastes generated at laboratories are expired and unused chemicals. **Avoid throwing valuable research dollars away by doing the following:**

- Check if you have a chemical in stock before you order a new one. Keep an updated chemical inventory.
- When ordering chemicals, only order what you will need.

Share unused or rarely used chemicals. Check the Resource Research Center Scientific Supply Center's webpage to see an inventory of surplus chemicals. http://www.rrc.uic.edu/supplycenter You can have these chemicals for free! Share chemicals with your neighbors. If you only need a small amount of a chemical for a pilot study, check with your neighbor before purchasing a large quantity. There's a good chance someone around you will have that chemical on hand.

- Periodically inspect stored chemicals for signs of leakage, poor storage practices, and other problems. Conduct a laboratory clean out annually to check for unused chemicals and complete a waste removal request for chemicals you are no longer using.

Chapter 10: Emergency Procedures

Emergency Safety Equipment:

Safety *Showers*

General Specifications

- Shall be located within a 10 second travel time (approx 100 ft), away from obstructions or chemical hazards.
- Maintain a 36-inch circumference area free and clear of obstructions.
- Do not house electrical equipment where it may be splashed by the shower.
- When the system does not include a drain, have a means for collecting the water.
- Must be separately plumbed with tepid and potable water.
- Must be tested at least annually by Facilities Management (FM) for proper flow and operation. A tag displays the date of the test. If testing is past due, request FM to test the equipment by placing a non-billable work order. http://fmweb.fm.uic.edu/FMweb/default.aspx

***Eyewash* stations**

- Flush weekly to flush out stale water and microorganisms such as bacteria, fungi and amoebae. A flush must be kept for all eyewashes.
- Maintain a 1-foot circumference area around eyewashes attached to sinks. Clear around eyewashes so they can be readily accessed in an emergency. A co-worker with acid in their eyes will not be able to see to move clutter from the eyewash.
- Portable, wall-mounted eyewash units are prohibited.

Fire Protection:

Fire extinguishers

- When there is no fire extinguisher within 50 feet (travel distance) of the exit door or inside the laboratory, contact EHSO Fire Safety Officer at 3-3706 for assessment or replacement.
- When located inside the lab, they must be hung near the exit door and never be obstructed.

Overhead Sprinkler Systems

- In buildings with a sprinkler system, an 18” clearance from the ceiling must be maintained to allow full water coverage from the sprinklers.

Laboratory Corridor Doors

- Keep closed at all times for fire protection and to maintain negative pressure.
- Two exits from labs are required when:
- highly toxic gases, pyrophoric materials, large quantities of flammable liquids or gases are stored
- lab area is over 1000 square feet
- travel distance to the exit door exceeds 50 feet
- Doors shall swing in the direction of egress if there are found to swing in the opposite direction please contact EHSO 6-SAFE.

Chemical Spills:

Complicated Spills

- Require outside assistance and professional staff: DO NOT ATTEMPT TO CLEAN UP complicated spills. Call campus police 5-5555.

Complicated spills are the following:

- A person is injured
- Identity of the chemical is unknown
- Multiple chemicals are involved
- The chemical is highly toxic, flammable, or reactive
- Any spill greater than 4 liters.
- The spill occurs in a "public space" such as a corridor
- The spill has the potential to spread to other parts of the building such as through the ventilation system.

Responding to Simple Chemical Spills

Simple spills are spills where one person can clean up using a spill kit as defined at www.uic.edu/depts/envh and with guidance from EHSO.

WHAT TO DO INCASE OF A SPILL

1. Tell someone else in the lab and get their help
2. Call the EHSO emergency number, 6-SAFE (312-996-7233)
3. If you are injured:

a. Go to nearest eye wash and flush eyes for 15 minutes (if chemical splashed into eye)
b. Go to nearest safety shower, remove affected clothing, and flush injured area for 15 minutes (if chemical splashed anywhere else on body)
c. Go to the UIC Emergency Room and bring 1) UIC Employee's Injury Report Form and 2) MSDS of the chemical

4. If the spill is not producing hazardous vapors:

a. Put on all Personal Protective Equipment (nitrile gloves, lab coat or apron, goggles)
b. Remove any broken glass pieces
c. Dike and cover spill with sorbent material

Before a spill occurs you should evaluate the potential hazards in advance of using the chemicals. The first source of information to consult would be your Material Safety Data Sheets (MSDSs). [If you need an MSDS, contact the Chemical Safety Section at 3-3387 or 6-9706. Some types of hazards are:

- air reactive
- water reactive
- flammable
- polymerizable
- corrosive
- highly toxic

Based on these hazards, you can then determine:

- Appropriate personal protective equipment for spill response (e. g. gloves, respirators, etc.)
- types of fire suppression equipment
- appropriate clean up materials
- first aid procedures

Recommend Spill Kits:

Prepackaged spill kits are available from various vendors. The prepackaged kits tend to be expensive, so campus units typically make their own kits. To make your own kit, include the following items at a minimum:

- Disposable nitrile gloves (1 box)
- Neoprene gloves (1 set) (Used for corrosive)
- Safety goggles
- Hand broom
- Plastic dustpan
- 4-mil plastic zippered bags
- Appropriate absorbent material (such as spill pads, spill pillows or loose sorbents)

Guidelines for all simple spills

- If you have questions about the proper procedure, call EHSO 6-7233(SAFE).
- Double glove with nitrile rubber gloves, wear goggles when quantities are greater than 100 ml concentrated acid or base and a lab coat or apron.
- If the spill is an acid, base, mercury, or flammable liquid see the special spill guidelines.
- Cover the spill with the appropriate absorbent material. See the guidelines for specific spill types below.
- Isolate area by taping it off so people do not step in the spill and track it through the laboratory. Have those not involved in spill response leave the area.
- Using a plastic scoop
- Scoop the absorbed mixture into a plastic bag or spill kit bucket.
- Clean spill area with detergent and water. Rinse the area with fresh water. Then contact house cleaning to mop the floor.
- Place contaminated material in a sealed container and fill out waste removal form at EHSO website if you think the material spilled would be a hazardous waste. (http://www.uic.edu/depts/envh/HSS/ChemWaste.html)

Acid and Caustic Spills

- Cover the spill with an acid and caustic absorbent. You may also use a universal spill pads for liquid acids.
- Do not attempt to neutralize.
- These procedures do not apply to hydrofluoric acid. Call EHSO for HF spills

Flammable Liquid Spills (i.e. Solvent Spills)

- Shut off all sources of ignition if it is safe to do so.

- Flammable liquids must not be absorbed into paper towels or other combustible materials (material that will burn when a match is put to it).
- A universal spill pad is appropriate for flammable liquids.

Antineoplastic Drug Spills

- Utilize a Chemo Spill Kit, such as made available through Chemo-Safety Systems, Division of Biosafety Systems Inc., San Diego, CA, (1-800-421-6556).

Mercury Spills

- If you use mercury thermometers or stock mercury please contact Lab Safety Supply for item # 39963, a mercury spill kit.
- Verify the equipment contains mercury, a silvery metallic liquid.
- If the spill is small, such as from a thermometer, and relatively contained, use the method described in the box below.

Small Mercury Spill Clean-up Procedures

- Put on nitrile gloves. If the thermometer has broken on the floor, put on Tyvek shoe covers.
- Open up a plastic debris bag which can be used to collect contaminated gloves, shoe covers, and glass from the thermometer.
- Carefully collect mercury droplets using index cards or folded paper and place into a small container (glass or plastic) and label as hazardous waste.
- Visually scan area to ensure that all mercury has been cleaned up, using a flashlight to look for shiny droplets. Look in cracks and crevices for mercury.
- Seal container of mercury generated. Seal bag of gloves, shoe covers, and cleanup materials, and label as mercury contaminated debris.

Disposal of Waste Generated during Clean-up:

See Chapter 8- Hazardous Waste.

Fires

In case of fire, follow the acronym **RACE**
RESCUE anyone in immediate danger of the fire.
ACTIVATE alarm (For alarm locations see Part 3, Section 1.0) and dial 6-3473 (6-FIRE). Retain phone contact with the UIC Police who will notify the Chicago Fire Department.
CONFINE the fire by closing windows and doors to the fire.
EVACUATE to an area of refuge or EXTINGUISH fire only if you have been trained and the fire is small. If you choose to extinguish the fire, be sure you have a safe escape route, with your back to the exit, in case you are unsuccessful in fighting the fire.

Evacuation Procedures (if you have doubts about your ability to extinguish the fire):
Leave the scene. Close doors completely to inhibit the spread of the fire and to diminish smoke. Never use elevators. Before opening a door, feel the door's surface with the back of your hand to be sure the fire hasn't spread to the room or corridor you wish to enter. If smoke is a problem,

place a wet cloth over the mouth and nose and stay as low to the floor as possible. Keep in mind that hot gases rise, but most chemical vapors are heavier than air, so they will tend to sink towards the ground.

Types of Fire Extinguishers

- Class A extinguishers (water-filled) are used on fires involving ordinary combustibles such as paper, cloth and plastics.
- Class BC extinguishers (identified by the large horn and producing carbon dioxide gas) are used for flammable liquid fires or charged electrical equipment fires.
- Class ABC extinguishers (dry powder) can be used for all three types of fires (i.e., fires involving ordinary combustibles, flammable liquids, or charged electrical equipment.

How to use a fire extinguishers PASS:

PULL the safety pin out, release a lock latch or press a puncture lever.
AIM the extinguisher nozzle, horn or hose low at the base of the fire's leading edge.
SQUEEZE or press the extinguisher's handle to release the extinguishing agent.
SWEEP the extinguisher from side to side, progressing from the leading edge of the fire toward the center, until the fire is extinguished. Extinguishing techniques may vary; read the directions on the extinguisher.

Procedures for Clothing on Fire (Do not use a fire blanket as they retain the heat):

STOP moving and call for help.
DROP to the ground.
ROLL to smother the flames and to keep flames from the face and hair.

Then call police 5-5555 immediately and seek medical attention at UIC Emergency Room.

Power outages:

To prevent a potentially dangerous situation in laboratory buildings when a power outage occurs, before leaving the area, scan the laboratory making sure that experiments are brought to a safe mode. Ensuring that chemical containers, including waste containers, are capped to minimize hazardous vapors in the air and that gas to equipment are turned off at the source. During a power outage, the accumulation of vapors in air, followed by spark producing power start-ups, increases the chance of igniting the accumulated vapors, so please shut down any laboratory equipment that uses flammable solvents. Ensure the following in a power outage:

- Biohazards should stay in place inside that Biosafety cabinets with the sash pulled all the way down. When returning back to the laboratory after the power outage run the cabinet for at least ten minutes for filtration and wash the surfaces with a10% bleach spray before beginning any work inside the cabinet.
- Radioisotopes are appropriately stored and locked away.
- Volatile liquids are stored in closed cabinets, preferably approved flammable storage type. Make sure the cabinet vents on the side panels are covered with bungs.
- Light switches are in the OFF position.

Water Outages:

During water outages experiments and chemical manipulations that require water should be shut down. Since safety showers and eyewashes will not function, chemical process with hazardous materials should be shut down.

Chapter 11: Biological Safety

The Biological Safety Manual is a guidance document to provide assistance to lab personnel handling and generating waste from:

- specimens or tissue from humans or animals
- blood or body fluids from humans or non-human primates
- recombinant DNA
- microorganisms such as bacteria, viruses, fungi, prions, rickettsia and parasites
- biological toxins;

The Manual outlines risk assessment determination, specific policies and procedures, and work practices necessary to reduce or eliminate exposure to biological hazards and promote a safe laboratory work environment. The Biological Safety Manual is found at http://www.uic.edu/depts/envh/HSS/Documents/BSM2004.pdf
For any questions regarding handling of biohazardous materials and waste, please contact the Assistant Director for Biological Safety or the Biosafety Officer.

Shipping and Receiving Infectious Substances
For guidance on the shipping and receiving of infectious substances, please contact the Assistant Director for Biological Safety, the Biosafety Officer, or the Hazardous Waste Compliance Manager. Call 3-2426 for more information.

The Bloodborne Pathogen and Needlestick Prevention
This program is required by the Occupational Safety and Health Administration (OSHA) Standard 1910.1030 for all researchers, students, faculty and staff working in laboratories with potentially infectious materials. The Standard outlines procedures to protect workers against bloodborne diseases such as HIV and Hepatitis. It requires:

- A written Exposure Control Plan (ECP) which outlines the specific measures to be taken to protect employees. The University's ECP can be found at http://www.uic.edu/depts/envh/HSS/Documents/ExposureControlPlan2009.pdf
- Bloodborne Pathogen and Needlestick Prevention training which can be found at http://www.uictraining.org
- Engineering and work practice controls (such as Biosafety cabinets, hand washing sinks and personal protective equipment (PPE) which the University/employer must make available to employees
- Vaccination and/or medical surveillance if the employer has identified this as a requirement for the employee in order to perform their job duties
- Procedures for potential exposure incidents
- A program for biohazardous waste management
- A training program on bloodborne pathogens and needlestick

The Select Agent Program
This program is designed to provide safety and security for the transfer, possession and use of CDC/USDA-listed Select Agents. The Select Agent policy, including a list of the CDC/USDA-listed Select Agents can be found at http://www.uic.edu/depts/envh/Departmental/Documents/UICSAPolicy1.pdf. Please contact the Senior Biological Safety Specialist if you plan on working with any of the listed select agents. No Select Agent/Toxin can be obtained, transferred, destroyed or used without the consultation of EHSO's Biological Safety Personnel.

Chapter 12 Reference Materials

Publications

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Safe Laboratories: Principles and Practices for Design and Remodeling, P. C. Ashbrook, and M. M. Renfrew, Lewis Publishers, Inc. Chelsea, MI, 1991.

Safe Storage of Laboratory Chemicals, David A. Pipitone, John Wiley & Sons, New York, 1991.

National Fire Protection Association (1996), NFPA 30: Flammable and Combustible Liquid Code. Batterymarch, PA: NFPA

National Fire Protection Association (1996), NFPA 45: Fire Protection for Laboratories Using Chemicals. Batterymarch, PA: NFPA

Occupational Safety and Health Administration (1996). General Industry Safety and Health Standards 29CFR 1910.106. Washington, DC: Bureau of National Affairs, Inc.

Appendix A: Incompatible Chemicals

Use as a guide; specific incompatibilities are in MSDSs. Consult *Bretherick's Handbook of Reactive Chemical Hazards* (Urben, P.G.; 6th ed; Butterworth-Heinemann: London, 2000; book or CD-ROM) for an extensive listing and thorough discussion of incompatibilities.

Chemical	Keep Out of Contact With
Acetic acid	Oxidizing agents, e.g., chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Nitric acid, sulfuric acid, other oxidizing agents
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals	Water, carbon tetrachloride or other chlorinated hydrocarbon compounds, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury (e.g., in manometers), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, other oxidizing agents
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Chromium trioxide (chromic acid)	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids
Copper	Acetylene, hydrogen peroxide
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons (e.g., butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide, other oxidizing agents
Hydrocyanic acid (anhydrous)	Alkali
Hydrofluoric acid	Potassium permanganate, sulfuric acid
Hydrogen sulfide	Metal oxides, powdered copper, oxidizing gases
Hypochlorites	Acids, activated carbon, ammonia
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Powdered metals and non-metals, metal sulfides, flammable/combustible liquids

Chemical	Keep Out of Contact With
Nitric acid	Acetic acid, aniline, sulfuric acid, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable/combustible liquids and gases, copper, brass, heavy metals, alkalis
Nitrites	Ammonium salts, amides, phosphides, reducing agents
Nitroparaffins	Acids, bases, amines, halides
Oxalic acid	Silver, chlorites, urea
Oxygen	Oils, grease, hydrogen, and other reducing agents, including flammable liquids, solids, and gases
Perchlorates	See Chlorates
Perchloric acid	Reducing agents such as acetic anhydride, bismuth and its alloys, alcohols, paper, wood, grease, oils
Phosphorus (white)	Air, oxygen, alkalies, halogens, halogen oxides, oxidizing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, other reducing agents, sulfuric acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium peroxide	Ethyl and methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Permanganates, water, aqueous solutions, reducing agents, chlorates, perchlorates, nitric acid

Emergency Preparedness for Individual Laboratory Units Site-Specific Plans

Emergency Equipment Locations

Fire Extinguishers:

Fire Alarms:

Emergency Exits:

Eye Wash Stations:

Emergency Showers:

Electrical Control Panel/Shut-Offs/Breaker Panels:

Chemical Spill Kits: