Lab Safety Manual

University of Massachusetts Boston

Office of Environmental Health and Safety

September 2021

www.umb.edu/ehs

Laboratory Safety Committee

Department	Members	Position	Email
Physics	Jonathan Celli	Chairperson, Principal Investigator	jonathan.celli@umb.edu
Art	Nancy McCormack	Tech Specialist	nancy.mccormack@umb.edu
Anthropology	Melody Henkel	Lab Director	melody.henkel@umb.edu
Biology	Emily Parodi	Lab Director	emily.parodi@umb.edu
Chemistry	Ryan Fitzgerald	Lab Director	ryan.fitzgerald@umb.edu
Chemistry	Niya Sa	Principal Investigator	niya.sa@umb.edu
Engineering	Matthew Bell	Principal Investigator	matthew.bell@umb.edu
Facilities	Jim O'Day	Deputy Director	james.oday@umb.edu
Office of Environmental Health and Safety	Lalitha Adusumilli	Associate Director	lalitha.adusumilli@umb.edu
Office of Environmental Health and Safety	Zehra Schneider Graham	Director	zehra@umb.edu
Office of Research and Sponsored Programs	Tracey Poston	Assistant Director of ORSP Research Compliance and Integrity	tracey.poston@umb.edu
Psychology	Eric Berry	Lab Director	eric.berry@umb.edu
School for the Environment	Robert Chen	Dean, Principal Investigator	bob.chen@umb.edu
School for the Environment	Karen Johnnesson	Principal Investigator	karen.johannesson@umb.edu
Registrar’s Office	Michael Pollard	Associate Registrar	mike.pollard@umb.edu

Table of Contents

Chapter I: Introduction

The UMass Boston Laboratory Safety Manual (the Manual) was developed by the Office of Environmental Health and Safety (OEHS) in collaboration with the Laboratory Safety Committee. Many of the Lab Safety Committee members are faculty, researchers, and lab directors.

The primary purpose of this Manual is to protect laboratory workers and students in laboratories and to protect the environment from hazardous material releases. This Manual establishes safe work practices, standard operating procedures, control measures and special precautions for work with particularly hazardous substances.

Safe laboratory practices are the responsibility of every worker and student and continuous improvement is an overriding goal of this Manual.

The Lab Safety Manual is built upon two federal government standards: the OSHA Lab Standard and the EPA Alternative Requirements for Hazardous Waste Determination and Accumulation of Unwanted Material for Laboratories Owned by Eligible Academic Entities. The OSHA Standard (see 29 CFR 1910.1450) is worker-oriented and establishes administrative, operational, and instructional requirements. The EPA Environmental Management Standard (see 40 CFR 262 Subpart J) focuses on laboratory waste management, establishes “minimum performance criteria,” and requires a written plan.

This Manual is designed as an essential element of the UMass Boston OEHS Management system as described in the OEHS Management Policy (FY 17-OEHS-002-00). The Policy adopted in November 2017 details the University’s commitment to environmental health and safety, describes the OEHS management system and clarifies roles and responsibilities. In this policy OEHS is delegated responsibility and authority for overall lab safety compliance.

Another UMass Boston manual provides broader guidance for environmental health and safety programs beyond the laboratory. This complementary document is called the “EHS Management Plan”. The EHS Management Plan establishes broad university policies and objectives for hazardous material spills, asbestos management, fire safety, waste management, pollution prevention, worker safety and other OEHS program areas.

Chemical Hygiene and Chemical Safety

In 1991 the Occupational Safety and Health Agency (OSHA) enacted the Lab Standard ("Occupational Exposure to Hazardous Chemicals in Laboratories Standard," 29 CFR 1910.1450), which states:

"The Laboratory Standard...is designed to provide a comprehensive approach for the protection of laboratory workers which is more appropriate to laboratory conditions than compliance with the substance-specific standards. The Laboratory Standard requires that employers protect workers through the development and implementation of work practices and control measures expressly tailored to the individual laboratory workplace."

The University of Massachusetts Boston, as an institution of the Commonwealth of Massachusetts, is not formally bound by federal occupational health standards. Nonetheless, it is the intent of UMass Boston to model its programs on the federal standards wherever feasible.

Environmental Protection

Protection of the environment is regulated by U.S EPA in part under the Resource Conservation and Recovery Act (RCRA). RCRA is the law that provides guidelines for the handling of hazardous wastes. Generators of waste are responsible to ensure that when waste is eventually removed from the laboratory it is handled properly. The laboratory worker who generates waste has an obligation to consider the fate of the materials resulting from his or her work. The high cost of disposal of many materials, the potential hazards to people outside the laboratory, and the impact on the environment are all important factors to be considered.

In September of 1999, the Environmental Protection Agency and three academic institutions (Boston College, University of Massachusetts Boston and University of Vermont) signed an agreement under the EPA's Project XL program to pilot a new system of managing hazardous wastes in laboratories. Like OSHA's Laboratory Standard, the Environmental Management Standard was developed to replace EPA's hazardous waste requirements that are more applicable to industrial facilities. Coinciding with the agreement, the EPA promulgated new regulations entitled "University Laboratories XL Project - Laboratory Environmental Management Standard." That remained in place until EPA promulgated new rules for academic laboratories in 2008 when they published a new rule known as Subpart K to RCRA "Alternative Requirements for Hazardous Waste Determination and Accumulation of Unwanted Material for Laboratories Owned by Eligible Academic Entities."

In November 2019, Massachusetts adopted the federal rule – see 310 C.M.R. 30.354.

The rule allows Eligible Academic Entities the flexibility to make hazardous waste determinations in the laboratory, at an on-site central accumulation area, or at an on-site treatment, storage, or disposal facility (TSDF). This rule also provides incentives to clean-out old and expired chemicals that may pose unnecessary risk, and requires a Laboratory Management Plan (LMP) which is intended to result in safer laboratory practices and increased awareness of hazardous waste management.

Chapter II: Roles and Responsibilities

Section 1 – Administrative Responsibilities

The activities of the university research community are varied, complex and constantly changing. Most decisions regarding safe work practices for a particular procedure will have to be made by the individual laboratory worker developing or carrying out that procedure. Our goal then is to create an organizational structure which ensures an adequate flow of pertinent, lab-specific information to workers. This requires the training needed to use this information and design of safe work practices for specific tasks. To this end, the following entities are responsible for implementing the requirements of the Manual:

University Senior Management

University Senior Management as defined by this plan consists of the Chancellor, the Provost, University Deans, and the Vice Chancellor of Administration and Finance. Senior management is bestowed with the ultimate authority to ensure proper and timely implementation of this plan. Senior management also has the authority to order cessation of hazardous activity within laboratories if danger or threat of release to the environment is present.

Lab Safety Committee

A standing committee appointed by the Provost and consisting of a representative from each laboratory-based Department of the University including Anthropology, Biology, Chemistry, Engineering, Psychology, Physics and the School for the Environment, and one or more representatives from OEHS. Its duties include:

- Reporting to the Chancellor's OEHS Steering Committee
- Regular review of the Lab Safety Manual
- Monitoring status and implementation of the Manual
- Maintaining records of committee activities
- Review of written guidelines and training programs
- Exercise of disciplinary or corrective action in cases of noncompliance

Office of Environmental Health and Safety

- Tracks legal requirements by utilizing current regulations, the internet, journals and memberships in relevant professional organizations
- Updates PIs as necessary on regulatory changes or other legal requirements via the OEHS web page, e-mail, direct mail, newsletter, etc.
- Designs training programs
- Conducts training programs which are not laboratory-specific
- Conducts site-specific training upon request
- Conducts annual comprehensive laboratory inspections
- Conducts annual and requested inspection of engineering controls
- Notifies and advises Facilities Administration of necessary repairs
- Carries out or assists with corrective actions in cases of noncompliance
- Maintains the campus Hazardous Chemicals Inventory
- Conducts annual review of Hazardous Chemicals of Concern (HCOC) from the annual campus Hazardous Chemicals Inventory
- Indexes the Laboratory Chemical List by Hazard Category
- Aids in Hazard Assessment and Standard Operating Procedure design
- Investigates cases of suspected exposure, or exposure due to accident
- Provides Chemical Spill Control services
- Provides small spill control materials to laboratories
- Provides Laboratory Waste Removal or Detoxification services
- Evaluates materials and makes hazardous waste determinations

- Ensures institutional compliance with RCRA regulations
- Maintains comprehensive compliance records

Principal Investigator (PI) or Lab Director

Typically, the Principal Investigator (PI) or Lab Director serves as the Chemical Hygiene Officer (CHO). The CHO must have the knowledge, background, and authority to ensure compliance with all OEHS requirements.

Both the Lab Standard and the Academic Laboratory Standard address the potential hazard posed by chemicals to individuals, which is determined in large part by the specific conditions of use. Each CHO will ensure an adequate transfer of information regarding hazards and physical properties of chemicals present at the laboratory. This information must be provided to each laboratory worker in order to aid them in design of safe work practices. In addition, the CHO ensures compliance with the requirements of the Lab Safety Manual. The Principal Investigator provides Laboratory Workers with specific training, instruction and information on the details of the Lab Safety Manual as it applies to his/her duties, including:

- Procedures for Spill Control
- Procedures for emergency notification
- Procedures for Evacuation
- Procedures for First Aid/Emergency Response
- Procedures for Obtaining Medical Consultation
- Procedures for Reporting Suspected Exposure
- Ensures that laboratory workers are in possession of, and are familiar with, all relevant Operational SDS sheets
- Be responsible for and maintain the Chemical Inventory
- Be responsible for the UMB Quarterly Laboratory Self Inspection
- Carries out corrective actions in cases of non-compliance
- Maintains adequate supplies of Personal Protective Equipment
- Personally supervises the activities of non-laboratory personnel while they are in the laboratory
- Follows posted emergency notification procedures in the event of an emergency (reportable or non-reportable)
- Maintains records as necessary

Laboratory Workers

Individuals who work in laboratories are responsible for performing their work in accordance with the Lab Safety Manual and complying with all requirements for the laboratory in which he or she works, including designing or obtaining aid in the design of Standard Operating Procedures applicable to those hazardous chemicals. Laboratory workers are also responsible for bringing to the attention of their Chemical Hygiene Officer, the UMB OEHS Office, and/or the Lab Safety Committee any problems with safety and concerns with respect to potential environmental impacts. Laboratory workers are responsible for informing the CHO of the introduction of new chemicals to the worksite. Laboratory workers have the following responsibilities:

- Choosing appropriate containers for laboratory waste
- Inspecting waste containers upon each use
- Ensuring that waste containers have secondary containment if necessary
- Ensuring that waste containers are closed unless waste is being added or removed
- Consulting Operational SDS sheets when working with chemicals in the laboratory

Visitors

All laboratory visitors (i.e., on-site contractors, vendors, visiting scientists/students, other university personnel, etc.) will be informed of the existence of a Lab Safety Plan. For those who must conduct work in a laboratory, specific training will be provided by OEHS as needed. Access to laboratory materials will not be permitted unless proper training has occurred. Copies of the University's Lab Safety Plan are available for review in the OEHS Office (150/UL/034) and from Principal Investigators. A copy of the plan may also be found at the website listed on the cover page of this document.

Facilities Administration

Works in conjunction with the OEHS to repair and maintain engineering control systems and/or other mechanical issues in laboratories.

Laboratories Covered Under the UMass Boston Lab Safety Manual

All laboratories that contain chemicals are covered by the UMass Boston Lab Safety Plan. The departments include: Anthropology, Biology, Chemistry, Engineering, the School for the Environment, Physics, Psychology, and VDC. A detailed list of all laboratories covered by this plan is available from OEHS.

Chapter III: General Guidelines

Section I – Safety Principles

Safety Awareness

Everyone involved in laboratory operations – from the highest administrative level to the individual workers – must be safety-minded. Safety awareness can become part of everyone's habits only if senior and responsible staff demonstrate a sincere and continuing interest in safety, and discuss it repeatedly. Over-familiarity with a particular laboratory operation may result in overlooking or underrating its hazards. This attitude can lead to a false sense of security, which frequently results in carelessness. Be alert to unsafe conditions and actions and call attention to them so that one can make corrections as soon as possible. Every laboratory worker has a basic responsibility to himself/herself and colleagues to plan and execute laboratory operations in a safe manner.

Eating, Drinking and Smoking

Contamination of food, drink, tobacco products, and cosmetics is a potential route for ingestion of a hazardous substance. University policy prohibits smoking in University buildings. Store, handle, and consume food and drink items in areas free of hazardous substances. Consider designating non-laboratory areas, such as nearby break rooms, lounges or conference rooms, as food storage and eating areas for laboratory personnel.

Working Alone in Lab

Avoid performing experiments alone in a laboratory building. Arrange with individuals working in separate laboratories outside of working hours to cross check periodically. Alternatively, UMass Boston Police can check on laboratory workers. Do not undertake experiments known to be hazardous when alone in a laboratory.

Under unusual conditions, special instructions may be necessary. The Principal Investigator must determine whether the work requires special safety precautions, such as having two persons in the same room during a particular operation.

Minors in Laboratories

The concern of UMass Boston ("University") for laboratory safety extends not only to employees but also to any persons visiting University laboratories, especially high school students and minors under the age of 18, who may potentially be exposed to hazardous materials. Laboratories are common sources of thermal dangers, compressed gases, electrical hazards, chemical, biological, and radioactive materials, lasers, and sharp objects. See Appendix A for Minors in Laboratories Standard Operating Procedures.

Children Under 12

Laboratories must never be utilized as a substitute for day care or other childcare options due to the risk presented to a child's developing immune/neurological systems and a child's general inability to recognize hazards. No one under the age of 12 is permitted in University laboratories. This includes instances when an employee office is inside a laboratory space.

Visitors Ages 12 to 18

Non-University students between the ages of 12 and 18 who are passing through or touring a laboratory must be under the direct supervision of a University employee who is trained and knowledgeable of the area's hazards. Persons between the ages of 12 and 18 may be present in laboratories solely as observers (unless the person is (a) a University student who has received the necessary training, or (b) a high school student who has met the High School Laboratory Worker requirements below) as part of officially sanctioned educational programs for high school or college students or other supervised educational activities that have been approved in writing in advance by the Department Chair or designee. No minor (unless the minor is a University student who has received the necessary training) shall be present during any activity with the potential for exposure to hazardous materials. Prior to allowing high school students or minor visitors to tour or observe in a lab, the supervising employee must conduct a basic safety orientation, including both general safety information and any hazards particular to the lab in question.

High School Lab Workers Ages 15 and Above

UMass Boston is committed to providing educational opportunities, when they arise, to high school students participating in officially sanctioned educational programs. Principal Investigators are allowed to have high-school students (9th grade and above) perform work in a laboratory. However, high school students may not perform duties in which they are required to directly handle radioactive materials, materials at biosafety level 2 or higher (including rDNA, human blood, tissues or cell cultures, or pathogens) or research animals. High school students ages 15 and older may handle lower risk chemicals in limited circumstances, with proper safety equipment as necessary, in the discretion of the principal investigator.

Before a high school student may participate in educational activities in a laboratory:

- The student must be sponsored by a faculty member.
- The sponsoring faculty member must complete the "Application for Student Minor to Enter UMass Boston Laboratories Form," (Appendix A) describing the work the student will perform and obtain signatures from the principal investigator, department chair, direct supervisor of the student, and a representative of OEHS. The completed form is kept on file with the PI's safety records and OEHS.
- The student and his/her parents or guardian must sign the Student (Minor) Agreement and Release and Consent for Emergency Medical Treatment (Appendix A). The form is also kept on file with the PI's safety records and OEHS. One copy of the signed form must be readily available in an emergency if the student is ill or injured so medical personnel may be shown the student's medical treatment consent.
- The form must be completed with signatures and submitted to OEHS at least one month prior to the start date indicated on the form.
- The high school student or minor completes the Parental Consent Form for Minors Entering a UMass Boston Laboratory
- The high school student or minor completes the following training:
    - The online Laboratory Safety training
    - The initial laboratory safety plan training
    - Other training as indicated in the agreement
- High School students and minors must be under direct supervision in the laboratory at all times by a trained and knowledgeable University employee.

Unattended Operations

Frequently, laboratory operations must run continuously or overnight. Equipment and experiments that run unattended during the day or overnight can cause significant problems and harm to personnel, facilities, and equipment. If unattended operations are necessary, it is essential to plan for potential interruptions in utility services such as electricity, water and inert gas. Make sure you perform a hazard analysis to identify potential consequences of failures in utility services or equipment. Design operations to be "fail-safe," so that one malfunction will not cause a propagation of additional failures.

If necessary, arrange for routine inspection of the operation. If appropriate, leave laboratory lights on during unattended operations, and place a sign on the entrance door. Appendix B contains an example sign for unattended operations. You can use this design, or a similar type, to convey critical information to personnel (such as other lab personnel, maintenance, housekeepers, or incident responders) who could encounter your unattended operation. Contact OEHS if you have any questions.

Frequently Asked Questions about Unattended Operations:

1. What is meant by "unattended operation"?

For the purposes of this section, an unattended operation is any unmonitored lab activity that has the potential to release water, gas, chemical substances, electrical energy, or chemical energy during foreseeable failures of equipment or utility services.

2. Which types of unattended operations would require door signage?

Any unattended operation which could potentially harm personnel (such as maintenance workers or housekeepers) due to contact during normal operation or failure; or which could cause substantial damage to property or the environment during failures.

Figure 1. Example: Soxhlet extractor

- Should stay attended, but would certainly require a door sign if unattended.
- The hot plate could burn to the touch.
- In the event of flask breakage, a fire could start if a flammable solvent such as hexane or petroleum ether is in use.
- A rupture of the condenser water line could flood the lab or rooms below.

3. What are some examples of "fail-safe" designs?

Fail-safe designs help ensure that a failure will leave the experiment unaffected, or convert it to a state that minimizes injury or damage. Examples include:

- Water flow monitors and solenoid valves that shut off water to a condenser in the event of water line rupture;
- Temperature-sensing monitors that turn off power to hot plates or vessels if the temperature exceeds a pre-set limit for any reason;

- Automatic gas shutoff valves that shut off gas flow in the event of a power outage, leak, or significant seismic event.

Chapter IV: Laboratory Practices and Safety Equipment

Section 1 – Safety Procedures

Laboratory Inspections

There are four types of laboratory inspections on campus:

1. Monthly waste container checks posted on or near waste accumulation area in laboratories;
2. Quarterly Laboratory Self-inspections which are completed electronically;
3. OEHS Annual Laboratory Inspections which are completed electronically; and
4. Unannounced inspections outside regulators.

The Principal Investigator, or the PI designated laboratory representative (a graduate student in most cases) shall conduct quarterly self-inspections, with an emphasis on chemical container checks. Quarterly Laboratory Self-Inspection forms will be maintained electronically. OEHS will review quarterly inspections for compliance. Annually, OEHS will present a summary of inspection findings and assessing the success of the program on a lab-by-lab basis to the Lab Safety Committee.

Annual comprehensive laboratory inspections will be performed by the OEHS. The focus of the inspections will be conformance with the Lab Safety Plan. The format of the inspections will be reviewed annually by the Lab Safety Committee.

Inspections may be unannounced. However, OEHS will always attempt to include responsible personnel in the inspection. All departments and laboratory workers will continue to maintain Monthly Laboratory waste container inspection checklist sheets to ensure compliance with the Lab Safety Plan.

Compliance with the Plan will also be reviewed by OEHS during routine laboratory waste pick-ups. Documentation of annual inspections will be maintained in the OEHS Office.

Chemical Storage

Storage Symbols

Most chemical manufacturers include chemical storage symbols on their labels. Many manufacturers use symbols that include a hazard ranking system, such as the National Fire Protection Association (NFPA 704) diamond symbol or the Hazardous Materials Identification System (HMIS) colored rectangle. Picture glyphs are another common label element. Below are examples of the NFPA and HMIS hazard ranking systems (Figure 2), and glyph systems from the European Union (Figure 3) which are commonly seen on U.S. chemical labels and safety data sheets.

Figure 2. NFPA diamond symbol (left), HMIS label (right)

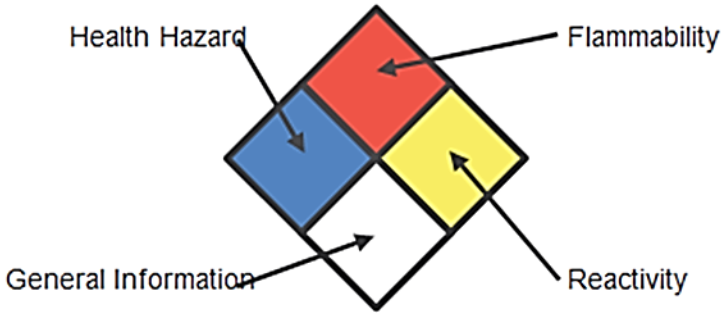
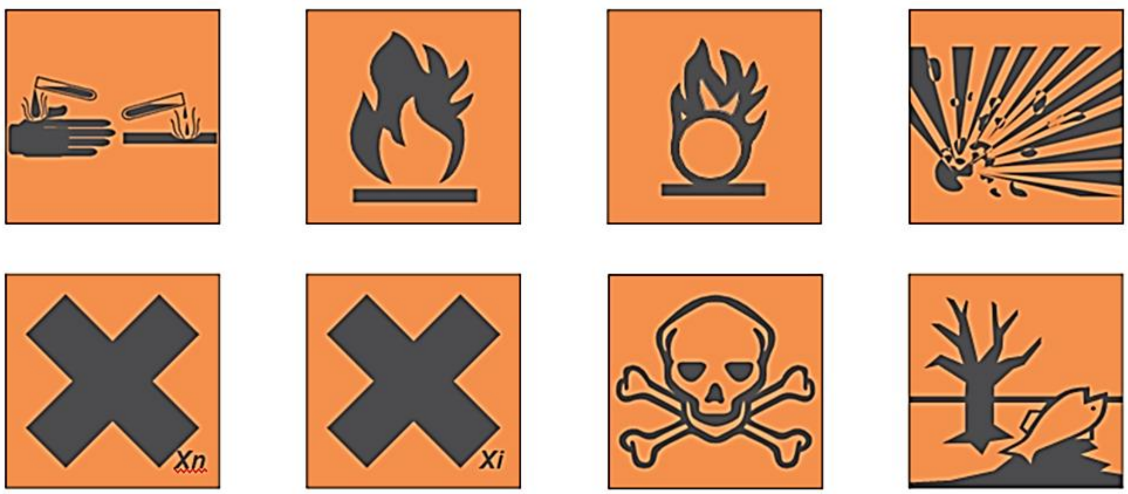


Figure 3. European Union hazard glyphs, which are now common on domestic chemicals. (Top, left to right): Corrosive, Flammable, Oxidizing, Explosive. (Bottom, left to right): Harmful, Irritant, Poisonous, Toxic to the Environment.



Many labels now use the Globally Harmonized System (GHS). This system was created by the United Nations as a worldwide standard for label elements and safety data sheets. Because of the numerous languages used by the worldwide research community, the GHS relies heavily on picture glyphs to convey the basic information. Below are GHS glyphs that are now appearing on chemical labels and SDSs. OEHS provides training on the GHS standards.

Figure 4. United Nations GHS label elements (left to right): Flammable, Harmful, Oxidizing, Toxic to the Environment, Corrosive, Compressed Gas, Explosive, Human Health Hazard, Highly Toxic.

Color Codes

Some chemical manufacturers also use color codes on labels and/or caps to indicate health, physical, and chemical hazards. These colors can be used as a guide for storage by storing same colors together and segregating from other colors. Unfortunately, the color schemes are not always consistent among manufacturers. Under most schemes, colors convey the following message:

- Red: Fire Hazard and/or Flammables
- White: Contact Hazard and/or Corrosive (acids or bases)
- Blue: Health Hazard and/or Toxic or Poisonous
- Yellow: Reactivity Hazard and/or Oxidizers
- Green, Gray or Orange: Moderate or slight hazard (general chemical storage)
- Striped or “Stop”: Exceptions within the same color code labels (example – yellow label chemicals are stored apart from striped yellow label chemicals)

Chemical Storage Locations

Optimally, incompatible chemicals such as acids and alkalis should be stored completely separate from one another to prevent mixing in the event of an accidental spill or release of the materials. Limited storage space within the laboratories, however, sometimes prevents such prudent practice of chemical segregation and storage. If space is limited, you can store incompatible chemicals on the same shelf if you segregate the chemicals according to their hazard class and you store them in tubs, trays, or buckets. These secondary containers reduce the chance that incompatible chemicals will inadvertently contact each other.

Laboratory Hoods

Do not store chemicals in laboratory hoods because the containers may impede airflow and thereby reduce the effectiveness of the hood.

Refrigerated Storage

Store flammable solvents that require storage at reduced temperature (such as isopentane) in refrigerators or freezers designed for storage of flammable liquids. “Safety” refrigerators for flammable liquid storage and “explosion proof” refrigerators are both acceptable. Ordinary household refrigerators are not appropriate for storage of flammable liquids because of interior arcing contacts. Since refrigerators and freezers have no interior space venting, all chemicals should have tightly sealed caps.

Apply signage to the doors of chemical refrigerators stating: “NO FOOD, BEVERAGE, OR ICE FOR HUMAN CONSUMPTION.”

Figure 5. Example sign for a household refrigerator used for storage of lab materials. Flammable storage requires a “safety” or “explosion-proof” refrigerator.

Flammable and Combustible Liquid Storage

Fire protection regulations limit the storage of flammable and combustible liquids to 10 gallons (37.9 liters) in open storage, 25 gallons (94.7 liters) in “safety cans,” and 60 gallons* (227.3 liters) in “flammable liquid storage cabinets” per laboratory room. These limits are for the total quantities on hand, including chemicals in storage, chemicals in use, and wastes.

*Note that only 30 gallons (113.6 liters) of Class I liquids are permitted per room. Class I liquids have a flash points less than 100 °F (37.8 °C), and are traditionally known as “flammable” liquids. Most liquids labeled as flammable are Class I liquids. Combustible liquids are Class II or III liquids, and have flashpoints above 100 °F (37.8 °C). Regulations permit up to 60 gallons (227.3 liters) of combustible plus flammable liquids per room, provided no more than 30 gallons are Class I.

Also, the International Fire Code (adopted by Massachusetts) places limits on the amounts of flammable and combustible liquids stored in new or renovated buildings as the number of floors above grade increases. For some laboratories located on higher floors in new or renovated buildings, the flammable liquid storage limit per room might be less than 30 gallons. Contact OEHS if you have questions about the flammable storage limits for your lab spaces.

Cabinets

You can use cabinets under hoods and laboratory benches for storage of chemicals. In some cases, laboratory furniture manufacturers design cabinets specifically for storage of flammable and/or corrosive materials. However, do not store laboratory chemicals near or under sinks where there may be exposure to water. Storage of cleaning supplies under sinks is acceptable.

Desiccator Jars or Cabinets

Desiccator jars and cabinets are useful for storage of air and water reactive, toxic, and malodorous chemicals. In case of especially malodorous compounds such as mercaptans, replace the desiccator material with a vapor absorber (e.g. charcoal) to control odors.

Bench Tops and Shelves

Chemical storage on bench tops is undesirable, and is vulnerable to accidental breakage by laboratory, housekeeping, and emergency response personnel. Do not store liquids on shelves that are above eye-level. When storing chemicals on open shelves, consider several factors such as compatibility grouping (see below), the container material (plastic or metal versus breakable glass), physical state of the chemical (it's riskier to store liquids on open shelves compared to solids), the relative toxicity of the chemical, and the height and depth of the shelving.

Storage by Compatibility Group

Store chemicals in the laboratory according to their compatibility groups. Do not store chemicals in alphabetical order, as this might place incompatible chemicals next to each other (examples include acetic acid and acetaldehyde, sodium cyanide and sulfuric acid, sodium borohydride and sodium chlorate), increasing the potential for accidental mixing of incompatible chemicals. The Table below "Suggested Shelf Storage Pattern" indicates a recommended arrangement of chemicals according to compatibility. These compatibility groups should be stored separately, especially chemicals with an NFPA 704 or HMIS reactive rating of 3 or higher, and in dedicated and labeled cabinets. Within any compatibility group, you can arrange chemicals alphabetically to facilitate ease of retrieval. The following are recommended compatibility groupings:

Group A Acids, Inorganics	Store large bottles of acid in special acid cabinets, cabinets under lab benches, or on low shelves. Place acids in plastic trays for secondary containment in case of breakage. Segregate inorganic and oxidizing acids from organic compounds including organic acids (e.g., acetic acid) and other combustible materials. Segregate nitric acid (>40%) from organic chemicals, including organic acids. Store acids separate from bases and other reducing agents. Inorganic salts, except those of heavy metals, may be stored in this group. Glacial acetic acid should be stored with flammable and combustible materials since it is combustible.
Group B Bases	Segregate bases from acids and oxidizers on shelves near the floor. The preferred storage container for inorganic hydroxides is polyethylene instead of glass. Place containers in trays for secondary containment in the event of leakage or breaks.
Group C Organic Chemicals	Segregate organic compounds from inorganics. Organics and inorganics with NFPA 704 or HMIS reactive hazard rating of two (2) or less may be stored together. Chemicals with a reactive hazard rating of three (3) or four (4) are to be stored separately.
Group D Flammable and Combustible Organic Liquids	Flammable and combustible liquid storage per room is limited to 10 gallons (37.9 liters) in open storage and use, 25 gallons (94.7 liters) in safety cans, and 60 gallons (227.3 liters) in flammable storage cabinets. Remember that only 30 gallons (113.6 liters) of Class I liquids are permitted per room, and International Fire Code restrictions might limit this even further if your lab is located on an

upper floor in a new or renovated building. Store flammable and combustible materials away from sources of ignition such as heat, sparks, or open flames, and segregated from oxidizers.

Group E Inorganic Oxidizers and Salts	Store inorganic oxidizers in a cool, dry place away from combustible materials such as zinc, alkaline metals, formic acid, and other reducing agents. Inorganic salts may also be stored in this group. Store ammonium nitrate separately.
Group F Organic Peroxides and Explosives	Peroxides contain a double-oxygen bond (R1-O-O-R2) in their molecular structure. They are shock and heat sensitive (e.g. benzoyl peroxide), and readily decompose in storage. Store shock and heat-sensitive chemicals in a dedicated cabinet. Some non-peroxide chemicals can readily form shock-sensitive, explosive peroxides when stored in the presence of oxygen. Examples include ethyl ether, tetrahydrofuran, and cumene. Dispose of, or use, these by their expiration date. See Chapter 9 for information on safe storage of peroxidizable compounds. Common explosive compounds include 2,4,6-trinitrotoluene (TNT), nitroglycerin, and several metal fulminates and azides. 2,4,6-trinitrophenol, also known as picric acid, is normally sold as a saturated solution containing at least 40% water, and classified as a flammable solid. If allowed to dry to less than 10% water, picric acid becomes a DOT Class 1.1 explosive. Nitroglycerin in research is usually sold as a tincture mixed with alcohol, but if the alcohol evaporates, the result is explosive nitroglycerin. Please contact OEHS if you use or handle compounds that are explosive or can become explosive with age or evaporation.
Group G Reactives	*Water Reactives* Store water reactives in a cool, dry place, protected from water sources. Alkali metals (lithium, sodium, potassium, rubidium, and cesium) should be stored under mineral oil, or in waterproof enclosures such as glove boxes. A Class D fire extinguisher should be available in case of fire. Contact OEHS if one is not available in your laboratory. As an added precaution, store containers in trays or other secondary containers filled with sand. *Pyrophorics (Air Reactives)*

	Store pyrophorics in a cool, dry place, and provide for an air tight seal. Store white or yellow phosphorous under water in glass stoppered bottles inside a metal can for added protection.
Group H Cyanides and Sulfides	Cyanides and sulfides react with acids to release highly toxic gases. They must be isolated from acids and other oxidizers.
Group I Carcinogens, Highly Toxic Chemicals, and Reproductive Toxins	A "designated area" for carcinogens and highly toxic chemicals is the preferred storage method. Stock quantities of reproductive toxins are to be stored in designated storage areas. Use unbreakable, chemically resistant secondary containers. Post the storage cabinet with a sign stating "CANCER SUSPECT AGENT," "HIGHLY TOXIC CHEMICALS," or "REPRODUCTIVE TOXINS."

Suggested Shelf Storage Pattern

Figure 6. Table of chemical compatibility groups.

Compatibility Group	Group Name	Chemical Class
Group A	Inorganic Acids, Inorganic Salts	inorganic acids (except nitric), sulfur, arsenic, halides, sulfates, sulfites, thiosulfates, halogens, phosphorus, phosphates
Group B	Inorganic Bases	hydroxides, oxides, silicates, carbonates
Group C	Organics	alcohols, glycols, amines, amides, hydrocarbons, esters, aldehydes, phenol cresols, organic sulfides, organic acids
Group D	Flammables, Combustibles	ethers, aliphatic solvents, aromatic solvents
Group E	Inorganic Oxidizers	borates, chromates, manganates, permanganates, chlorates, perchlorates, chlorites, hypochlorites, hydrogen peroxides, amides, nitrates, nitrites, azides
Group F	Organic Peroxides and Explosives	peroxides, azides, hydroperoxides
Group G	Reactives	air and water reactives, metals and hydrides
Group H	Cyanides, Sulfides	cyanides, cyanates, sulfides, carbides, nitrides
Group I	Highly Toxics, Carcinogens, Reproductive Toxins	highly toxic compounds, carcinogens, mutagens, teratogens

Cleanouts and Decommissioning Laboratories

Whenever a laboratory changes ownership, the UMB SOP for Decommissioning Laboratories must be followed (see Appendix C).

Section 2 – Laboratory Safety Equipment

Chemical Fume Hoods

The chemical fume hood is the primary mechanical mechanism preventing individual exposure to vapor emissions by hazardous chemicals during experimental processes. It is essential that the fume hood always be operating properly. Any observed malfunction should be reported immediately to OEHS at 617-287-5445 or umbehs@umb.edu, who will act as liaison between Facilities personnel and the lab.

The Office Environmental Health & Safety will monitor the function of all fume hoods, and any other local exhaust ventilation devices annually and post the results on each hood. If at any time the performance level of a hood comes into question, OEHS will respond immediately. On a daily basis, check the air flow monitor before using the fume hood. A 'flag,' such as a kimwipe, should be taped to the sash edge to act as a 'no flow' indicator. All requests for hood maintenance must be forwarded through OEHS, and not reported directly to Facilities Administration.

It is forbidden to use fume hoods to evaporate laboratory chemicals for the purpose of disposal. Close all caps tightly and seal containers to minimize escape of vapors. Chemicals should not be stored in fume hoods long term. Excess storage not only clutters the workspace but can inhibit air flow needed for proper fume hood operation.

Frequently Asked Questions

WHAT DO I DO IF MY HOOD ALARM ACTIVATES?

The alarm on the laboratory chemical hood notifies you that the hood is not performing as desired, which could lead to overexposure to chemicals. If the alarm triggers, take the following steps:

- Shut down your experiment;
- Close the sash;
- Report malfunction to OEHS at umbehs@umb.edu.

If the alarm sounds due to a scheduled power outage and someone turns it off, post the hood as "Out of Service" until power is restored. Turn the alarm back on before conducting further work in the hood.

WHY DOES MY ALARM ALWAYS GO OFF WHEN THE LABORATORY DOOR IS OPEN?

Please keep in mind that when doors are propped open, the airflow in the laboratory is affected and the hood may go into alarm. If you believe your alarm is too sensitive, notify OEHS for a calibration assessment. Never tamper with the alarm by taping over openings.

CAN I USE RADIOACTIVE MATERIAL IN MY LABORATORY HOOD?

The Radiation Safety Committee, appointed by the Provost, formulates radiation policies and procedures. Responsibility for carrying out these policies and procedures rests with the Radiation Safety Officer. Hoods must receive individual authorization by the Radiation Safety Committee. OEHS provides the radiation caution signs that indicate which hoods it has authorized for use with radioactive materials. Hoods must have this posting before you use radioactive materials in them.

CAN I DO MY VIROLOGY/BACTERIOLOGY WORK IN MY LABORATORY HOOD?

In general, virology and bacteria work shall not occur in a laboratory chemical hood. When working with cultures, use a biological safety cabinet.

HOW DO I MAKE MODIFICATIONS TO MY EXISTING HOOD OR EXHAUST SYSTEM?

Students, faculty, staff and Facilities Services personnel must not modify hoods by drilling, cutting, or removing the hardware originally provided with the hoods. Such modifications are likely to degrade hood containment performance and result in hood leakage. Installing a standard latticework of "monkey" bars at the rear of the hood is an exception. The installer must follow the hood manufacturer's recommendations when installing these support bars in the hood. OEHS must review and approve in advance any other proposed hood modifications, and post-test following modification.

Do not add shelving to the hood, nor block the rear slots or front airfoil at any time. Ensure the sash and panels are in place before operating.

Laboratory Hood Work Practice Guidelines

1. Do not work in a malfunctioning hood.
2. Check the OEHS inspection sticker on the hood (usually on the top right-hand corner) to ensure it has been inspected within the past 12 months. OEHS measures the face velocity of all hoods annually, notes any deficiencies, and refers them to UMass Boston Facilities Services for correction. Recommended face velocities are between 80-120 feet per minute (fpm).
3. Test the airflow alarm prior to using the hood to ensure it is operating properly.
4. Check the sash height:
    a. OEHS affixes stickers to vertical-sash laboratory hoods to remind users not to work with the sash above 18". Try to keep the sash closed unless you are setting up or actively using the hood.
    b. You can raise and lower a correctly operating hood sash smoothly and with minimal effort. If you have difficulty operating the sash, or you cannot lower it completely, contact OEHS. Do not place equipment, cords, tubing, etc. so that you cannot lower the sash quickly and completely.
    c. The recommended best practice for a combination sash hood (horizontal sliding panels within a vertical sliding sash) relies on completely closing the vertical sash while working through the horizontal sliders. Regular use of the horizontal sliding panels with the vertical sliding sash closed reduces chemical exposure and reduces energy expense. The vertical sliding sash should only be open during set up, not while manipulating objects in the hood with reactions present.

Figure 7. Combination Sash Hoods. Left: Correct position of a combination sash while performing experiments. Right: Only raise the vertical sash when setting up experiments.

5. Work at least 6" in the hood to keep chemicals and vapors from exiting.
6. Do not work with your head breaking the front plane of the hood! Sashes at the proper working height generally create a physical barrier between the operator's head and the inside of the hood. Working with your head in the hood often means that the sash is too high, or that the horizontal panels are opened too wide on a combination sash hood.

Figure 8. Laboratory worker with his head between the horizonal sashes on a combination sash hood.

7. Take steps to maximize containment:
    a. Place blocks under large equipment to allow air to flow underneath the equipment.
    b. Keep the work area and bottom baffles clear from clutter.
8. Use chemical storage cabinets for long-term storage, not your hood. Items in a hood will impede and disturb the exhaust airflow and potentially reduce or eliminate the safety factor.
9. Reduce cross drafts, foot traffic past the hood, and quick movements in and around the hood. The recommended 100 fpm for hood face velocity is only a little more than one mile per hour (1.14 mph; 1.83 kph). Other sources of air movement can easily overcome this.
10. Remove electrical units or other spark sources from the hood when flammable liquids or gases are present. Do not place power strips or surge protectors in the hood. Plug in all electrical equipment outside of the hood.

11. The use of a laboratory hood does not negate the University policy on eye protection. Eye protection is required for all faculty, staff, students, and visitors in laboratories during experimental procedures while working with hazardous materials.

Snorkel Ducts

Several laboratories are equipped with snorkel ducts, which consist of a bell mouth and an articulated connection to the exhaust system.

Figure 9. Two images of snorkel ducts in labs.

The main difference between a laboratory chemical hood and the snorkel is that the latter does not fully surround the reaction at the point of release. For this reason, snorkels are not a substitute for a laboratory hood when handling toxic chemicals. Snorkels are far less effective in capturing dusts, mists, or fumes, and can typically only capture contaminants released within 6 inches (15 cm) of the unit. Snorkels are extremely susceptible to cross drafts.

A good use for laboratory snorkels is the capture and removal of thermal updrafts from benchtop-heated processes, or as local ventilation for benchtop apparatuses such as gas chromatographs. Snorkels generally operate at 45 feet per minute (fpm) flowrate.

Eyewash, Facewash and Deluge Showers

Indoors, emergency eyewash and safety showers are required within 10-seconds travel distance and not more than 75 feet from where toxic chemicals are used. These facilities must be on the same level as the chemical area; there can be no stairs or ramps between the hazard and the eyewash and/or safety shower. Units must be plumbed units that meet the ANSI Standard Z358.1.

Some field operations and other locations where plumbing connections are not available might require a non-plumbed unit. Do not use these non-plumbed units in areas where plumbed units can be installed. Non-plumbed units are available that meet the ANSI requirements for flow and duration (1.5 liters/0.4 gallons per minute for 15 minutes). However, non-plumbed units are more difficult to maintain. Their solutions require frequent changing per manufacturer's instructions. Because most non-plumbed units do not have a significant reserve capacity, you must refill them after every use or test to ensure they maintain the required minimum flow and duration.

Hand held drench hoses in laboratories are a supplement, but not a substitute, for an eyewash and safety shower. Personal eye flush squeeze bottles do not meet ANSI requirements, because they cannot deliver the required minimum flow rate and duration. OEHS discourages the presence of these bottles in your lab because they have a limited shelf life, are prone to contamination, and are ineffective at dual-eye or eye-face irrigation.

Because some chemicals, even in small amounts, can irritate or damage skin upon contact, flush affected areas with water as soon as possible. Remove personal protective equipment and clothing in the areas of chemical contact once you or your co-workers have activated the shower. Fellow workers may need to help remove contaminated clothing. Call 911 if immediate medical attention is necessary. Contact University Health Services (617-287-5660) immediately. Remain in the shower or continue flushing the eyes for no less than 15 minutes.

Each research group is responsible for ensuring that emergency eyewash facilities, both within its laboratory space and in nearby common areas, remain operational and accessible. Check the system at least once a month. A quick (~5 second) activation of the eyewash verifies water pressure, and flushes rust, scale, and other debris out of the system. Perform these checks on all eyewash facilities that your research group might use, even if the facilities are located in common areas outside the group's lab room(s). Verify monthly eyewash checks by filling out inspection tags located on or near the units. After performing the monthly check, make sure that water does not remain on the floor to create a slip hazard for personnel. This is an especially important consideration for eyewash facilities located in common corridors and that lack floor drains. For these facilities, use buckets, secondary containment trays, or other collection devices to prevent discharge of water directly onto the floor.

OEHS checks safety showers and has the equipment necessary to contain, collect, and clean up the large volume of water discharged by a safety shower test.

BioSafety Cabinets and Laminar Flow Benches

Biological safety cabinets (BSCs) provide a primary level of containment for working safely with potentially hazardous biological materials. When combined with good microbiological practices, BSCs can provide protection to laboratory personnel, the environment, and products being manipulated. Laminar benches provide a clean work environment to protect cell cultures or sterile apparatus.

BSCs are designated as Class I, II, or III based on specific airflow patterns within the BSC and on the locations of HEPA filters within the unit (Table 4.1). HEPA filters are usually composed of a pleated sheet of borosilicate fiber material that has been treated with a wet-strength water-repellant binder. These filters are specifically designed to remove particles equal and greater than 0.3 microns with an efficiency of 99.97%. This filtration level will capture a majority of bacteria, spores, and viruses from the filtered air. Table 4.1 illustrates typical airflow patterns in a BSC.

Table 4.1 Biological Safety Cabinet Characteristics[1]				
New NSF Class and Type	**Previous NSF Class and Type**	**Face Velocity (linear ft/min)**	**Airflow Pattern**	**Use of Volatile Toxic Chemicals and Radionuclides**
A1	II, A	75	70% of intake air recirculated; 30% exhausted from a common plenum to the room. Plenum contaminated with biological materials under positive pressure.	No
A2	II, A/B3	100	70% of intake air recirculated; 30% exhausted from a common plenum to the room. Plenum contaminated with biological materials under negative pressure or surrounded by negative pressure.	Yes (small amounts[2])
A2	II, B3	100	70% of intake air recirculated; 30% exhausted from a common plenum to the room. Plenum contaminated with biological materials under negative pressure or surrounded by negative pressure.	Yes (small amounts)
B1	II, B1	100	40% of intake air recirculated; 60% exhausted from cabinet; exhaust air pulled through dedicated exhaust duct into facility exhaust system. All plenums contaminated with biological materials are negative to the room or surrounded by negative pressure plenums.	Yes (small amounts[2])
B2	II, B2	100	No intake air recirculated; 100% exhausted from cabinet. Exhaust air pulled through dedicated exhaust duct into facility exhaust system. All ducts and plenums are under negative pressure; all ducts contaminated with biological materials are under negative pressure or surrounded by directly exhausted negative pressure ducts or plenums.	Yes (small amounts[2])

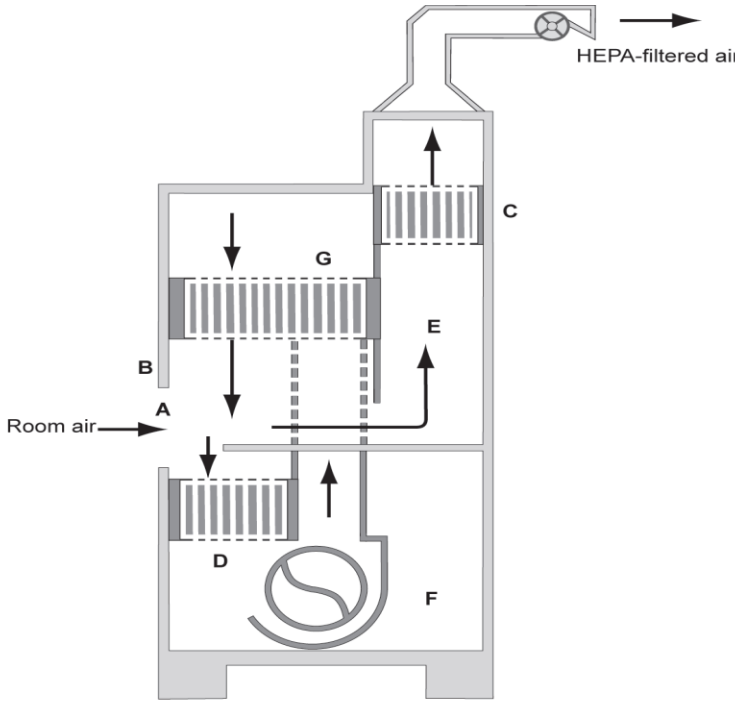
NSF National Sanitation Foundation

ft/min feet per minute

1 Information from The Baker Company: https://www.bakerco.com/introduction-biological-safety-cabinets

2 Under no circumstances should the chemical concentration approach the lower explosion limits of the compound.

Figure 10. Figure taken from Biosafety in Microbiological and Biomedical Laboratories, Fifth Edition, 2009.



Implementation of the following procedures will ensure optimal operation of a BSC:

- Front and rear grills should be free of clutter to allow proper air intake.
- Sash should not be raised above the specified level.
- Disinfect work surfaces before and after working in the BSC.
- Use slow and deliberate arm movements when moving hands/arms in and out of the BSC.
- Avoid Bunsen burner use to prevent airflow disruptions and damage to the HEPA filter.
- Wear PPE at all times for personal and product protection.
- Certification must be performed annually and whenever the BSC is moved or repaired.

Equipment Decontamination

Before equipment can be moved, disposed of, etc. it must be properly decontaminated. The Laboratory Equipment Decontamination SOP can be found in Appendix D.

Chapter V: Personal Protective Equipment

Section 1 – Precautions and Guidelines

Personal protective equipment, commonly referred to as "PPE," is equipment worn to minimize exposure to hazards that can cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits. PPE selection should be based on a job hazard analysis (JHA), which includes evaluation of hazards, specific tasks, procedures and work practices, in consultation with area supervision and OEHS as needed.

Section 2 – Eye and Face Protection

University policy on eye protection requires students, faculty, staff, and visitors in laboratories to wear eye protective devices during any experiment or laboratory procedure (regardless of anticipated eye hazards). The type of safety device required depends on the nature of the hazard and the frequency with which the wearer encounters it. There are three basic types of eye and face protection that meet the majority of University laboratory requirements: safety glasses with side shields, goggles, and face shields. Each of these meets basic eye protection standards for frontal exposure to flying particles. Laboratory supervisors must determine the appropriate level of eye protection for particular tasks, and enforce eye protection rules.

Ordinary prescription glasses do not provide adequate protection from injury to the eyes. Adequate eye protection requires the use of hardened-glass or plastic safety spectacles with side shields.

Safety glasses used in the laboratory must comply with the Standard for Occupational and Educational Eye and Face Protection (Z87.1) established by the American National Standards Institute. This standard specifies a minimum lens thickness of 3 mm, impact resistance requirements, passage of a flammability test, and lens-retaining frames.

Three important dimensions for fit and comfort include temple length, nose bridge width, and lens diameter. Safety spectacles with side shields, bendable temples, and universal nose bridges are available in several lens diameters. Prescription safety spectacles are recommended for employees wearing glasses. Contact OEHS for information on obtaining prescription safety glasses. Do not wear photogrey (transition) lenses indoors in laboratory environments, because the percentage of light transmitted under normal light conditions is below ANSI standards.

Figure 11. Three types of safety glasses.

Wear chemical splash goggles or full-face shields when significant liquid splash hazards exist. The side shields on safety glasses offer some protection from objects approaching from the side, but do not provide adequate splash protection.

Goggles

Goggles provide a tighter face seal than safety glasses, and are not for general laboratory use. Wear them when there is a hazard from splashing chemicals or flying particles. For example, wear goggles when using glassware under reduced or elevated pressure, or using glass apparatus in combustion or other high temperature operations.

Impact-protection goggles have perforated sides to provide ventilation and reduce fogging of the lens, but do not offer full protection against chemical splashes. Use chemical goggles with splash-proof sides for protection from harmful chemical splash.

There are also specific goggles and masks for glassblowing and intense light sources such as welding or lasers. For questions about laser safety, including eye protection, contact OEHS at 617-287-5445.

Figure 12. A pair of goggles.

Face Shields

Goggles or safety glasses alone do not meet ANSI standards for protection to the face and neck. When you need greater protection from flying particles and harmful liquids, wear full-face shields that protect the face and throat. For full protection, always wear a pair of safety glasses or goggles when wearing a face shield.

Figure 13. One pair of goggles and two face shields. Face shields should be worn with safety glasses or goggles.

A metal-framed "nitrometer" mask offers greater protection for the head and throat from hazards such as flying glass or other light fragments. Consider using a face shield or mask when operating a vacuum system (which may implode), or conducting a reaction with the potential for mild explosions. Always use a UV-blocking face shield when working with transilluminators or other devices that produce ultraviolet radiation.

Cost, Care, and Reclamation

The University is committed to a policy of providing eye and face protection devices without cost to students, employees and visitors. Each department is responsible for funding its eye and face protection program. The employee and/or student are responsible for scheduling and payment for eye examinations to obtain safety glasses prescriptions. Eye protective devices issued to employees, students and visitors remain the property of the University. Persons issued eye protective devices return it when the use of the device is no longer necessary. For students, this is normally at the end of each semester, and for employees, upon termination of employment or change in duties where eye protection is no longer required. The department shall determine the disposition of prescription glasses. You may replace eye protective devices damaged during normal wear and use without charge at the discretion of the department head or designated administrative officer. Replacement of lost or stolen devices is the responsibility of the employee or student issued the equipment.

Eye protective devices are personal items, issued for the exclusive use of each individual. Clean with soap and water and store in a clean, protected area. Thoroughly clean and disinfect all eye protective devices before issuing to another person.

Contact Lenses

The National Society to Prevent Blindness points out that contact lenses do not provide adequate eye protection for hazardous operations and must be worn in conjunction with approved safety eyewear. The University permits the wearing of contact lenses in laboratories, only if the wearer has other forms of eye protection mentioned above. Earlier guidance recommended against wearing of contact lenses in laboratories, due to concerns about lenses trapping chemicals. However, several years of subsequent studies have shown that contact lenses do not create an additional hazard; in fact, the improved visual acuity from contact lenses might help prevent accidents, compared to no corrective lenses.

Section 3 – Gloves, Laboratory Clothing, and Foot Protection

Gloves

Wear proper protective gloves for potential contact with corrosive or toxic materials, materials of unknown toxicity, sharp edged objects, and very hot or cold materials. Select gloves based on the material handled, the particular hazard involved, and their suitability for the operation conducted.

Chemicals eventually permeate all glove materials. However, gloves are safe for limited periods if one knows the specific use and glove characteristics (such as thickness and permeation rate and time). Common glove materials include neoprene, polyvinyl chloride, nitrile, butyl, and natural rubbers (latex). These materials differ in their resistance to various substances (Appendix E). Consider double-gloving (the wearing of two gloves on each hand) when handling highly toxic or carcinogenic materials. Before each use, inspect gloves for discoloration, punctures, and tears. Before removal, wash gloves if the material is impermeable to water. Dispose single-use gloves after they are contaminated, or after you have removed them. Do not reuse single-use disposable gloves. Always store gloves properly (e.g. away from windows, transilluminators, etc.), since some glove materials are susceptible to ultraviolet damage.

Laboratory gloves have a shelf life stamped on the box. Dispose gloves if they are old. You can dispose gloves in the regular trash if they are not contaminated with bloodborne pathogens, radionuclides, highly toxic chemicals, or select carcinogens. For gloves contaminated with these substances, dispose in the proper waste stream. Do not dispose of contaminated gloves in a manner that could expose other personnel.

While it is important to wear gloves while performing laboratory manipulation of potentially hazardous materials, it is equally important to remove gloves before contacting "clean" areas such as food area surfaces, or common equipment such as telephones, computer keyboards, and photocopiers. Do not wear gloves outside the laboratory, as you could possibly contaminate surfaces you touch, such as doorknobs, elevator buttons, or restroom fixtures.

Figure 14. Possible contamination of gloves by touching common items, such as a phone.

Remove your gloves even if you believe they are non-contaminated, as others do not know if you might have handled hazardous materials with your gloved hand(s). Consider posting a reminder at the exit door to your lab so that you do not wear lab gloves into common areas of your building. Use secondary containment for items that you must transport from your lab but do not want to touch with bare hands (e.g. samples susceptible to RNAse).

Wear sturdier gloves such as leather for handling broken glassware, inserting glass tubes into rubber stoppers, and similar operations where you do not need protection from chemicals. Use insulated gloves when working at temperature extremes. Various synthetic materials such as Nomex® and Kevlar® can briefly withstand temperatures up to 1000 °F (538 °C). Gloves made with these materials or in combination with other materials, such as leather, are available. Do not use gloves containing asbestos, a regulated carcinogen under OSHA. Contact OEHS for disposal of any asbestos containing gloves. The laboratory supervisor must determine the need for specialized hand protection in any operation, and ensure that needed protection is available.

Do not wear woven gloves while working with cryogens as the liquid may work its way through the glove to your hand. Use gloves specifically designed for work with cryogens. Gloves worn for working with elevated temperatures may not be appropriate for working with extremely low temperature liquids.

Laboratory Clothing and Protective Apparel

The clothing you wear in the laboratory can affect your safety. Do not wear loose (e.g., saris, dangling neckties, oversized or ragged laboratory coats), skimpy (e.g., shorts, halter-tops), or torn clothing in the laboratory. Loose or torn clothing and unrestrained long hair can easily catch fire, dip into chemicals, or become ensnared in apparatus and moving machinery. Skimpy clothing offers little protection to the skin in the event of chemical splash. If the possibility of chemical contamination exists, cover any personal clothing that you wear home with protective apparel. Finger rings can react with chemicals, and you should avoid wearing them around equipment with moving parts. Appropriate protective apparel is advisable for most laboratory work and may be required for some. Such apparel can include laboratory coats and aprons, jump suits, special boots, shoe covers, and gauntlets, which can be washable or disposable in nature. Commercial garments are available to protect from chemical splashes or spills, heat/cold, moisture, and radiation.

Laboratory coats help prevent contact with dirt and the minor chemical splashes or spills encountered in laboratory-scale work. The cloth laboratory coat is, however, primarily a protection for clothing and may itself present a hazard (e.g. combustibility) to the wearer. Cotton and synthetic materials such as Nomex® or Tyvek® are satisfactory, whereas rayon and polyesters are not. Laboratory coats do not significantly resist penetration by organic liquids. Remove your lab coat immediately upon significant contamination.

Do not take lab coats home and launder them because of the potential for contamination of the home environment. Currently, OEHS offers a service through an outside vendor to clean and press lab coats. Contact OEHS at 617-287-5445 to arrange for pick-up and delivery of lab coats. Plastic or rubber aprons provide better protection from corrosive or irritating liquids but can complicate injuries in the event of fire. Furthermore, plastic aprons accumulate a considerable charge of static electricity, so avoid use in areas with flammable solvents or other materials ignitable by static discharge.

In some cases, disposable outer garments (e.g., Tyvek®) are preferable to reusable ones. One example is handling appreciable quantities of known carcinogenic materials, for which OEHS also recommends long sleeves and gloves. Wear disposable full-length jump suits for high-risk exposure situations, which may also require the use of head and shoe covers. Many disposable garments, however, offer only limited protection from vapor penetration and you need to exercise considerable judgment when using them. Impervious suits fully enclosing the body may be necessary in emergencies.

Know the appropriate techniques for removing protective apparel if contaminated. Chemical spills on leather clothing accessories (e.g. watchbands, shoes, belts, etc.) are especially hazardous, since many chemicals absorb in the leather, which holds the chemical close to the skin for long periods. Remove such items promptly and decontaminate or discard them to prevent chemical burns.

Foot Protection

Wear shoes at all times in laboratories or other chemical use and storage areas. Do not wear perforated shoes, sandals, or cloth sneakers in laboratories or mechanical work areas. Safety shoes protect the feet against injuries from heavy falling objects, crushing by rolling objects, or lacerations from sharp edges. Safety shoes are required for employees whose job duties require the lifting, carrying, moving, etc. of objects weighing more than fifteen pounds which, if dropped, would likely result in a foot or toe injury.

Contact OEHS for further questions about foot protection.

Section 4 – Respiratory Protection

Respiratory protection might be necessary when working with highly toxic chemicals, biological hazards, or dusts known to cause asthma or pulmonary fibrosis. However, respirators are a "last line" of defense, and should not be used until all engineering controls (e.g. ventilation) and work practice controls (e.g. product substitution) are exhausted. Respirators have specific regulatory requirements for equipment certification, fit testing, medical evaluation, and training. These requirements are from the OSHA Respiratory Protection Standard 29 CFR 1910.134. Requirements differ based on respirator type.

The respirator regulations do not cover "comfort masks" or surgical masks.

Figure 15. Surgical masks, also known as "comfort masks."

These are technically not respirators, as they are not certified by NIOSH (National Institute for Occupational Safety and Health), and have no protection factor rating. If you are using these masks in the lab, consider whether you might need a true respirator, such as those seen here:

Figure 16. Six different respirators.

Because of the training, fit testing, and medical evaluation requirements, you cannot "casually" wear true respirators in the lab. If you wish to wear an N95 disposable respirator, you must receive training on its proper use and limitations. This training is available from OEHS.

Other types of respirators such as APRs, PAPRs, SARs, and SCBAs have more rigorous training and fit testing requirements. Contact OEHS if you are contemplating their use. If you will use any type of respirators voluntarily, including N95 disposable respirators, you must read and understand the information included below.

Information for Employees Using Respirators When Not Required Under the Respiratory Protection Standard

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker.

Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, of if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

You should do the following:

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirator's limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes and smoke.
4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

Reference: 29 CFR 1910.134

Chapter VI: Special Procedures for Handling Chemicals

Section 1 – Criteria for Chemical Classification

Working with Chemicals/Handling Chemicals

The goal of the Laboratory Safety Plan is to provide a tool which allows the user to quickly and easily design a safe SOP for the use of any chemical found in his/her workplace. When the specific hazards of a chemical are identified and, wherever possible, quantified, selection of appropriate controls and work practices are automatic. In order to use the information presented however, it is vital that the user have a clear understanding of the nature of the information, including its limitations. For this reason, preparation of the hazard indices and Op SDSs, and clarity and consistency in the use of toxicological and risk terminology are extremely important goals. This section illustrates precisely what information has been utilized and how it has been integrated into the final determination of risk for each of the 12 categories of hazard for which each chemical has been classified.

Classifications:

A. Select Carcinogens
B. Select Teratogens and Reproductive Hazards
C. Highly Toxic Substances
D. Inhalation Hazards
E. Dermal Hazards
F. Corrosive / Serious Irritant
G. Specific Eye Hazard
H. Regulated Chemicals: STEL, Ceiling Values

I. Neurotoxins
J. Suspect Carcinogens
K. Suspect Teratogens and Reproductive Hazards
L. Sensitizers

A. Select Carcinogens

By definition in the Lab Standard (29 CFR 1910.1450 (b)), "Select Carcinogen" means any substance which meets one of the following criteria:

i. It is regulated by OSHA as a carcinogen, or
ii. It is listed under the category "known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP), or
iii. It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC), or
iv. It is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP and causes statistically significant tumor incidence in experimental animals in accordance with the following criteria:
    a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3.
    b. After repeated skin application of less than 300 (mg/kg body weight) per week, or
    c. After oral dosages of less than 50 mg/kg of body weight per day.

The criteria employed include all OSHA, IARC1A, and NTP 'known' Carcinogens. As some different definitions of dose, species, and endpoint exist, secondary criteria were taken from:

Gold, L.G., Sloane, T.H., and Bernstein, L. Summary of Carcinogenic Potency and Positivity for 492 Rodent Carcinogens in the Carcinogenic Potency Database. (Envrtl. Hlth. Perspect. 79: 259 272 (1989)).

In addition to the reported Rat Oral Doses, results reported for Mouse studies only were scaled by a factor of .58 to approximate equivalent Rat dosages (Davidson, I.W.F., Parker, J.C., Beliles, R.P. Biological Basis for Extrapolation across Mammalian Species. Acad Press 211 238 (1986)).

B. Select Teratogens and Reproductive Hazards

The criteria for this category are taken from:

- Table 2. Teratogenic Agents in Human Beings, Shepard, T.H., Catalog of Teratogenic Agents, 6th Ed., Johns Hopkins Univ. Press 1988.
- Chemicals with a Reproductive Risk Index 0f 3 or greater (see Classification K for details).
- Any chemical classified as antineoplastic

C. Acutely Toxic Substances

Toxic potency is expressed as the dose which produces an effect in a certain percentage of the test population. For acutely toxic effects, this is often the dose in mg/kg body weight which is lethal to half of the population, the LD50 (for oral, topical or injected dosages; by inhalation, the ratio of the concentration of the chemical to air, in parts per million (ppm) is used with the designation LC50). Toxic effects other than lethality may be monitored, for example the initiation of tumors, and given the designation TD50. These values are generally reported for or extrapolated to a standardized population (rats), and are useful for indexing the relative toxicity of chemicals. The actual effect on humans may vary considerably due to differences in metabolism and distribution in the body and mechanisms of detoxification. For some effects, for example reproductive toxicity, the value reported will be the lowest dose at which any individual in the observed group showed an effect, the Tdlo or LDlo. While this number is less statistically reliable, it has the advantage of accommodating some of this uncertainty and more clearly stating the relative risk.

Level	Probable Lethal Human Dose	Description
Extremely Toxic	Approximately 1 grain (65 mg)	• A chemical that has a median lethal dose (LD50) of 1 milligram or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each. • A chemical that has a median lethal does (LD50) of 5 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each. • A chemical that has a median lethal concentration (LC50) in air of 10 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.
Highly Toxic	Approximately 1tsp (4g)	• LD50 ≤50 mg/kg when orally administered as above. • LD50 ≤200 mg/kg administered by continuous contact as above. • LD50 ≤200 ppm or 2 mg/L when administered by continuous inhalation as above.
Toxic	Approximately 1oz (30g)	• 50 mg/kg > LD50 ≤500 mg/kg when orally administered as above. • 200 mg/kg > LD50 ≤1000 mg/kg when administered by continuous contact as above. • 200 ppm or 2 mg/L > LD50 ≤ 2000 ppm or 20 mg/L when administered by continuous inhalation as above.

Where available, an equivalent Acute Rat Oral LD50 (the dose level which results in the death of 50% of the test population) is presented.

Summary:

- Substances with an LD50 of 5 mg/kg or less are considered highly toxic.
- Substances with an LD50 of 50 mg/kg or less are considered very toxic.
- Substances with an LD50 of 500 mg/kg or less are considered toxic.
- Substances with an LD50 of 5000 mg/kg or less are considered slightly toxic.

Acute Toxicity of Some Typical Laboratory Chemicals	
Substance	***Acute Toxicity (RAT LD50) mg/kg***
MERCURIC CHLORIDE	1
AFLATOXIN B1	5
POTASSIUM CYANIDE	5
SODIUM AZIDE	27
NICOTINE	50
FORMALDEHYDE	100
HYDRAZINE	129
PICRIC ACID	200
PHENOL	317
ATROPINE	500
ACETALDEHYDE	661
ARSENIC	763
BENZENE	930
LEAD CHLORIDE	1500
EDTA	2000
ACETONITRILE	2460
XYLENE	4300
METHANOL	5628
ACETONE	5800
ETHANOL	7060
IODINE	14000

GLUCOSE	25800
GLUTAMINE (L)	80941

D. Inhalation Hazards

The criteria used to construct Classification "D" include both qualitative and quantitative data. Qualitative information was gathered by selection from the SDS sheets using the keyword expressions:

- "ASPHYXIANT"
- "SUFFOCATION"
- "COUGHING"
- "DIFFICULTY IN BREATHING"
- "BRONCHOCHONSTRICTION"
- "BRONCHOSPASM"
- "ASTHMA"
- "INHALATION MAY BE FATAL"
- "MAY BE FATAL IF INHALED"
- "PULMONARY EDEMA"
- "HARMFUL BY INHALATION"
- "HARMFUL IF INHALED"

INDEX of INHALATION POTENTIAL

Inhalation Risk Index was computed as the common log of the ratio of vapor pressure to toxicity. The value was then normalized to a scale of 0-5 representing increasing severity.

Recommended Response Based on Index	
Index ≥3	Fume Hood, specifically designed Canopy/Slot Ventilation, or closed reaction vessel required.
Index <3, ≥2	Above methods MAY be necessary.
Index <2	Normal laboratory ventilation probably adequate

In consideration of specific conditions of use, note the following:

Vapor Pressure is essentially the upper limit equilibrium concentration of a substance in air over a pure solution of the same substance in a closed system. Static conditions of this sort do not occur in 'real life'; the more relevant parameter, Generation Rate, is strongly influenced by:

- The Temperature, governing molecular activity
- The Partition Coefficient for solutions of more than one component
- The Surface Area of the liquid/air interface
- The Ventilation Rate at the interface

The effect of temperature on Vapor Pressure may be estimated by assuming a 6% change in VP per degree Centigrade. Though not a highly precise technique, this can provide valuable information in assessing potential hazard under your conditions of use. Except for extremely toxic substances, chemicals with Vapor Pressures under 5 mm Hg are rarely an inhalation hazard.

Vapor Pressure-derived Indices above are chiefly relevant to pure organic solvents or mixtures of organic solvents with similar physical characteristics:

- The Generation Rate of the substance is dependent on its relative concentration in the solution. Low concentration, low risk.
- For aqueous solutions, the tendency for the solute to vaporize is balanced by its water solubility. As polarity increases, generation rate rapidly decreases and is virtually nonexistent for many organics and most inorganics. Note this effect particularly for some mineral acids (HF, HCL) which are extremely serious inhalation hazards in the form of pure gasses, but pose no vapor potential as aqueous solutions. The formation of suspended liquid or solid particles in the air – Aerosols – results in a particularly high inhalation risk, and is totally independent of vapor pressure. These particles impact the inner surface of the lung and provide a nearly 100% effective delivery of dose. Substances without appreciable vapor pressure can become serious inhalation hazards if aerosolized. Be cautious particularly of 'benchtop' centrifuges, and any sonicating device. Be particularly cautious as well when using fine or light dust; the general air motion in our laboratories is sufficient to aerosolize these dusts and maintain relatively stable high ambient air concentrations for extended periods of time.

Although the General Dilution Ventilation Rate in the laboratory is usually quite high – typically 10 Air Changes per hour or more – substances with appreciable vapor pressure and toxicity, or a tendency to aerosolize, and which are generated from a localized source are best handled by Local Exhaust Ventilation: either the Chemical Fume Hood, or well-designed Canopy or Slotted-Duct exhausts. Note particularly in designing work practices that the employee should not be positioned between the source of the contaminant and the face of the exhaust. Note also that the geometry of suction of Local Exhaust Ventilation does NOT resemble a forced 'jet' of air. The efficiency of capture instead falls off as the square of the distance from the face, and may thus be effective only within a few inches, and seldom as much as a foot from the source of generation. Further information regarding the use of the fume hood may be found in Chapter IV Section 2.

Inhalation Risk Index of Some Common Laboratory Chemicals	
Substance	***Inhalation Risk Index***
HEXAFLUOROACETONE	5.0
ACROLEIN, CHLORINE	4.6
PROPYLENE OXIDE	4.3
1,1 DIMETHYLHYDRAZINE, CARBON DISULFIDE	4.2

ETHYL ETHER	4.1
CHLOROFORM, DICHLOROMETHANE	4.0
GLUTARALDEHYDE OSMIUM TETROXIDE	3.9
BENZENE, TETRAHYDROFURAN	3.8
FORMALDEHYDE	3.7
TOLUENE	3.6
ACETONE	3.5
ACETONITRILE, HYDRAZINE	3.4
METHANOL, HEXANE (N)	3.2
DIOXANE, MERCRCAPTOETHANOL, ETHANOL	3.1
CELLOSOLVE, ANILINE, XYLENE	3.0
DIMETHYL FORMAMIDE	2.8
ISOAMYL ACETATE	2.6
METHYL SALICYLATE, ACRYLAMIDE	2.5
DIMETHYL SULFOXIDE	2.3
BIPHENYL	2.0
FORMAMIDE	1.8
TRIETHANOLAMINE	1.5
PICRIC ACID	1.0
CARBAZOLE	0.5
OLEIC ACID	0.1
LEAD CHLORIDE	0

E. Dermal Hazards

Criteria for Dermal Hazards comes chiefly from the Skin Hazard designations defined by OSHA, NIOSH and the ACGIH; and for the values relating dermal penetration to toxic dose as defined by Fiserova-Bergerova, V., Pierce, J.T., Droz, P.O. (Dermal Absorption Potential of Industrial Chemicals: Criteria for Skin Notation. Am. J. Ind. Med. 17:617-635 (1990)). Currently, only published values are selected.

Qualitative information was gathered by selection from the SDS sheets using the keyword expressions:

- "READILY ABSORBED THROUGH SKIN"
- "SENSITIZATION BY SKIN CONTACT"
- "(SKIN)"

In addition, data has been abstracted from the bibliographic information presented in Forsberg, K, and Keith, L.H (Chemical Protective Clothing Performance Index Book, John Wiley and Sons, 1989) to characterize specific response of polymer formulations to chemical class. This has been incorporated into a glove selection strategy presented in Section 3.

F. Corrosive Chemicals

Corrosive chemicals are selected from information obtained from the SDS sheets or RTECs notations, by keyword selection. The keywords employed were:

- "CAUSES BLISTERS"
- "CAUSES BURNS"
- "EXTREMELY DESTRUCTIVE"
- "SKIN BURNS"
- "SEVERE IRRITATION OR BURNS"
- "SEVERE DESTRUCTION"
- "VESICANT"
- "SUNBURN-LIKE"

No attempt at quantification was made in defining this list, rather selection was 'conservative' in the direction of inclusion rather than exclusion. "Severe Irritant" by OSHA-defined terminology would not fall into this category, as the definition of "Irritant" excludes those substances capable of producing tissue destruction. However, it was included in our selection criterion to accommodate potential variation in terminology employed by other parties. Similarly, all Organic Acids were automatically included without regard to their ionization potential. In determining the level of protection required, you may wish to consider that corrosivity, and any other toxic property is concentration dependent. Acid solutions with a pH greater than 2 present little hazard. Greater caution should be exercised in extrapolating hazards of basic substances. The tendency of these substances to solubilize in protein typically leads to greater penetration in intact tissue, with greater tissue destruction occurring over protracted periods of time.

For corrosive substances, tight fitting chemical splash goggles are mandatory, at least when mixing stock solutions. Additional protective clothing may also be required, and a face shield may be advisable. Ordinary rubber gloves of any polymer composition and suitable thickness to withstand abrasion are sufficient for mineral acids and bases, but may not be for organic corrosives.

G. Specific Eye Hazards

The criteria for specific eye hazards have been taken from a number of sources, including regulatory designations of OSHA, NIOSH, and the ACGIH, information from SDS sheets and RTECs notations, and published reviews. In addition, any substance listed under Category "F," "Corrosive" was automatically classified as an Eye Hazard. We have thus far not categorized this information further as to degree of toxicity. For all such substances, subject to the amounts employed and concentration of the contaminant, but not the frequency of use, chemical splash goggles are required.

Qualitative information was gathered by selection from the SDS sheets using the keyword expressions:

- "CAN CAUSE BLINDNESS"
- "PHOTOSENSITIVITY"
- "CONJUNCTIVITIS"
- "DAMAGE TO THE EYES"
- "CORNEA"

H. Regulated Substances: PEL, TIV, REL, STEL, CEIL

OSHA has recently revised their listing of maximum permissible breathing zone air concentrations for about 600 substances. These may be found at 29 CFR 1910.1000, summarized there as Tables Z-1 through Z-3. Additional limit values may be found in the Substance Specific Standards (29 CFR 1910.1001 through 29 CFR 1910.1048). These may be found in the EH&S Office. Publication of the Final Rule revising the PELS is in the Federal Register (FR 54 #12 pp 2329-2984, Jan 19, 1989) and this document includes the preamble, which contains the arguments justifying the selected values, and a very valuable summary on the toxicological properties of the regulated substances. In the Laboratory Standard, we are required to maintain air concentrations below these limit values. We are also required to inform our employees of these values, and any additional values proposed by the American Conference of Governmental Industrial Hygienists (ACGIH) or the National Institute for Occupational Safety and Health (NIOSH) for any substances not regulated by OSHA. The PEL-equivalent ACGIH limits are termed the Threshold Limit Values (TLV's), published yearly by that association in the Threshold Limit Value and Biological Exposure Indices. NIOSH limit values are termed the Recommended Limit Values (REL's), are time-weighted over 10 rather than 8 hours, and are summarized in the NIOSH Pocket Guide to Chemical Hazards. As OSHA drew heavily on these sources in revising the PEL's, currently required additions are few in number, so the criterion selected for categories A and B is listing by any of the above sources. In listing specific values for the chemicals in your workplace, preference is given to the OSHA value.

OSHA prioritizes chemicals for regulation based on their toxicity, and usage in the industrial and manufacturing industries. Many of these chemicals are thus commonplace. Eight (and ten) hour time-weighted averages are also designed to afford control in the manufacturing and other process-oriented industries. As much of our use of these chemicals involves brief and intermittent exposure, the PEL's are typically not relevant. If your task analyses indicate 'regular' exposure (see Standard Conditions of Use, Section 2) you should contact OEHS for advice on the advisability of additional control procedures and monitoring. Also, OSHA does not address the potential for synergistic effects of chemicals in its' Standards. The discussion provided in the Preamble to the Laboratory Standard does however indicate a sense of concern, and support for the activities of Associations in providing guidelines. It would be prudent, when considering tasks presenting the possibility of multiple exposures, to adopt the procedures defined by the ACGIH in determining allowable limits. Essentially, these state that for chemicals which affect the same target organ, simultaneous exposures should be considered additive unless there is clear evidence that they are not. Observance of the combined limit value should be determined by summing the ratio of the specific chemical air concentrations to their Limit Values, the combined limit being exceeded when the sum of the ratios exceed 1.

STEL, Ceiling Values

In the recent revision of the PEL's (effective May 1, 1990), OSHA identified substances for which brief exposures could result in significant pathologies. For 116 such substances, supplemental Short-Term Exposure Limits (STEL's) were defined as the maximum allowable air concentrations to which an individual may be exposed during any 15-minute period. There are also Ceiling limit Values, or maximum allowable instantaneous peak concentrations; as instantaneous monitoring is seldom feasible, these are handled as STEL's. Combining the Z-table STEL's and Ceiling Values, similar values in the OSHA Substance-Specific Standards, and the ACGIH and NIOSH recommended values, a total of 172 substances can be defined for which 15-minute time weighted averages are in force.

I. Neurotoxins

Semi-quantitative data for this group was obtained from a list generated by Simonsen and Lund, AJIM 21:773-792 (1992). An index of hazard potential was assigned in the range 0 (no risk) to 5 (maximum risk) based on toxicological and physical properties of each substance.

Values of Some Typical Laboratory Chemicals	
Substance	***Neurotoxic Risk Index***
ACETONITRILE	5
ACRYLAMIDE	5
BENZENE	5
CARBON DISULFIDE	5
HYDRAZINE	5
LEAD COMPOUNDS	5
PHENOL	5
STRYCHNINE	5
1,1 DICHLOROETHANE	4
CHLOROFORM	4
DIMETHYLFORMAMIDE	4
DIOXANE	4

MERCURIC CHLORIDE	4
TOLUENE	4
CYCLOHEXANE	3
DIETHYL ETHER	3
OZONE	3
SODIUM AZIDE	3
ACETONE	2
BARIUM	2
ETHYL ACETATE	2
HALOTHANE	2
ACETALDEHYDE	1
ETHANOL	1
ETHYLENEDIAMINE	1
METHYL METHACRYLATE	1

Note that many non-polar solvents found in the laboratory possess transient, but potent, narcotizing effects. Key words employed in recognition of these and other neurotoxic effects are:

- "NERVOUS"
- "ANESTHETIC"
- "CNS"
- "DEMYELINATION"
- "NARCOSIS"
- "CEREBROSPINAL"
- "MEMORY LOSS"
- "PSYCHOS"
- "ENCEPHALOPATHY"
- "NEUROTOXIC"
- "NERVES"
- "HYPNOTIC"
- "CONVULSIONS"
- "PARALYSIS"
- "ATAXIA"

- "NEURITIS"
- "INFLAMMATION OF NERVES"
- "TREMOR"
- "INCOORDINATION"

J. Suspect Carcinogens

Criteria for this category include substances from the IARC 2A and 2B and NTP 'Reasonably Anticipated to be Carcinogens' lists for which reported toxicity does not meet the criteria employed in Category "A," or for which insufficient data exists to render judgement. Substances identified as possible Carcinogenic, Tumorigenic, or Mutagenic on SDS sheets or RTECS reports will be included in this category, whether or not quantitative data exists. The selection keyword expressions employed were:

- "TUMOR"
- "CARCINOGEN"
- "CANCER"
- "MUTAGEN"
- "ALTER GENETIC MATERIAL"

While the requirement for special consideration of defined types of control does not apply to this category, particular attention should be paid to physical properties and task analysis to identify potential routes of exposure. Clear warnings should be posted in potentially contaminated areas, particularly when the area is unattended.

For those chemicals in Category "J" for which a derived Rat Oral TD50 value has been obtained, this information is presented as "Other Known Carcinogens: Relative Chronic Toxicity." Note that these values span a range of 109. Some representative values are presented here to aid you in interpreting your data set:

Chronic Toxicity of Some Common Laboratory Chemicals	
Substance	***Toxicity (TD50) mg/kg***
Dioxin (TCDD)	0.00001
Aflatoxins	0.001
Nitrogen Mustard	0.01
Enovid, Diethylstilbestrol	0.1
NitrosoAmines	0.5
PCB's, Ethylene Dibromide	1
Formaldehyde, PCB's	1
Propylthiouracil	10

Chloroform, PERC	100
Saccharin, Hematoxylin	1000
Ethanol	10000

Note that TD50 values above 50 mg/Kg (e.g. not special carcinogens) are typical for 'environmental' carcinogens. Some substances with TD50 values in the range of 200 mg/Kg have been cleared by the FDA as food additives representing 'de minimis' levels of risk.

K. Suspect Teratogens and Reproductive Hazards

Criterion employed in keyword search were:

- "REPRODUCTIVE"
- "FETUS"
- "UNBORN CHILD"
- "NEWBORN"
- "PATERNAL"
- "MATERNAL"
- "FERTILITY"
- "BIRTH DEFECT"
- "CONGENITAL MALFORMATION"
- "DEVELOPMENTAL ABNORMALITIES"
- "TERATOGEN"

Cautions employed should be as for Category F, and special consideration given in task analysis to individuals at special risk from exposure to these agents. This category is intended to be inclusive.

Quantitative data for this group was obtained from a list of recommended limit values compiled by Jankovic and Drake, AIHAJ 57:641-649 (1996). An index of hazard potential was developed from the inverse log value of the recommended limit, normalized to the range 0 (very low risk) to 5 (maximum risk).

Values of Some Typical Laboratory Chemicals	
Substance	***Reproductive Risk Index***
BENZO(A)PYRENE	5
CYCLOPHOSPHAMIDE	4
DIETHYLSTILBESTEROL	3
NICOTINE	3

NITROSAMINES	3
ARSENIC	3
DIAZINON	2
AMINOPTERIDINE	2
METHYL ISOCYANATE	2
AFLATOXINS	2
LEAD AND COMPOUNDS	2
MERCURY AND COMPOUNDS	2
DIELDRIN	2
HALOTHANES	2
BISPHENOL A	1
BAYGON	1
IODINE	1
XYLENE	1
METHYLENE CHLORIDE	1
CHLOROFORM	1
PHENOL	1
ACETONITRILE	1
TETRAHYDROFURAN	0
ETHANOL	0

L. Sensitizing Agents

Taken from regulatory listings, etc., insofar as possible, an attempt has been made to limit this group to substances with demonstrated allergenic potential and to exclude agents which simply promote chemical dermatitis. Specific control procedures are not defined for this diverse group; rather, extra attention should be paid to the route and likelihood of exposure, and employees using such substances should consider their history of allergic response.

Keywords employed in the identification of these chemicals include:

- "ALLERGIC"
- "SENSITIZATION"

- "SENSITIVITY"

Section 2 – Management of Chemicals

Chemical Inventory

UMass Boston is required by the Boston Fire Department to have complete chemical inventories for all locations on campus. Initial inventories were conducted in 1995.

OEHS online chemical inventory database: PI's and lab directors have access to online database. OEHS barcodes all incoming chemicals before delivering them to laboratories. Accuracy of the chemical inventory depends on labs tracking the barcode number of the empty container or chemical given to OEHS for disposal on a barcode tracking sheet posted near waste accumulation area. Additionally, OEHS utilizes the chemical inventory data to generate lab safety signage and NFPA diamond for the Boston Fire Department according to the NFPA 704 standard. PI's are required to notify OEHS if the NFPA hazard rating or hazards listed on the signage must be changed due to the addition or subtraction of certain chemicals such as compressed gas cylinders, oxidizers, or water-reactive materials. OEHS began barcoding all hazardous materials on campus in 2002. OEHS conducted physical re-inventory of chemicals for all laboratories in 2008.

Transfer of Chemicals

Whenever chemicals are transported outside the laboratory, the primary container should be placed in a secondary, non-breakable carrier container. When transporting more than one container of hazardous waste, use of a cart is mandatory. Before moving containers, check and tighten caps or other enclosures.

Only OEHS personnel are authorized to transport laboratory waste to designated accumulation areas.

If you need assistance or additional information, please contact OEHS at umbehs@umb.edu or 617-287-5445.

Labeling Waste Containers

All laboratory waste will be labeled with the following information:

- The words "laboratory waste"
- Chemical name(s)
- Principal investigator
- Building, floor and room
- Accumulation start date
- General hazard class:
  - Ignitable
  - Reactive
  - Corrosive
  - Toxic
- Amount

All containers of laboratory waste will be labeled immediately when filling begins. Labels are available from OEHS. If a container is too small to hold a label, the label may be placed on a secondary container.

Chapter VII: Laboratory Waste Management

Section 1 – Identifying Reactive Acutely Hazardous Laboratory Waste

Reactive acutely hazardous laboratory waste or p-listed waste is defined in 40 C.F.R. 261.33 and 310 C.M.R. 30.136. For academic laboratories the only P-listed reactive acutely hazardous Lab Waste materials are:

- P006 – Aluminum phosphide
- P009 – Ammonium picrate
- P065 – Mercury fulminate
- P081 - Nitroglycerine
- P112 - Tetranitromethane
- P122 – Zinc phosphide (> 10%)

In laboratories at UMass Boston, this type of waste originates from the following sources:

- UNUSED commercial p-listed chemical products
- Residue of p-listed chemicals from a spill
- Residue and the container from a p-listed chemical
- The generic name for these chemicals is listed in Appendix F

Laboratory workers will be responsible for ensuring that no more than 1L (1 Qt.) of reactive acutely hazardous laboratory waste is accumulated at any time in a laboratory. If an accumulation threshold is reached, follow the procedures for pick-up of waste material from a laboratory.

Section 2 – Container Collection of Laboratory Waste

Containers of laboratory waste must be closed at all times with a secure cap, lid, or funnel (with attached lid) except when waste is being added or removed. The only exception is for in-line waste collection (described below).

In-Line Waste Collection

Definition: "In-line waste collection" refers to any system that automatically collects laboratory waste and is directly connected to laboratory activity. The system may be a piece of laboratory equipment, such as an HPLC, or a repetitive manual motion.

Under these types of "systems" a container of laboratory waste should have a cap or a lid to run the tubing. The system must be constructed and/or operated in a way that prevents any release of laboratory waste into the environment.

- All in-line waste collection systems must have secondary containment in case of accidental overflow.

- All in-line waste collection systems must be attended or periodically inspected by trained personnel to ensure that the contents do not overflow secondary containment.

Section 3 – Discharges of Laboratory Waste

Laboratory waste is not to be disposed of as solid waste. Discharges into the air, land, or water are prohibited.

In addition, the Massachusetts Water Resources Authority (MWRA) prohibits the disposal of any of the following items down any sink or drain or any other way that will introduce the materials into the municipal sewage system:

- Any water or wastewater with a pH lower than 5.5 or higher than 10.5
- Any liquid, solid, or gas, including, but not limited to, gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides and methyl ethyl ketone, which is a fire or explosion hazard, or is otherwise injurious either alone or by interaction with other substances
- Any noxious or malodorous liquid, solid, or gas, or any other pollutant which either singly or by interaction with any other waste causes a public nuisance, a dangerous situation, or which results in the presence of toxic gases, vapors, or fumes that may cause acute worker health and safety problems
- Any hazardous waste or any wastewater which results from the treatment of hazardous waste
- Any discharge of mercury, pesticides, or phenanthrene
- Any substance containing pathogenic organisms in such quantities as determined by local, state, and/or federal law as hazardous to public health or the environment
- Specific substances in excess of predetermined concentrations, as listed in Appendix G

The University has been issued a Sewer Use Discharge Permit by the MWRA. The permit requires self-monitoring of all laboratory discharges on a quarterly basis. Additionally, at any time the MWRA can conduct sampling. All laboratory sinks are posted with warnings not to discharge strong acids & bases (pH < 5.5 OR > 10.5), mercury and other heavy metals (all mercury-containing compounds) or volatile organic compounds (common laboratory solvents).

Section 4 – Laboratory Waste Determination

According to 40 CFR Part 262.200, "Unwanted material" means any chemical, mixtures of chemicals, products of experiments or other material from a laboratory that is no longer needed, wanted or usable in the laboratory and that is destined for hazardous waste determination by a trained professional. Unwanted materials include reactive acutely hazardous unwanted materials and materials that may eventually be determined not to be solid waste pursuant to §261.2, or a hazardous waste pursuant to §261.3. UMass Boston is using **laboratory waste** in lieu of "unwanted material," as allowed by §262.206(a)(1)(i), the equally effective term has the same meaning and is subject to the same requirements as "unwanted material". Based on this definition, in UMB Labs a chemical becomes a laboratory waste when:

- It has gone through a research process or class experiment and is no longer needed, or

- It is a virgin chemical no longer needed, or
- It is a clean-up material from a chemical spill.

The following individuals may determine if materials within a laboratory are laboratory waste

- Laboratory Workers
- OEHS Personnel
- Trained Hazardous Waste Contractor

Section 5 – Accumulation and Storage of Laboratory Waste

All laboratory waste containers should be labeled as described in Section 2 – Management of Chemicals. Each laboratory may temporarily hold up to 208L (55 gallons) of laboratory waste or 1L (1 QT) of reactive acutely hazardous laboratory waste. Once containers are full, they must be removed from a laboratory within 10 days.

Laboratory waste shall be stored in a manner that prevents leaks, spills, and releases to the environment. Secondary containers are recommended and are available from OEHS.

Containers of waste must be compatible with their contents. Containers should be segregated by chemical class.

Section 6 – Removal of Waste from Laboratories

When a container is ready for removal, when quantity thresholds have been reached or when material has been designated "excess" in a laboratory, a request for pickup will be forwarded by email to OEHS at umbehs@umb.edu. OEHS will pick up the material(s) upon request as soon as possible but in no longer than 30 days.
Unused chemicals that are no longer needed in a laboratory will be labeled with a "laboratory waste" tie-on label (available from OEHS), and will be removed with the other laboratory waste.

Waste containers may only be stored in the laboratory for a maximum of six (6) months. OEHS will remove all waste containers in January and July.

Section 7 – Waste Determination in the Central Accumulation Area

Once OEHS brings laboratory waste containers to the central accumulation area a determination will be made if the material is a waste (solid or hazardous) or may be re-used.

Section 8 – Re-Use and Redistribution of Laboratory Waste

Material that may be re-used or redistributed comes from the hazardous waste determination made by OEHS at the central accumulation area or may come from laboratory cleanouts. During routine laboratory waste collections, once material is removed from the laboratory, OEHS will evaluate these materials for reuse opportunities on campus. When there are chemicals available for re-use or redistribution, a list of excess chemicals will be maintained and published by OEHS. Principal investigators or laboratory workers may request excess re-usable chemicals on the list and OEHS will deliver the material to their laboratory. If an excess chemical remains in the OEHS inventory for more than 2 years, the material will be disposed of.

Chapter VIII: Emergencies

For all emergency situations such as any fire or non-incidental release, the appropriate response for the CHO is to:

- Ensure that all individuals in the affected area evacuate immediately
- Notify Public Safety (911) of the location and situation
- Tend to any injured personnel
- Ensure that no one enters the area until it can be isolated by security personnel

If the CHO is not available, anyone else in that lab may proceed with the aforementioned steps. OEHS provides emergency notification procedures and signage for emergency response equipment in the laboratories and elevators. The CHO must ensure that this equipment, including fire extinguishers and spill control materials, are properly maintained in the laboratory. Keep in mind that emergency situations are usually ill-defined and subject to rapidly changing conditions. When any doubt exists, report the situation immediately by calling 911. Additional information may be found in the UMass Boston Emergency Response Plan.

Section 1 – Chemical Spill Cleanup

Many laboratory spills are of limited hazard potential, and laboratory personnel can clean up safely. Your laboratory should be equipped to handle small, low-hazard spills. OEHS has provided spill cleanup kits to respond to small low-hazard chemical spills. You should call and email OEHS if you need assistance with a spill.

General Instructions for Chemical Spill Cleanup

General Instructions for Chemical Spill Cleanup	
SPILL ASSESSMENT	Identify the material and select the appropriate cleanup material. **Chemical Classification** — **Cleanup Material** Acids — Neutrasorb OR Sodium Bicarbonate Caustic — Neutracit 2 Organic and Flammable liquids — Solusorb Unknowns — Vermiculite Mercury — Mercury Absorb Sponges; Cinnasorb, Resisorb
PRECAUTIONS	1) Be aware of safety and health hazards. • Acids and caustics can cause serious burns to exposed skin/eyes • Flammables/combustibles can cause fires/explosions

	• Many chemicals (particularly the organics) are toxic. Avoid breathing vapor and skin exposure. 2) Select and put on appropriate respiratory, eye, hand, and body protection before proceeding with cleanup. 3) Do not step into spills.
CLEANUP METHOD	1) Apply cleanup material around the spill's perimeter first, and then inward. 2) Thoroughly mix the cleanup material and spilled chemical with plastic utensils until: • Neutrasorb maintains a blue color throughout and fall foaming stops. • Sodium bicarbonate forms slurry. • Neutracit-2 maintains a yellow/yellow-green color throughout. • Solusorb appears dry and free running with very slight or undetectable odor. 3) Carefully scoop the spill material into a plastic disposal bag with plastic utensils. • **CAUTION:** NEUTRALIZED CAUSTICS AND ACIDS MAY PRODUCE HEAT. WAIT UNTIL MIXERS HAVE COOLED BEFORE HANDLING. 4) Thoroughly clean spill area until all spill residues are removed. Deposit used sponges and other contaminated materials into disposal bag. a) Twist bag shut with bag ties. b) Label the disposal bag with the full chemical name(s) of the contents. c) Contact OEHS for the disposal arrangements. **DO NOT** THROW BAG AND CONTENTS INTO GENERAL TRASH CONTAINERS. 5) Complete the CHEMICAL SPILL FORM and send it to OEHS.

Organic and Flammable Liquid Spills – SOLUSORB

Organic and Flammable Liquid Spills - SOLUSORB	
SOLUSORB	Use for the cleanup of: Common organic liquids including flammable liquids with flash point below 100°F.
PRECAUTIONS	1) Fires/Explosions can occur when flammable or combustible liquids spill. a) IMMEDIATELY remove all sources of ignition (e.g. Bunsen burner). b) IMMEDIATELY apply Solusorb to keep the vapor level down. c) Wear nonconductive shoe covers for large floor spills. 2) Avoid inhalation of organic vapors with skin and eye contact. a) In case of contact, IMMEDIATELY and THOROUGHLY flush skin/eyes with water for at least 15 minutes. b) Wear approved respiratory protection. A full-face respirator is required for chemicals that cause eye irritation. c) Wear chemical protective splash goggles and gloves. d) Seek follow-up medical attention for inhalation skin/eye exposures.

	3) Do not step in the spill.
CLEANUP METHOD	1) Apply Solusorb around the spill's perimeter first and then inward. Completely cover the spill with the Solusorb. 2) Thoroughly mix the Solusorb and the liquid with the plastic utensils until: a) The Solusorb regains its appearance as a dry, free running granular material. b) Solvent odor is very slight or undetectable. 3) Carefully scoop the spill material into a plastic disposable bag. 4) Thoroughly clean spill area until all solvent residues are removed. Deposit used sponges and other contaminated materials into disposable bag. 5) Twist bag shut with a bag tie. 6) Label the disposal bag with the full chemical name(s) of the content. 7) Contact EHS for disposal arrangements. **DO NOT** THROW BAG AND CONTENTS INTO THE GENERAL TRASH CONTAINERS. 8) Complete the CHEMICAL SPILL FORM and send it to OEHS.

Acid Spills

NEUTRASORB

Acid Spills - NEUTRASORB	
NEUTRASORB	Use for the cleanup of*: • Acrylic Acid • 3-Bromopropionic Acid • Butyric Acid • Iso-Butyric Acid • Deuterium Bromide • Deuterium Iodide • Fluoboric Acid • Fluosulfonic Acid • Formic Acid • Hydriodic Acid • Hydrobromic Acid • Hydrochloric Acid • Iodoacetic Acid • Nitric Acid • Perchloric Acid • Periodic acid • Phosphoric Acid

<table>
<tr><td></td><td>

- Propionic Acid
- Pyruvic Acid
- Sulfuric Acid
- Sulfurous Acid
- Thioacetic Acid

*NOTE: USE SODIUM BICARBONATE FOR ALL OTHER ACIDS
</td></tr>
<tr><td>PRECAUTIONS</td><td>
1) Acids can cause serious burns to exposed skin/eyes.
  a) In case of contact, IMMEDIATELY flush skin/eyes with water for 15 minutes.
  b) Remove contaminated clothing/shoes while rinsing.
  c) Immediately seek follow-up medical attention.
2) Wear protective gloves and goggles.
3) Wear an approved respirator for CONCENTRATED acid spills.
4) Do not step in the spill. Wear protective booties, if necessary.
</td></tr>
<tr><td>CLEANUP METHOD</td><td>
1) Apply Neutrasorb around the spill’s perimeter first, and then inward.
2) After foaming has stopped, carefully add Neutrasorb and water in small amounts and mix with plastic utensil until:
  a) The mixture maintains a BLUE COLOR THROUGHOUT.
  b) All foaming has stopped.

Color Code
<table>
<tr><th>Color</th><th>Acid Content</th><th>Hazard</th></tr>
<tr><td>Red/Pink</td><td>High</td><td>Hazardous</td></tr>
<tr><td>Yellow/Blue</td><td>Low</td><td>Hazardous</td></tr>
<tr><td>Blue</td><td>Neutralized</td><td>Safe</td></tr>
</table>
1) Carefully scoop the blue neutralized spill material into a plastic disposal bag.
  a) CAUTION: IF MATERIAL IS WARM, WAIT A FEW MINUTES FOR IT TO COOL.
2) Thoroughly clean spill area until all neutralized acid is removed. Deposit used sponges and other contaminated materials into the disposal bag.
3) Twist bag shut with a bag tie.
4) Label the disposal bag with the full chemical name(s) of the contents.
5) Contact EHS for disposal arrangements. DO NOT THROW BAG AND CONTENTS INTO THE GENERAL TRASH CONTAINERS.
</td></tr>
</table>

	6) Complete the CHEMICAL SPILL FORM and send to OEHS.

SODIUM BICARBONATE

Acid Spills – SODIUM BICARBONATE	
SODIUM BICARBONATE	Use for the cleanup of: • Acetic Acid • Acetic Anhydride • Benzoic Acid • Citric Acid • Hydrofluoric Acid • Oxalic Acid • Phosphoric Anhydride • Sulfur Trioxide • All other acids not listed for Neutrasorb CAUTION: DO NOT USE FOR ACIDS LISTED UNDER NEUTRASORB
PRECAUTIONS	1) Acids can cause serious burns to exposed skin/eyes. a) In case of contact, IMMEDIATELY flush skin/eyes with water for 15 minutes. b) Remove contaminated clothing/shoes while rinsing. c) Immediately seek follow-up medical attention. 2) Wear protective gloves and goggles. 3) Wear an approved respirator for CONCENTRATED ACID SPILLS. 4) Do not step in the spill.
CLEANUP METHOD	1) Apply Sodium bicarbonate around the spill's perimeter first, and then inward. 2) Mix with plastic utensils and add water if necessary to form a slurry. 3) Carefully scoop the slurry into a plastic disposable bag. 4) Thoroughly clean spill area until acid is removed. Deposit used sponges and other contaminated materials into disposable bag. 5) Twist bag shut with a bag tie. 6) Label the disposal bag with the full chemical name(s) of the contents. 7) Contact EHS for the disposal arrangements. **DO NOT** THROW BAG AND CONTENTS INTO THE GENERAL TRASH CONTAINERS. 8) Complete the CHEMICAL SPILL FORM and send to OEHS.

Caustic Spills – NEUTRACIT 2

Caustic Spills – NEUTRACIT 2	
NEUTRACIT 2	Use for the cleanup of: • Ammonia Solution • Ammonium Hydroxide • Potassium Hydroxide • Sodium Hydroxide
PRECAUTIONS	1) Caustic substances can cause severe burns to exposed skin and eyes. a) In case of contact, IMMEDIATELY flush skin/eyes with water for 15 minutes. b) Remove contaminated clothing/shoes while rinsing. c) Seek follow-up medical attention. 2) Wear protective gloves and goggles. 3) Wear an approved full-face respirator for concentrated ammonium hydroxide and ammonia.
CLEANUP METHOD	1) Apply Neutracit 2 around the spill's perimeter first, and then inward. The Neutracit 2 will change color from yellow to blue. 2) Thoroughly mix with plastic utensils. Carefully add water and Neutracit 2 in small amounts until: a) The mixture maintains a yellow/yellow-green color throughout. **Color Code** Blue — Caustic — Hazardous Yellow/Yellow-Green — Neutralized — Safe 3) Carefully scoop the yellow-green neutralized mixture into a plastic disposal bag with plastic utensils a) **CAUTION:** NEUTRALIZED CAUSTIC PRODUCE HEAT. WAIT UNTIL MIXURE HAS COOLED BEFORE HANDLING. 4) Thoroughly clean spill area until all caustic material is removed. Deposit used sponges and other contaminated materials into disposal bag. 5) Twist bag shut with a bag tie. 6) Label the disposal bag with the full chemical name(s) of the contents.

	7) Contact EHS for disposal arrangements. **DO NOT** THROW BAG AND CONTENTS INTO THE GENERAL TRASH CONTAINERS. 8) Complete the chemical spill form and send to OEHS.

MERCURY

Use a pipette or medicine dropper to pick up mercury droplets.

1. Do not use a commercial or domestic vacuum cleaner.
2. Cover the area of the spill with one of the following:
    a. Sodium polysulfide solution or
    b. Powdered sulfur or
    c. Silver metal compounds
3. Clean up residue in a separate container for waste collection. Spill debris must be managed as hazardous chemical waste.

For specific clean-up information, contact Office of Environmental Health & Safety.

Hazardous Material Spill Report Form

Hazardous Material Spill Report Form

Name Reporting:

Campus Phone Number: 7-___________

Location of Spill:

- Building:
- Floor:
- Room:

Material Spilled:

Quantity:

Describe Incident:

Injured:

Describe Injuries:

Section 2 – Incident and Injury Reporting

Any incident resulting in a student injury should be reported to University Health Services. Any incident resulting in an injury to faculty or staff should be reported to Human Resources.

Chapter IX: Standard Operating Procedures

Section 1 – Developing Standard Operating Procedures

The Laboratory Standard and the Environmental Management Standard require that Standard Operating Procedures (SOPs) be established for the use of any hazardous chemical or laboratory waste, respectively. UMass Boston has developed a program which provides laboratory staff with a set of rules comprising a 'Basic SOP' which is applicable to every chemical procedure in the laboratory. In many circumstances however, it will be necessary to take additional measures to protect yourself and others in your laboratory. It is not a requirement to formally document these additional steps.

OEHS had taken each chemical inventory and developed a Primary Index which identifies potential hazards beyond those controlled by the Basic SOP and Secondary Indices which rank the relative degree of hazard. The Primary and Secondary Indices are presented as Operational Safety Data Sheets. An explanation of how to read these sheets is included. Operational SDS's should be reviewed before beginning each new procedure.

A dominant characteristic of the research laboratory is the presence of very many chemical substances, coupled with few closely defined routine tasks or processes. This makes the development of Standard Operating Procedures for the handling of hazardous chemicals in this environment a particularly challenging task. The OEHS has developed a set of guiding principles which laboratory workers will employ to lighten the burden and help create procedures which ensure a safe and healthful workplace for all UMB employees.

This section is intended as a practical guide to aid you in choosing additional measures and control procedures necessary for the safe handling of hazardous chemicals in your laboratory. The basic tool provided is the Basic Standard Operating Procedure (Appendix I), a 'floor' of rules for the handling of ANY chemical in the laboratory. From your chemical inventory, we have prepared a set of Laboratory-specific Operational Safety Data Sheets. These contain a Primary Index which identifies potential hazards beyond those controlled by the Basic SOP, and Secondary Indices which rank the relative degree of hazard. From this information, and your estimate of potential exposure under your particular conditions of use, you should be able to quickly and effectively design a SOP for the majority of procedures in use in your laboratory, or recognize circumstances in which additional aid or information from the OEHS is warranted. It is not a requirement to formally document any additional procedures, however, laboratory workers may often find it beneficial. If you need assistance, please contact OEHS.

Hazard Assessment

1. Identify the Hazardous Chemicals used
2. Characterize the nature and degree of toxicity of each chemical

Hazard Identification

Chemicals considered ‘hazardous’ under the Standard are broadly defined and include practically anything in the laboratory. Mixtures identified by product or brand name are included, except where their use is not 'occupational' – that is, their use has a pattern and frequency like normal 'household' use, such as hand soap. Components of kits may also be excluded, if the kit is self-contained and presents no potential for exposure; chemicals impregnated in another material such as test strips may also be excluded. OEHS has your current inventory, which you prepared for the hazardous waste program. On obtaining new chemicals (not in your current inventory), send name and Chemical Abstract Service Registry Number (CAS #) to the OEHS. The CAS # is vitally important in assigning a unique identification code to the substance, required by our computerized database. It is often listed on the container label, and nearly always listed in the Identification section of the SDS. If you are unable to locate the number, the RTECS Accession # is the next most valuable identifier. If none of these are available, or if the product is a proprietary mixture of chemicals, include the name of the Manufacturer and the Product # if possible. We will contact the Manufacturer and obtain the necessary information, although there will be some resulting delay.

Hazard Characterization

This step will be carried out for you by the OEHS. Your chemical inventory will be qualitatively classified and indexed with regard to specific health hazard and also reactivity/compatibility for segregation and storage. Wherever possible, quantitative data on the relative degree of hazard will also be compiled and presented. A full description of the lists employed, and the criteria used in extracting information from the SDS's can be found in: **Criteria for Chemical Classification.**

Design of a Control Program

1. Evaluate the effectiveness of existing engineering controls, personal protective equipment, and administrative controls (work practices) in minimizing such exposure.
2. Select from the available control practices a set enough to achieve the desired goals (meet regulatory limits or minimize potential for injury) for each use of hazardous chemical in the laboratory.

Selecting Control Procedures

The Standard Operating Procedures should address the control procedures required for the handling of each chemical and should establish the level of stringency required for the chemical in the application under consideration. To aid you in that task, the Chemical Hygiene Committee has prepared Basic Standard Operating Procedures for the Handling of Hazardous Chemicals in the Laboratory. These are 'baseline' procedures for any use of any chemical in the laboratory. The Laboratory Standard requires that certain classes of chemicals be given special consideration. In addition, more precise data on the physical nature or degree of hazard exists for some chemicals, which can aid you in determining appropriate control procedures. While some of the information needed for this classification can be found in the SDS's, additional information is required, particularly for the selection of control procedures. To aid you in this task, the OEHS has classified your inventory list according to the following criteria:

Special Substances These substances specifically require consideration of defined control procedures	A. Special Carcinogens B. Human Teratogens and Reproductive Hazards C. Highly Toxic Substances
Defined Physical Characteristics Substances possessing physical characteristics which potentiate the hazard, and aid in determining proper control procedures	D. Inhalation Hazards E. Dermal Hazards F. Corrosive / Serious Irritant G. Specific Eye Hazard
Regulated Chemicals Substances for which exposure limit values are mandated by OSHA, or recommended by NIOSH or the ACGIH	H. Short Term Exposure Limits (STELs) indicate the potential for serious injury or pathology following brief exposure to the chemical.
Possible Special Risks Substances suspected of special toxicity or posing a hazard to susceptible individuals	I. Neurotoxins J. Suspect Carcinogens K. Suspect Teratogens and Reproductive Hazards L. Allergens and Sensitizers

Your inventory list will be returned to you as a Primary Index, with each chemical identified by the letter designation of the relevant categories. Note that there are four basic 'sets' of categories:

- Special substances require a consideration of specific control procedures with regard to Designated Areas, Containment, Waste Handling, and Area Decontamination.
- Defined Physical Characteristics are defined by specific physical characteristics. In addition to the Basic SOP, a determination of additional control procedures relevant to the specific hazard named must be made.

The remaining categories are intended to bring your attention to Regulatory Requirements, and to Chemicals for which additional precautions may be advisable. While important in your determination of appropriate control procedures, they do not automatically trigger a requirement for specific hazard determination on the SOP. Some additional information is included in the above Secondary Indices. In addition, we have extracted relevant information from the SDS for each chemical listed and are providing these to you as a single-page, Operational SDS collection on the health and physical hazards of the chemicals in your workplace. These contain:

- The Hazard Index for the chemical
- NFPA Hazard Codes
- Limit Values proposed by OSHA, NIOSH or the ACGIH
- Toxicity Data

- Identification and quantification of the relative potency of the hazard for inhalation hazards, neurotoxins, reproductive toxins, and carcinogens
- Health Hazards and Symptoms of Exposure
- Physical Hazards
- Physical Appearance and Characteristics.
- Data Relevant to Safe Storage
- Chemical Reactivity Information
- Appropriate Fire Extinguisher

These should provide all the information necessary to complete the SOP. Criteria used in classification, and full explanation of the material presented on the Operational SDSs. Should you require additional information, contact OEHS for assistance. The Primary and Secondary Indices described above are tools intended to aid you in classifying chemical hazards and determining appropriate levels of control. They are computer-generated lists, selected on narrowly-defined criteria, and are not intended to be taken as inclusive or exclusive identifiers of these hazards. The 'Operational SDS' sheets are vital in identifying hazards which do not fall within the criteria used in preparing the indices. In addition, these sheets satisfy the mandated requirement for training in the specific health hazards, symptoms of exposure, regulatory limits, and means of detection contained in the Standard.

Response Based on Classification

Any chemical which lacks a Letter Designation in all categories in the Primary Index requires no control procedures beyond those defined in the Core SOP or suggested by information contained in the Operational SDS.

- A chemical listed "I," "J," "K," or "L"
    - A listing in any of these categories indicates that a special risk may exist but does not indicate that a common route of exposure occurs which would permit selection of a control technique. Additional quantitative information may exist, however, particularly for Categories "I" and "J," in the relevant Secondary Indices, which will permit better characterization of the hazard and selection of an appropriate level of control.
- A chemical listed "A," "B," or "C"
    - Has been classified as a 'Special Hazard,' according to the Standard, either as a Carcinogen, a known Reproductive Hazard, or a substance of very high toxicity. Inclusion in this group obligates the consideration of additional control procedures, specifically:
        - Designated Area. An area of the workspace which has clearly posted as to the substance and hazard. All individuals accessing the area must be warned of the hazard, but no other access limitation is required, and the 'designation' may be removed when the hazard is no longer present.
        - Use of Containment devices such as fume hoods or glove boxes. Contingent on the likelihood of inhalation (e.g. dust, aerosol or gas/vapor) exposure.

        - Hazardous Waste. Attention should be paid to the safe storage and handling of the material prior to pick up. The waste must be clearly identified, and OEHS must be notified in advance of the contents.
        - Decontamination Procedures. For small quantities employed in most experiments, wash down of surfaces with detergent, followed by alcohol will be sufficient. Toweling etc. employed must be clearly labeled and disposed of as hazardous waste. For larger areas, gross contamination, and materials such as spent reagents, OEHS has compiled a reference collection on decontamination procedures including the IARC Monographs on Laboratory Decontamination and Destruction of Carcinogens in Laboratory Wastes. If these techniques are to be employed, special attention should be paid to the carcinogenic potency of products of the reaction, completeness of the destruction, and reaction times. If any doubt exists as to the efficiency of the procedure, endpoints should be monitored.
        - None of the above need necessarily to be adopted, but rather must be considered, and the decision or level of protection required based on the conditions of use.
- A chemical listed "D," "E," "F," or "G"
    - Has been classified as a specific hazard for which defined control procedures are automatically prescribed. These procedures are in addition to any procedures earlier defined, but the level of stringency is dependent on the degree of exposure expected and the toxicity of the agent. Wherever possible, additional qualitative and quantitative information has been provided in the Secondary Indices.

Standard Condition of Use

An automatic selection of control procedures is presented based on the classification scheme employed. This selection presumes 'normal laboratory' conditions and frequencies of use of the substance. There are three main components to be considered:

- Potential source strength, a function of the amounts used
- Duration of individual exposures
- Frequency of exposures

In keeping with the Standard, our operational definition infers that the amounts of hazardous chemicals employed at any one time are minimal, e.g. contained in typical laboratory glassware, and do not approach levels found in process chemistry.

'Typical' frequency and duration of exposure are more difficult to define, as they are more closely associated with specific procedures than with specific chemicals. Operationally we will define 'typical duration and frequency' as some combination of exposures approximating 10 hours per week: for example, 2 hours per day, 5 days per week, or 3 hours per day, 3 days per week. Note that this 'benchmark' for our selection of control procedures implies significant exposure. These levels approach typical 'industrial' or process levels, or the definition of 'Regularly Exposed' found elsewhere in the Standard.

Duration and frequency of exposure are most important when assessing the potential hazard posed by chronic health hazards – for example, Carcinogens and organ-specific or systemic toxins which result in cumulative pathologies, or poorly metabolized substances which lead to cumulative body-burdens. Brief or intermittent exposures to these agents typically present no risk. For substances regulated by OSHA or with limit values prescribed by the ACGIH or NIOSH, the relevant value is the PEL, TLV, or REL, respectively, which are averaged over 8 (10 for NIOSH RELs) hours per day.

Certain chemicals, such as Serious Irritants and Narcotics, which include most of the Organic Solvents found in the laboratory, are relatively less sensitive to variations in frequency and duration in selection of control procedures. Among regulated substances these are given STEL's, or Short-Term Exposure Limits, which are time-averaged over 15 minutes. Brief exposures to these substances typically do not present a health risk but may indicate that a 'process' is not under good control. The frequency and duration of the process may thus be a critical determinant in selection of adequate controls.

For substances which pose a more acute Health Hazard or Physical Hazard such as Corrosives, duration and frequency are NOT important in determining the level of protection. Adjustments to stringency of recommended control procedures for these agents should not be made based on 'contact time' alone. For those agents which are Agency-regulated, this is reflected in Ceiling Limit Values, which are not to be exceeded at any time.

Section 2 – Operational Safety Data Sheets

UMass Boston employs a comprehensive hazard management information system as part of the Laboratory Chemical Hygiene Program. Under this program, manufacturer's Safety Data Sheets are replaced by **Operational Safety Data Sheets (Op SDSs)** which contain additional information and more quantitative presentation of health risk. OEHS has prepared one-page Op SDSs for most chemicals at the facility. It is essential that you use this information in your design of safe operating procedures. Consult these to determine the nature and degree of hazard posed by the procedure which you are designing. The information on these sheets is organized as:

- Name and Chemical Abstract Series #
- The Hazard Index for the chemical
- NFPA Hazard Codes
- Limit Values proposed by OSHA, NIOSH or the ACGIH
- Toxicity Data
- Identification and quantification of the relative potency of the hazard for:
    - Inhalation Hazards
    - Neurotoxins
    - Reproductive Toxins and Teratogens
    - Carcinogens
- Particular Significant or Unusual Effects of the Chemical
- Acute Health Hazards and Symptoms of Exposure

- Chronic Health Hazards
- Physical Hazards
- Adverse Chemical Reactions
- Physical Appearance and Characteristics
- Data Relevant to Safe Storage
- Chemical Reactivity Information
- Appropriate Fire Extinguisher
- Unusual Toxic Emissions when Burned
- Globally harmonized system of classification statement

A complete set of SDS's for all chemicals on campus can be found at:
https://www.umb.edu/ehs/lab_safety/chemical_hazard.

Sample Operational Safety Data Sheet (SDS)

DIMETHYLHYDRAZINE (1,1) CAS # 57147

A	Special Carcinogen	E	Dermal Hazard	I	Neurotoxin
B	Human Terato\Repro Haz	F	Corrosive	J	Suspect Carcinogen
C	Highly Toxic	G	Eye Damage	K	Suspect Terato\Repro Haz
D	Inhalation Hazard	H	STEL	L	Sensitizers

HAZARD INDEX A . . D E F G . . . . .
NFPA HAZARD CODES (H,F,R,O) 3 3 1
SPECIAL CARCINOGEN DESIGNATED AREA MAY BE REQUIRED
CHRONIC TOXICITY RISK INDEX 5++ 1.2 mg/Kg
ACUTE TOXICTY RISK INDEX 3.9 122.0 mg/Kg
INHALATION HAZARD INHALATION RISK INDEX 5++
OSHA PERMISSIBLE EXPOSURE LIMIT .5 PPM
ACGIH THRESHOLD LIMIT VALUE .01 ppm
IMMEDIATELY DANGEROUS TO LIFE AND HEALTH 15 ppm

ROUTE OF EXPOSURE
Multiple Routes: May be fatal if inhaled, swallowed or absorbed through skin.

TARGET ORGAN(S) OR SYSTEM(S)
Damage to the liver. Damage to the kidneys.

SIGNS AND SYMPTOMS OF EXPOSURE
Warning: Unsymmetrical dimethyl hydrazine can cause convulsions resulting in death, pulmonary edema, CNS stimulation, and hemolytic anemia. Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes and skin. Inhalation may result in spasm, inflammation and edema of larynx and bronchi, chemical pneumonitis and pulmonary edema. Symptoms of exposure may include burning sensation coughing, wheezing, and laryngitis, shortness of breath, headache, nausea and vomiting. Exposure can cause: Damage to liver, Damage to kidneys, Blood effects and gastrointestinal disturbances.

PHYSICAL CHARACTERISTICS
PHYSICAL STATE: LIQUID
FLAMMABLE
VAPOR PRESSURE - 103.0 mm Hg @ 20øC
FLASH POINT 14o F
STORE IN EXPLOSIONPROOF REFRIGERATOR, OR TIGHTLY STOPPERED IN A WELL-VENTILATED AREA
REACTS VIOLENTLY IN AIR

SEGREGATION: SHELF # 1

STORAGE GROUP(S):
a - ORGANIC BASE/FLAMMABLE/TOXIC
b - PYROPHORIC/WATER REACTIVE
1 - FLAMMABLE/COMBUSIBLE SOLVENT

WASTE CHARACTERISTIC HAZARD:
- IGNITABLE REACTIVE TOXIC CORROSIVE

INCOMPATIBILITIES:
- OXIDIZING AGENTS
- COPPER, COPPER ALLOYS
- BRASS
- IRON AND IRON SALTS

FIRE EXTINGUISHER: CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM

GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION:
- Symbol of Danger: F T N
- Indication of Danger: Highly Flammable, Toxic, Dangerous for the environment.
- R: 45 11 23/25 34 51/53
- Risk Statements: May cause cancer, Highly flammable. Also toxic by inhalation and causes burns if swallowed. Toxic to aquatic organisms, may cause long term adverse effects in the aquatic environment.

Explanation of Information Contained in the SDS

- NFPA HAZARD INDEX

- Where assigned, the National Fire Protection Association Index is presented. This code contains a numerical designation of severity (from 0, lowest to 4, highest) in the categories Health, Flammability, Reactivity, and a letter designator in the category of Other indicating oxidizing activity (OX), violent reactivity with water (W), or compressed gas (G).
- NFPA codes exist only for a selected list of chemicals in widespread use in manufacturing. While especially useful in identifying potential fire or explosion threat, the absence of a code should not be taken as the absence of hazard.

- SELECT CARCINOGEN, TOXIN, NEUROTOXIN, OR REPRODUCTIVE TOXIN
  - If the chemical falls into one of the especially toxic categories (Carcinogenicity, Nonspecific Systemic Toxicity, Neurotoxicity, or Reproductive Toxicity), this information is next presented. Where quantitative or indexed data is available, this too is presented.
- REGULATORY LIMIT VALUES
  - If exposure limits have been set for the chemical they will be presented here. Note that particular attention should be paid to Short Term Exposure Limits (STELs) or Ceiling Limit Values (CEILs) which indicate significant hazard exists even for brief exposure.
- TOXICITY
  - Where available, data will be presented on chronic and acute toxicity, as well as indexed values for inhalation, neurotoxic, and teratogenic or reproductive risk potential. Note that for any particular chemical, risk may be limited to only one of these categories.
- SPECIAL WARNINGS
  - In some cases, the manufacturer has identified specific circumstances which create unusual hazard, or especially significant or unusual toxic effects which are presented here.
- ACUTE HEALTH EFFECTS
  - This entry comprises a list of the known toxic outcomes involving short-term exposure to high concentrations of a chemical. These types of exposures are typically sudden and severe and may lead to irritation, illness, or death.
- CHRONIC HEALTH EFFECTS
  - This entry comprises a list of known toxic outcomes of continuous or long-term exposure to the chemical.
- PHYSICAL CHARACTERISTICS
  - If the manufacturer has identified specific or unusual conditions/reactions pertaining to this chemical, they will be presented here. Following this, information is presented on the following characteristic(s) where available:
  - APPEARANCE
    - This entry describes the typical appearance of the product as supplied by the manufacturer. Note that if the material is listed as a solid, but exists in the spill as a liquid, the presence of an unknown solvent must be inferred.
  - FLAMMABILITY
    - Based on flash point and reactivity, where applicable the chemical will be identified as flammable, combustible, or explosive.

- VAPOR PRESSURE
  - The vapor pressure is the partial pressure (in mmHg) exerted by the gas-phase of a liquid in the head space of an enclosing container at 20°C at normal atmospheric pressure (760 mmHg). As such, it is an indicator of the tendency of the chemical to 'off-gas.' Solids and 'oily' liquids typically have values less than 5 mmHg. Water has a vapor pressure of approximately 12 mmHg, and the range for many alcohols is 12 to 50 mmHg. Aromatic Hydrocarbon solvents typically fall in the range of 5-25 mmHg, and Aliphatic Hydrocarbons 100-500 mmHg (Chloroform - 160 mmHg; Ethyl Ether - 442 mmHg). Vapor pressures greater than 760 mmHg define a gas at normal temperature and pressure (Chlorine - 4800 mmHg).
- FLASH POINT
  - Flash point is the temperature (in degrees Fahrenheit) at which a flammable liquid can release enough vapor in air to reach the LEL (lower explosive limit) or LFL (lower flammable limit). The LEL is the minimum concentration (usually described in %) of a flammable vapor or gas in air that will support combustion if an ignition source is present. It is not the ignition temperature. This is a critical value in spill control. A value near or below room temperature indicates that the material may form a flammable range of vapor at a distance from the spilled source which may 'flash back' and ignite the source. It is also critical with regard to storage. A chemical with a flash point at or below that of the laboratory refrigerator (approx. 40°F) can form an ignitable atmosphere in the sealed box. Such a chemical must not be stored in a conventional refrigerator where potential ignition sources (e.g. lights, compressor motor) are located. Store instead in a UP listed flammable refrigerator, or tightly stoppered on the bench.
- PEROXIDE OR PEROXIDE FORMER
  - This information indicates that the chemical is or may form unstable peroxides capable of self-detonating or sensitive to small inputs of energy.
- WATER REACTIVE
  - This information indicates that the chemical reacts violently with water generating heat or fire or producing toxic or flammable gas.

- INCOMPATIBILITIES
  - This category presents a list of chemicals or characteristics of chemicals known to produce violent thermal or toxic reactions on mixing with the chemical.
- FIRE EXTINGUISHER
  - The most appropriate fire extinguisher type is listed here.

Chemical Storage Groups – Guidelines

Storage group guidelines are used for:

- Storing solids, liquids and gases

- Grouping hazardous chemicals in the same secondary containment tray, including laboratory waste
- Determining the appropriate re-use of empty chemical containers

Never store chemicals from different storage groups in the same secondary container.

STORAGE GROUP	CHEMICALS
A	Compatible Organic Bases, Flammables and Toxics
B	Pyrophoric and Water Reactive Materials
C	Compatible Inorganic Bases, Oxidizers and Toxics
D	Compatible Organic Acids, Flammables and Toxics
E	Compatible Oxidizers, Organic Peroxides and Acids
F	Inorganic Acids not including Oxidizing or Organic Acids
G	Non-Reactive Materials and Non-Hazardous Materials
H	Flammable or Pyrophoric Compressed Gases
I	Compatible Corrosive and Oxidizing Gases and Inert Gases
J	Poison Compressed Gases
K	Explosive or other unstable material
L	Solvents, Flammables and Combustible Materials
X	Needs secondary containment separate from ALL groups and from each other individually

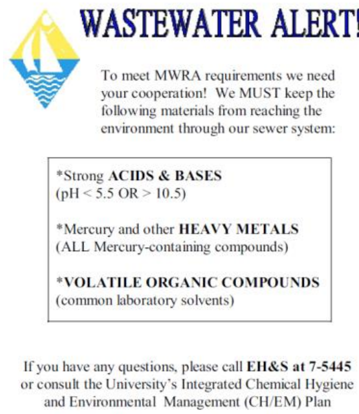
Storage Groups that can be stored on the same shelf, or within the same storage cabinet, if each group is segregated by secondary containment:

SHELF	STORAGE GROUP
1	A, B, D, G, L
2	C, E, F, G
3	X

Chapter X: Environment Management and Pollution Prevention

Section 1 – Waste Water Management

All laboratories have signs posted at sinks listing prohibited materials. If there are any questions about this please contact OEHS.



Section 2 – Pollution Prevention

Pollution prevention is the practice of reducing or eliminating the generation of waste while avoiding shifting the hazards from one medium to another (e.g. from water to air, from hazardous waste to solid waste, or from environmental concerns to fire safety concerns). Although the pollution prevention concept is traditionally associated with hazardous chemicals, it is also applicable to energy consumption and natural resource use (e.g. water, minerals, and wood). Generally speaking, pollution prevention strategies reduce the overall use of waste- or hazard-generating material by:

- substitution with a lower-hazard alternative material or chemical;
- process reformulation, product redesign, or process modernization;
- improved housekeeping or operation and maintenance practices; or
- extending the useful life of the material, product or process through reuse and recycling.

The strict definition of pollution prevention excludes the treatment of wastes prior to disposal, since treatment methods typically involve the addition of hazardous chemical, energy, and natural resource inputs. Toxics use reduction refers to pollution prevention efforts that focus on processes with hazardous material inputs.

Chapter XI: Training

Section 1 – Laboratory Safety

All individuals working with chemicals in laboratories in a generally unsupervised capacity, including, but not limited to faculty, staff, post-doctorates, graduate students, and some undergraduate students, are required to be trained in the application of the Laboratory Safety Manual. This training must be done once, and need not be repeated, unless a significant new hazard is introduced into the laboratory. Training will be conducted by OEHS at the beginning of each semester, and whenever required by the addition of new staff/students. OEHS is notified when orientation sessions will take place for new faculty/staff members and a representative always attends. In addition, each laboratory department is contacted at the beginning of each semester and asked to identify new students, staff and faculty. OEHS then schedules times for training sessions.

Sessions are either large groups or small groups depending on the number of new people each semester. Principal Investigators also can request individual visits to their laboratories. Follow-up training will also be provided if laboratory workers work with new hazards for which they have not been previously trained. Sign-up sheets for each training session will be filled out before each session. Documentation of training records will be maintained in a training database in OEHS. On-line lab safety refresher training is also required within one year from taking the in-person class. Other on-line training classes may be assigned depending on the work that the PI does.

The syllabus of the training program shall include the following:

1. Contents of the Laboratory Standard and the Laboratory Management Plan and its Appendices
    a. Emergency Response / Spill Control
    b. Medical Consultation
    c. Labeling and Signage: Physical and Health Hazard Categories
    d. Special Considerations for Highly Hazardous Substances
    e. Chemical/Physical Hazards of Laboratory Waste
2. Location of the Lab Safety Manual
3. Location of Indexed Lists, SOP's, SDS's, Reference Material
4. Detection of Exposure:
    a. Exposure Routes
    b. Employer: Methods, how to access
    c. Employee/Laboratory Worker:
        i. Warning Properties
        ii. Signs and Symptoms of Exposure/Release
    d. Release Prevention
5. Standard Operating Procedures:
    a. Defined as Basic SOP plus Site-Specific variations
    b. Use of Lists, SOP's, SDS's, additional reference
    c. Use and Limitations of Engineering Controls
        i. Eye Wash and Drench Showers
        ii. Fume Hoods
        iii. BioSafety Cabinets
    d. Use and Limitations of Personal Protective Equipment
        i. Eye Protection
        ii. Skin Protection: Gloves
        iii. Skin Protection: Aprons, Coats, Jumpsuits
        iv. Respiratory Protection (Program)
            1. Conditions warranting protection
            2. Medical Surveillance
            3. Selection and Fit Test
    e. On-Site Work Practices and Procedures
6. Pollution Prevention

Classroom Training

OEHS provides classroom lab safety training at the start of each semester. All PIs and graduate students who work in UMass laboratories must attend a session as soon as possible once they arrive on campus.

Online Training

OEHS offers a lab safety refresher course and it should be taken within one year after taking the classroom training. Sometimes when faculty or students arrive on campus mid-semester they may take an online lab safety training course first.

Section 2 – Supplemental Training

OHES offers a number of additional on-line courses. Students may be assigned based on the Department or specific lab they are in. Including but not limited to:

Introduction to Biosafety
Fume Hood Safety
Bloodborne Pathogens
Biosafety Cabinets
Fire and Emergency Preparedness
Ergonomics
Laser Safety

Chapter XII: Recordkeeping

The following records will be maintained in both paper and electronic format. Paper records will be maintained for 1 year, or in the case of annual items, for the current year. Electronic records, to the extent possible, will be maintained indefinitely.

- Training records
- Annual laboratory inspection reports
- Monthly laboratory self-inspection reports
- Institutional hazardous chemical inventory

The following records will be maintained indefinitely:

- Biennial Hazardous Waste Report
- Hazardous waste manifests/exception reports
- Land ban forms

Additional items to be maintained in OEHS include:

- Records of non-conformance/corrective actions

- Regulations (local, state, federal)
- List of Principal Investigators and associated laboratories
- Incident reports
- Lab Safety Manual
- EHS Manual
- SPCC Plan
- Contingency Plan

Departmental Offices/Individual Laboratories (will vary depending on individual Departmental policies)

- Lab Safety Manual
- List of Principal Investigators and associated laboratories
- Monthly laboratory self-inspection reports will be submitted to OEHS and maintained for one year following implementation
- Hazardous chemical inventories (including HCOC)
- Monthly container inspections (posted)
- Operational SDS's

Section 1 – Chemical Inventories

OEHS maintains laboratory chemical inventories electronically. PIs have access to electronic inventories.

Section 2 – Training

Documentation of training records will be maintained in a training database in the OEHS office.

Section 3 – Identification and Tracking Legal Requirements

OEHS will actively identify and track legal requirements applicable to the management of laboratory waste through a variety of means, including:

- Journals (e.g. Chemical Health and Safety, published by the American Chemical Society)
- Internet and World Wide Web (may include EPA Web Site, DEP Web Site, mail lists)
- Professional organizations such as the Campus Safety Health and Environmental Management Association (CSHEMA), the College and University Hazardous Waste Management Association (CUHWMA), EPA Compliance Assistance Program

At least once a month OEHS staff will perform a search of one or more of these resources in order to determine if there have been any changes in regulatory requirements. Any changes found that are applicable to the EMP will be considered for CH/EM Plan updates.

In addition, lab workers will be updated with new information via the following means:

- UMB OEHS Web Site
- Memos periodically sent to faculty and staff in the science departments
- Meetings with affected departments, or other University meetings related to laboratory issues (such as the Lab Safety Committee meetings)

- Lab Safety training

Appendix A – Minors

Environmental Health and Safety

100 Morrissey Blvd.

Boston, MA 02125-3393

617.287.5445

www.ehs.umb.edu

Minors in Laboratories

Standard Operating Procedure

SOP Number: L-04-14
Effective Date: December 1, 2019
Next Review:

1. PURPOSE

The purpose of this policy is to (a) outline when it is permissible for minors to work or conduct research in laboratories, and/or animal facilities; and (b) identify the responsibilities of Principal Investigators/Faculty/Sponsors/Supervisors and Department Heads for minors working or conducting research in laboratories, and/or animal facilities.

By adhering to this policy, the exposure of minors to chemical, physical, biological, animal and radiation hazards will be minimized.

2. SCOPE

This SOP covers all UMass Boston laboratories and animal facilities. This SOP includes any persons under the age of 18, whether students (unless enrolled as a UMass Boston student), employees, or volunteers. Minors under the age of 14 may not enter laboratories, and/or animal facilities at UMass Boston. An exception is permitted for minors who are part of an approved UMass Boston program designed for youth under age 14 who are observers or are approved by the PI/Supervisor of the laboratory or animal facility.

All Minors are prohibited from working or conducting research in the following areas:

- Any laboratory or facility designated higher than BSL-2 for recombinant or infectious organisms.
- Any laboratory or facility where select agents or explosives are used or stored.
- Any laboratory or facility where radioactive materials or radiation (X-rays) are used.

- Any laboratory or facility where acutely toxic (and high hazard chemicals (including air and water reactive chemicals) are used.

Minors who work in any capacity with animals must be added to an Animal Care and Use protocol currently approved by the IACUC.

Minors who are not part of an approved UMass Boston program are not permitted in any laboratory or animal facility at any time under any circumstances. This includes children of UMass Boston employees and students.

Laboratories and animal facilities must be in compliance with all applicable federal, state, local, and university environmental health and safety regulations, and meet university environmental health and safety requirements in order to allow minors to work within their facility.

3. PRECAUTIONS AND HAZARDS

Students should dress appropriately: long pants, close-toed shoes, etc. General PPE should be provided gloves, eye-protection. PI is responsible for identifying specific hazards and precautions.

4. PROCEDURE

(1) The faculty sponsor submits the completed application form to his or her department chair.

(2) The department chair, or designee reviews the application, adds comments if necessary, then electronically forwards the application with their recommendation to the provost (or his/her designee) for review and approval.

(3) Approval by the provost (or designee) is given subject to the following:
   (a) Review of proposed activities by designated entities, such as EHS, IRB, IACUC, etc.;
   (b) Completion of all training/requirements stipulated in the reviews by these entities;
   (c) Understanding that the stipend (if any) is not for employment;
   (d) Understanding that all applicable aspects of this policy will be followed by any sponsoring organization/mentor, and the student

(4) Approval by the provost or his/her designee, including any conditions, is sent to the faculty sponsor(s) via email, and copied to the following:
   (a) Entities that require review or training in advance of the activity
   (b) Program director for centralized programs, if applicable
   (c) Other unit(s) as might be applicable

(5) Reviewing entities such as EHS, IRB, IACUC etc. contact the faculty sponsor following their reviews, providing information on all training and other restrictions/requirements to be addressed before the research activity begins. If the nature/scope of the student's research changes, the faculty sponsor must notify the approving entities and ask them to revise the risk assessments.

Note: EHS reserves the right to inspect the laboratory in which the minor is participating in laboratory activities at any time while such activities are in progress, and all labs determined by EHS as conducting higher-risk activities will be inspected prior to the commencement of the minor's educational program.

EHS has the authority to suspend the minor's laboratory activities if EHS finds any uncorrected safety deficiencies or other violations of stipulations made by EHS, the sponsor's department, or the provost. The IACUC and IRBs offices likewise have the authority to oversee research in their areas of responsibility and to suspend activities when such action is appropriate.

5. ROLES AND RESPONSIBILITIES

The PI/Lab Supervisor/Sponsor is responsible for the health and safety of minors working in his/her laboratory. This includes the provision for and enforcement of correct use of engineering controls, work practices, and personal protective equipment (PPE).

The PI/Lab Supervisor/Sponsor may delegate daily supervision of minors to trained and knowledgeable lab personnel. However, the PI retains primary responsibility for providing a safe and healthy activity.

The Minor/Minor's Guardian are responsible for –

a) Thoroughly reading and understanding the consent form and the Minors in Laboratories and Animal Facilities Policy.
b) Thoroughly reading and understanding the written description of the minor's research project, the risks involved and the steps required minimize exposure to those risks. When working in the lab minors must sign off on all relevant safe operating procedures, policies, and plans including Exposure Control Plans.
c) Completing all training prior to beginning laboratory activities.
d) Complying with all safety standards and practices as provided in training.
e) Wearing all required personal protective equipment.

6. REFERENCES

N/A

7. EQUIPMENT AND MATERIALS

N/A

8. TRAINING

1) Lab-Specific or Animal Facility-Specific Training – Minors working in laboratories or animal facilities must complete all appropriate safety training before beginning work with hazardous materials. The PI is responsible for making sure minors are provided with lab-specific training which includes review of the specific hazards that exist in the lab and the procedures, equipment, and resources available for working safely with these hazards.
2) EHS-provided Training – The PI is responsible for ensuring minor completes all EHS training, if applicable, prior to beginning any laboratory activity.
3) Personal Protective Equipment Training – The PI should provide minors with appropriate PPE for the work they are doing. The PI will also provide instruction on how to properly don PPE.

9. DEFINITIONS

- Minor – Any person under the age of 18.
- Laboratory – Any room, suite, or part of a building used to conduct research, academic, animal, clinical, other technical work or scientific experimentation which may pose potential chemical, physical, biological, or radiation hazards.
- Animal facility – Any UMass Boston property where animals are housed or used for research purposes.
- CDC/USDA Select Agent or Toxin – Biological agent or toxin listed in 73 CFR part 4 and 9 CFR part 121.4.
- Visitor – Any person who enters a laboratory, or animal facility with the express or implied invitation of the laboratory director or supervisor.
- Volunteer – Any person who freely and willingly provides services to UMass Boston for civic, charitable, or humanitarian reasons without promise, expectation or receipt of compensation.

10. RECORDKEEPING

The PI/Sponsor intending to have minors work in their lab are responsible for preparing the following documents which are to be completed by the PI, minor, and minor's parent/guardian:

i. Minors in Research Lab or Animal Facility Parental Consent Form
i. Application for Student Minors to Enter UMass Boston Laboratories
ii. IBC Modification Form (if necessary)
iii. IACUC Modification (if necessary)

11. ATTACHMENTS

Parental Consent Form for Minors Entering a UMass Boston Laboratory

	Zehra Schneider Graham EHS Director	
Approved by signature	Name, Title	Date

Parental Consent Form for Minors Entering a UMass Boston Laboratory

Parental Consent Form for Minors Entering a UMass Boston Laboratory

Office of Environmental Health and Safety (OEHS)
December 2019

DRAFT

____ ____________________

Parent/Legal Guardian Name Date

____

____

____

Address

Consent and Release Form

Dear Parent/Legal Guardian:

This consent and release form is required as part of an application for __________________________ to participate in an educational program or work at the University of Massachusetts Boston in a research laboratory in the Department of________________________. Your child will work under the direct supervision of ___________________________________ in _______________________________.

Individual laboratories vary in the inherent types of potential hazards present. While participating in this program, your child may need to work with or around biological materials, chemicals, radioactive materials or other potentially hazardous materials. As part of [his or her] project, ____________________________ will work with or perform the following:

Briefly describe proposed lab activities – include potentially hazardous materials the student will work with in the laboratory, as well as a specific description of any work involving animals that will be performed by the student.

All educational plans for minors in laboratories are reviewed by the University of Massachusetts Boston Office of Environmental Health and Safety to determine that the project is appropriate for a minor student, that appropriate safety precautions are in place and all training requirements are identified and completed before the lab activity begins.

The University of Massachusetts Boston provides safety training to all personnel who may work with or in the vicinity of potentially hazardous materials – your child will be required to attend laboratory safety training, and may also be required to attend additional training sessions, depending on the nature of his or her particular project. If you have further question on these topics, please call the Office of Environmental Health and Safety at (617) 287-5445

Sincerely,

Supervisor or Program Director

By signing this consent and release, I consent to the conditions as outlined above. In addition, I further understand that University of Massachusetts Boston's facilities are being made available to ______________________as an educational opportunity and that he or she is not a student, regular employee, or affiliate of the University of Massachusetts Boston. I further understand that University of Massachusetts Boston laboratories may contain hazardous substances and equipment and that ____________________ may be subjected to potential risks that could result in illnesses or injuries. ________________________ and I understand these risks and assume them knowingly and willingly.

I agree, on behalf of my family, heirs and personal representatives, to assume all risks and responsibilities surrounding ___________________ use of and access to University of Massachusetts Boston's laboratories. To the maximum extent permitted by law, I release, hold harmless and agree to indemnify the University of Massachusetts Boston, its officers, directors, faculty, staff, or agents from and against any claim, loss, or liability for injury to person or property which ___________________ may suffer, or for which ______________________ may be liable to any other person, during his or her use of and access to the laboratories resulting from any cause, including but not limited to, negligence by University of Massachusetts Boston, its officers, directors, faculty, staff, students or agents.

Minor's Name (PRINT): ____

Parent's/Legal Guardian's Name (PRINT): _________________________________

Parent's/Legal Guardian's Name (Signature): _______________________________

Application for Student Minors to Enter UMass Boston Laboratories

Application for Student Minors to Enter UMass Boston Laboratories

This form should be completed and submitted by the faculty sponsor of the minor who wishes to participate in an educational opportunity in a UMass Boston Laboratory. The student must be at least 16 years of age at the start of the proposed activities. For Faculty this form should be submitted to your department chair for review. The proposed activities must not begin until approval is received from the Provost or his/her designee and all stipulated reviews and training are completed.

Please submit this form via email

<u>Section 1 – Faculty Sponsor or Program Director to complete this section</u>

Name and Department of PI:

Email address of PI:

Contact Person for PI (if different):

Name of student:

Date of birth: Age at the start of proposed activities:

Address:

Relationship to PI (if applicable):

Name of the UMass sponsored program organizing the activity, if applicable:

Program Director (if applicable):

Name/location of High School:

Description of proposed activities. Please include:

- A detailed summary of the educational component of the proposed program ("work in lab," "apprenticeship," etc. are insufficient). Proposed activities must be primarily educational in nature and must be for the benefit of the student.
- Chemicals, model systems, human subjects, materials and/or lab equipment to be used by the participant during the course of the activity

Do the proposed activities involve any of the following? (check all that apply)

A. ____Biological Materials

Human materials and other potentially infectious materials (includes primary or continuous human cells, human tissues and bodily fluids)

Human infectious organisms (BL2 and higher) and/or non-exempt recombinant DNA materials

Note:

- Applicants will require authorization from the UMass Boston Biological Safety Committee in order to work with Risk Group 2 human pathogens
- Applicants may not conduct work with Risk Group 3 pathogens
- No work with Risk Group 4 pathogens is allowed at UMass Boston by any personnel

Live animals

Work with protected health information

B. ____Chemical Materials

Known carcinogenic materials
Known human reproductive toxins
Highly toxic chemicals (LD_{50}<50 m/kg oral-rat)
Reactive or pyrophoric materials
Controlled substances
Disinfectants (e.g. Cidex, Caviwipes)

C. ____Radiation

Ionizing radiation-generating equipment (XRD, X-ray, fluoroscopy, accelerator, cyclotron)
Radioactive materials
Unshielded lasers ≥class 3B
Highly magnetic field equipment (>5 G)

D. ____Physical Materials

High voltage equipment
Class 3 or higher shop equipment

If you checked any of the above items in A-D, please describe:

E. **____Animal Research** (if checked, please refer to Appendix A, section II)
F. **____Human subjects** (if checked, please refer to Appendix A, section III)

Location and description of the area where the activity will take place:
Building
Room
Other location(s) (if applicable):

Proposed start/end dates:

Person responsible for ensuring that all training is complete before any research activity begins:

Person responsible for day-to-day lab supervision:
Contact number for day-to-day supervisor:

Supervisory plan: please provide a description of the planned oversight for the student's activities and the controls that will help ensure the safety of the student and others involved in the research, including any human subjects (e.g. observation only, protective equipment, fume hood, biosafety cabinet).

____By checking, I certify that I have reviewed the Minors in Lab SOP and will be responsible for following all procedures related to the student's participation in the proposed educational activities. I have received a copy of the parental consent form signed by the student's parent or legal guardian. I understand that I will keep this document on file for at least 2 years, and will make it available for review upon request.

Name (please type): Date:
Please email this form to your department chair for review.

<u>Section 2 – Reviewing Department Chair to complete this section</u>

I have reviewed the content of this proposal, have found it to be consistent with the University SOP governing Minors in Laboratories, and recommend approval by the Provost or his/her designee pending additional training or requirements stipulated by EHS and other bodies, as appropriate.

Name (please type): Date:

Comments:

Department Chairs: after electronically completing the above section please email this form to Provost or designee

Section 3 – Reviewing Provost or designee to complete this section

Note this section is optional. If the Provost or designee has no additional comments the application can be forwarded to OEHS for final approval of the application.

I have reviewed the content of this proposal, have found it to be consistent with the University SOP governing Minors in Laboratories, and recommend approval by the Provost or his/her designee pending additional training or requirements stipulated by OEHS and other bodies, as appropriate.

Name (please type): Date:

Comments

Section 4 – OEHS Review

I have reviewed the content of this proposal, have found it to be consistent with the University SOP governing Minors in Laboratories, and approve the proposal pending any requirements noted in the Comments below.

Name (please type): Date:

Comments

Appendix A: Training Requirements

I. Safety
   a. Environmental Health and Safety (OEHS) will review and approve applications to determine the specific training requirements, if any, that are applicable to the proposed activities.
   b. OEHS will communicate training requirements directly to the PI and the training coordinator identified on the application.
   c. If there are changes to the student's research plan, OEHS must be notified prior to new work being performed.
   d. For questions on safety training, please contact OEHS.

II. Animal Research
   a. OEHS will forward applications to IACUC (Institutional Animal Care and Use Committee), who will determine if any specific training requirements are applicable to the proposed activity.
   b. IACUC will communicate any training requirements related to animal research directly to the PI.
   c. For questions on requirements and training, please contact IACUC or OEHS.

III. Human Subjects
   a. If the proposed activity involves human subjects research, the protocol may need to be revised to include the student. In addition, please ensure that the individual receives the appropriate human subjects protection training as stipulated prior to participating in the proposed activity.
   b. For more information on human subjects protection training please contact the Office of Research and Sponsored Programs
   c. Some activities may have requirements for health screening and vaccinations. Any such requirements will be communicated by OEHS to the PI at the time of approval.
   d. For questions on requirements and training, please contact OEHS.

Appendix B – Unattended Operations Signage

UMASS BOSTON

Environmental Health and Safety

WARNING! Emergency Information - Unattended Operations

Contact Name:____

Contact Phone Number:____

Room Number:__________________ **Date**:_____________________

Hood Number:_______________ **Start time**:___________ **End time**:____________

Full Chemical Names and Quantities:

____
____
____
____
____

Compressed Gas Names:

____
____
____

Hazards:(circle all that apply)
Corrosive
Toxic
Reactive
Flammable
Pressurized
Water Reactive
Electrical

In Case of Emergency Shut off:
Electricity
Vacuum
Gas Source
Water Source
Hot Plate/Ignition Sources

Instructions: This form should be filled in complete and attached to the laboratory door whenever a process is left unattended. Assume the worst-case scenario when determining which hazards apply.

Appendix C – Decommissioning Laboratories SOP

Environmental Health and Safety

100 Morrissey Blvd.

Boston, MA 02125-3393

617.287.5445

www.ehs.umb.edu

Decommissioning Laboratories

Standard Operating Procedure

SOP Number: L-01-2015
Effective Date: August 1, 2015
Last Update: October 22, 2019

1. PURPOSE

UMass Boston is committed to the health and safety of its students, faculty, staff and visitors as well as the surrounding community and environment in which UMass Boston personnel conduct their studies, scholarship, and work. The goal of this SOP is to ensure safe and compliant transitions in laboratory occupancy. More specifically, in order to protect others when an investigator vacates laboratory space, this SOP requires that none of the investigator's research materials may be left behind in the laboratory. Further, the SOP requires that the investigator assure that proper laboratory decommissioning has been conducted, e.g., that all laboratory equipment, fixtures, furniture and space are properly cleaned and decontaminated.

Principal Investigators, Departments and Project Managers are equally responsible for complying with advanced notification and other requirements. These overlapping requirements are necessary because—depending on the situation—only one of these entities will have the ability to comply with this SOP.

This SOP will be administered by UMass Boston Office of Environmental Health and Safety (OEHS).

2. SCOPE

This SOP applies to:

- Research and teaching laboratories owned by UMass Boston or occupied by UMass Boston students, faculty or staff.

- Laboratories that use chemicals, radioactive materials, biologicals, human pathogens, controlled substances, compressed gases, large equipment, mercury containing monitors, etc.
- Laboratories or ancillary research spaces (e.g., cold rooms, freezers in hallways) that are vacated by an investigator.
- Laboratory space that is to be reused by a different investigator, as well as laboratory space that is to be converted to another use.
- Movement of safety critical equipment.

3. BACKGROUND

This SOP is necessary for the following reasons:

- EHS oversight of laboratory decommissioning and transfer ensures transportation and licensing compliance. If OEHS is not contacted in advance of a laboratory closure, there is a high risk of unsafe and/or noncompliant transport of research materials.
- The U.S. Environmental Protection Agency generally requires:
    - Within three days of vacating a laboratory, all chemicals must be removed.
    - Prior to vacating a laboratory, laboratory personnel (who are most knowledgeable) must properly label and/or identify all remaining chemicals, samples and containers.
- Prior to vacating a laboratory, the U.S. Nuclear Regulatory Commission requires removal of all radioactive materials and waste. No radioactive material or waste may be unsecured.
- Prior to vacating a laboratory, the U.S. Drug Enforcement Agency and the State of Massachusetts requires removal of all controlled substances. No controlled substance may be unsecured.
- Prior to vacating a laboratory, the State of Massachusetts requires removal of all human pathogens and infectious waste from research with human pathogens.
- Laboratory equipment, fixtures, furniture and space that has not been properly cleaned and decontaminated may pose a hazard to EHS staff, movers, construction and renovation personnel and future occupants.
- Research materials (e.g., chemicals, biologicals, radioactive materials, needles) left in a vacated laboratory pose hazards to EHS staff, hazardous waste contractors, construction and renovation personnel, and future occupants. These are extreme hazards when such materials are unlabeled, unidentified, unstable, improperly stored, contaminated or improperly contained. When unsecured in a vacant laboratory, these research materials are also at risk of theft, diversion and misuse.
- Research materials that are not promptly removed from a vacated laboratory are ineligible for redistribution or recycling making disposal the only viable option. Disposal costs are dramatically more expensive than recycling/redistribution costs due to extra characterization and necessarily conservative handling.
- To ensure safety, safety critical equipment must be certified in place. Prior to use, OEHS must recertify all safety critical equipment that has been moved.

The Principal Investigator and his or her laboratory staff are primarily responsible for complying with this Policy because they are most knowledgeable (and may have the only knowledge) of the identity, character and hazard of materials and contamination in their laboratory.

4. **PROCEDURE**

Laboratory Move Preparation Guide

Before any laboratory move or closure can occur, the following preparations must take place.

General – all laboratories:

1. Depending on the size and scope of the move, stop research activities 1-2 weeks prior to move. Contact OEHS to help estimate the time commitment.
2. Clean off all benches. Remove lab matting and clean any spilled materials. Wipe down all benches with an appropriate disinfectant.
3. Completely empty all drawers.
4. All razor blades, needles, syringes, pipette tips, etc. in drawers, on benches, shelves or the floor must be disposed of properly.
5. If research materials must be shipped to another location or institution, OEHS must be contacted and approve. Do not ship any material until contacted by OEHS.

Radiation Safety Preparations:

1. Collect all radioactive waste and contact OEHS to schedule a pick-up. Pick up requests can be emailed to umbehs@umb.edu; it may take up to 5 business days for waste removal.
2. Items which will be moved by non-lab personnel or which will be discarded must be cleared by EHS.
3. For in-house moves in which items stay inside buildings and are moved by laboratory staff, no OEHS clearance is necessary. Laboratory staff must wipe test and meter these items.
4. Radiation which is moved inside buildings may be properly packaged in 2 sealed leak-proof containers, placed on a cart and taken to the new location by trained lab staff. Care must be taken to ensure that proper shielding is in place, if necessary. OEHS personnel should be consulted if large amounts of isotope or isotope with significant dose rates are to be moved.
5. Do not deface labels on equipment to be checked by OEHS until it is cleared.
6. Assemble all labeled items (large items may be left where they are) for EHS to clear.
7. Conduct a final monthly survey of the lab. Clean any contamination found and re-survey and document results.

Chemical Safety Preparations:

1. Clean any equipment used with hazardous materials.
2. Hazardous waste and unwanted chemicals must be labeled as hazardous waste and inventoried on a laboratory clean-out sheet.
3. Contact OEHS for pick up by emailing umbehs@umb.edu.

4. Non-hazardous dry chemicals may be properly packed and moved within buildings. All other chemicals must be evaluated by OEHS or packaged and shipped by an OEHS approved hazmat transporter.
5. Chemicals which are moving within University buildings must be placed in a leak proof secondary container. Chemicals may be placed on a cart and moved by lab personnel with EHS clearance.
6. Have all gas cylinders removed by the vendor.

Biological Safety:

1. Use an appropriate disinfectant, prepared in accordance with manufacturer's instructions, to decontaminate all equipment. Post a "Biosafety Notice" on each item once decontamination procedures have been completed.
2. Properly autoclave/dispose of all infectious/biological waste.
3. Ensure biosafety cabinet (BSC) has been decontaminated. Decon should be performed at least 2 days pre-move.
4. Properly dispose of all sharps, including unused needles and syringes.
5. Biological material moved within buildings must be packaged in 2 sealed leak-proof containers and should be placed on a cart and moved to new location by lab personnel. Within University buildings, the moving company may move BL1 or BL2 materials in -80 freezers if the materials are properly packaged in 2 leak proof containers by the laboratory personnel.

Prior to moving company arrival:

- All chemicals must be removed from laboratory.
- All waste must be out of the laboratory. This includes chemical, biological and radioactive waste.
- All benches must be decontaminated.

After the moving company has finished:

- Ensure that all sharps (razors, syringes, needles, pipette tips, etc.) have been removed from areas where equipment may have been, including drawers and shelves

5. ROLES AND RESPONSIBILITES

OEHS RESPONSIBILITIES

When an investigator vacates laboratory space, OEHS is responsible for verifying that the space is free of hazardous materials and contamination. EHS will complete this verification in a timely manner, and will provide a written approval to the department (for new occupancy) or project manager (for space to undergo construction/renovation).

- OEHS staff will provide detailed instructions and guidance to investigators and their staff in advance of all laboratory moves, closures and decontamination, including requirements for labeling and identification of research materials.
- OEHS staff will evaluate and provide guidance for the movement of research materials.

- If the materials in question are to be moved on city streets and lab staff are not trained to properly package and/or ship these items, OEHS will provide a trained individual to assist in this process. Each Principal Investigator will be responsible for the cost of the shipping containers as well as all incurred shipping charges.
- OEHS will pay for the removal and ultimate disposal of all properly labeled and classified research materials. If research materials are inappropriately left after the space is vacated, OEHS will arrange for the proper disposal and decontamination. The costs of these activities, including labor charges to properly segregate and label hazardous materials, will be charged directly to the investigator.

PRINCIPAL INVESTIGATOR RESPONSIBILITIES

Each investigator is responsible for:

- **30 Day Notification of Laboratory Vacancy:** To ensure proper characterization and disposition of research materials and decontamination of laboratory equipment, fixtures, furniture, and space, investigators must notify OEHS 30 days prior to vacating laboratory space. OEHS notification is required even if only a single room is to be vacated, and even if the space is to be used by another investigator.
- The safety of materials and equipment, including the safety and compliance of materials and equipment left behind in a vacated laboratory, even if the laboratory is to be used by another Principal Investigator.
- Adherence to established UMass Boston Environmental Health and Safety procedures for safe and compliant disposal and decontamination of research materials. If these procedures are not followed, OEHS will arrange for the proper disposal and decontamination, as it deems necessary. The costs of these activities, including labor charges to properly segregate and label hazardous materials, will be charged directly to the investigator.
- Ensuring that research material cleanouts are performed by staff knowledgeable of hazards and trained in all required safety disciplines.
- Informing OEHS prior to the shipment or movement of any hazardous materials especially those requiring transportation on city streets.
- Notification of OEHS whenever they plan to move any of the following safety critical equipment, even if the move is across a room or from one room to another (see Attachment 2 for detailed clearance requirements):
    - Autoclaves
    - Automated film processors Biological safety cabinets
    - Clean Benches (Horizontal or Vertical Laminar Flow)
    - Compressed Gas manifold delivery systems
    - Electron microscopes
    - Ethylene oxide sterilizers
    - Fume hoods
    - Gamma counters (or gamma detectors)
    - Glove boxes

- High Magnetic Field Equipment
- Lasers - Class IIIb or IV
- Liquid scintillation counters (LSC)
- Refrigerators/Freezers
- X-ray equipment

DEPARTMENTAL RESPONSIBILITIES

Department Chairs and Business Managers are responsible for:

- **30 Day Notification of Laboratory Vacancy:** To ensure proper disposal of research materials and decontamination of laboratory equipment, fixtures, furniture and space, Departments must notify OEHS 30 days prior to vacating laboratory space. OEHS notification is required even if only a single room is to be vacated, and even if the space is to be used by another investigator.
- The costs of decontamination and disposal of research materials in situations where there has been a failure to meet the requirements listed in the Investigator Responsibilities section and those costs cannot be recovered from the investigator.
- Securing written approval from OEHS before reassigning vacated laboratory space.
- Securing written approval from OEHS before initiating construction or renovation in vacated laboratory space.
- Ensuring that research material cleanouts be performed by staff knowledgeable of hazards and trained in all required safety disciplines, including temporary hires on an as needed basis.

PROJECT MANAGER RESPONSIBILITIES

Project Managers who are assigned laboratory renovation projects are responsible for:

- **60 Day Notification of Laboratory Vacancy:** To ensure proper disposal of research materials and decontamination of laboratory equipment, fixtures, furniture and space, Project Managers must notify OEHS 60 days prior to vacating laboratory space.O EHS notification is required even if only a single room is to be vacated, and even if the space is to be used by another Principal Investigator.
- The costs of laboratory renovation projects that relate to decontamination and research material disposal.
- Ensuring that vacated laboratory space is not re-occupied without prior written approval from OEHS.
- Ensuring that construction or renovation not commence in vacated laboratory space without prior written approval from OEHS.

1. REFERENCES

UMass Boston Environmental Health and Safety procedures can be found on the website: www.umb.edu/ehs

Laboratory Decommissioning Standard, ANSI Z9.11 (2008), American National Standards Institute

UMass Boston Facilities Operations: https://www.umb.edu/facilities

2. **COMMITTEE REVIEWS and APPROVALS:**

- Biosafety Committee
- Radiation Safety Committee
- Laboratory Safety Committee

3. ATTACHMENTS

Laboratory Decommissioning Checklist

	Zehra Schneider Graham OEHS Director	October 22, 2019
Approved by signature	Name, Title	Date

Laboratory Decommissioning Checklist

Laboratory Decommissioning Checklist

Background Information

Faculty Member: ____________________________

Date: __________________

Research Staff: ____

____

Vacated Labs: ____

Biohazardous Materials	**YES**	**NO**	**NOT APPLICABLE**
All sharps including razor blades, needles, glass Pasteur pipettes, and pipette tips have been disposed in a red needle bucket.			
All materials have been removed from freezers, refrigerators, incubators, cabinets, or other storage areas.			
All liquid wastes have been appropriately decontaminated and disposed.			
All solid wastes have been placed in biohazard bags and autoclaved.			
Biosafety cabinet has been decontaminated with formaldehyde by an appropriate vendor (DO NOT TRY THIS YOURSELF).			
All select agents have been inactivated appropriately and disposed of.			
Faculty Signature: ____			

Chemicals	**YES**	**NO**	**NOT APPLICABLE**
All chemical solutions, chemical waste, expired chemicals, and old/obsolete chemicals have been removed from cabinets, shelving, fume hood or other storage areas. All remaining chemicals are appropriately labeled.			
All chemical bottles and transfer containers labeled appropriately.			
The OEHS Manager has been contacted to determine if any unopened containers can be redistributed to other labs.			
Chemical transport company has been contacted to lab pack all chemicals being relocated to another Institute.			
OEHS Manager has been contacted to remove all appropriately labeled hazardous waste.			
All empty containers have been triple-rinsed and disposed of appropriately or given to the OEHS Manager for redistribution.			

Faculty Signature: ____

Compressed Gases and Liquid Nitrogen	YES	NO	NOT APPLICABLE
For gas tanks, regulators have been removed, caps screwed in place. The Physical Plant Stockroom has been contacted for removal of gas tanks and Liquid nitrogen.			
Liquid nitrogen and other gases have been safely removed from equipment being disposed.			
If gas tanks cannot be returned to vendor, contact OEHS Manager for appropriate disposal.			
Faculty Signature: ____			

DEA Regulated Materials	YES	NO	NOT APPLICABLE
For Schedule 1 and/or 2 Controlled Substances, all blank Order Forms (Forms 222) have been mailed back to the DEA.			
A list of DEA materials for disposal has been given to the Chemistry Stockroom Manager along with the DEA registration number.			
Controlled Substance registrations (state and/or federal) have been terminated (attach appropriate documentation).			
Faculty Signature: ____			

Lasers	YES	NO	NOT APPLICABLE
If your lab contains a Class 3B or 4 laser, an appropriate vendor has been contacted to disconnect the equipment.			
All laboratory personnel working with Class 3B or 4 lasers have received exit eye examinations.			
Faculty Signature____			

Radioactive Materials	YES	NO	NOT APPLICABLE
The RSO has been contacted and a request to terminate or change access has been made.			
All radioactive materials have been disposed of appropriately.			
A Radiation Contamination Survey has been conducted and there is no presence of contamination (attach survey results).			
A walk-through survey has been performed with the RSO or Tech and all stickers labeled radioactive have been removed.			

All equipment including refrigerators, freezers, liquid scintillation counters, centrifuges, etc. have been cleared by the RSO.			
All sealed sources have been returned to the vendor or disposed of appropriately. The RSO has been given the documentation of its removal from the Institute (attach appropriate documentation).			
RSO Signature ____			
Faculty Signature____			

Radiation Containing Devices	**YES**	**NO**	**NOT APPLICABLE**
If the equipment will be relocating to another Institute, a copy of their Radiation License has been obtained and given to the RSO.			
If the equipment will be relocating within UMass Boston, the RSO has been contacted regarding a License Amendment request.			
If the device is being disposed, the RSO has been contacted for the appropriate steps for removal and disposal.			
RSO Signature ____			
Faculty Signature____			

Laboratory Equipment	**YES**	**NO**	**NOT APPLICABLE**
All equipment has been decontaminated using an appropriate disinfectant.			
Equipment Relocation Form has been posted and completed for each piece of equipment.			
All equipment being disposed has had all hazardous materials removed (i.e. batteries, oil, mercury, freon, etc.) by Physical Plant.			
Materials in any shared equipment (refrigerators, freezers, incubators, etc.) have been removed.			
If equipment is not wanted, the appropriate party has been contacted to try to redistribute to other labs. Proper disposal is necessary, if it cannot be redistributed.			
Faculty Signature____			

Housekeeping	**YES**	**NO**	**NOT APPLICABLE**
All materials (hazardous and non-hazardous) have been removed from all cabinets, shelving, or other storage areas.			
Arrangements have been made to have equipment relocated.			

All surfaces, including the inside and outside of the fume hood, bench tops, sinks, and cabinets, have been decontaminated and cleaned. All bench paper has been removed.
Each sink has been flushed with cold water for 5 minutes.
Any unwanted books, papers, notebooks, etc. have been recycled (contact the Custodial Manager if disposing a large quantity).
All materials and equipment from shared rooms have been removed (including, cold rooms, warm rooms, equipment rooms, etc.).
OEHS has been contacted if perchloric acid has been used in the lab and have indicated in which fume hood. Locations also provided of where other extremely hazardous materials may have been used in the laboratory.
All signage or placards have been removed from the laboratory door (i.e., emergency contact list, NFPA diamond, biohazard, radiation hazard, etc.).
Faculty Signature____

Please submit all completed forms to OEHS

Environmental Health and Safety

UMASS BOSTON

100 Morrissey Blvd.

Boston, MA 02125-3393

617.287.5445

www.ehs.umb.edu

Laboratory Equipment Decontamination

Standard Operating Procedure

SOP Number: L-01-14
Effective Date: May 1, 2014

1. PURPOSE

To ensure that lab equipment and devices are removed from service, whether for disposal, servicing or moving in a safe and compliant manner. The procedure will help minimize the risk of exposure to laboratory personnel, moving personnel and Environmental Health and Safety (EHS) staff when moving laboratory equipment.

2. SCOPE

Applies to all laboratory equipment at the UMass Boston campus including refrigerators, instruments, fume hoods, biosafety cabinets, pneumatic pumps, acid/base baths.

3. PRECAUTIONS AND HAZARDS

Lab equipment and apparatuses pose a special risk because of hazardous material used or stored in these articles and other possible physical hazards.

4. PROCEDURE

4.1 De-energized Equipment

Each piece of equipment needs to be de-energized. For most devices this will simply mean unplugging the apparatus from a wall outlet. In other cases, it could mean removing pressure from a pneumatic device or gas storage unit, or removing a charge from a stored capacitor.

4.2 Remove Hazardous Materials

All chemical or radioactive substances must be removed by lab staff and placed in the appropriate container for transport, storage or disposal. OEHS must be contacted for any disposal of hazardous material. In the case of a refrigerator or freezer, refrigerant must be removed by Facilities staff. In no circumstance will liquids or chemicals be permitted to remain in apparatuses.

4.3 Decontaminate Equipment

Apparatuses will need to be decontaminated by appropriately trained personnel. The work and environment in the lab will dictate what sort of decontamination is needed. In the event that only chemicals were used in the environment, wiping the surfaces with a cleaner will suffice if there are no heavy residues or major spills. Lab personnel should consult with OEHS in the case of heavy residue or spillage. Specialize decontamination procedures may be necessary for equipment that has been used with biological materials. Note the order of decontamination is important for equipment that has multiple hazards. First deal you should with radioactive materials followed by biological materials and then chemical hazards.

If the article was in the environs of radioactive materials, special decontamination protocols will be needed. These procedures may include a radiation contamination survey and should be adhered to strictly. The Radiation Safety Office should be consulted to determine the exact needs.

In the event that radiological and non-radiological materials are present both decontaminations will need to be followed.

If the article was in the environs of biological materials, special protocols will be needed. These procedures may include wiping surfaces with a dilute bleach mixture. For biosafety cabinets and/or clean benches an outside vendor may be required to properly decontaminate and disconnect the unit and to certify the unit once it is re- installed in its new destination. For questions about this please contact OEHS.

4.4 Complete and Attach Decon Form

Following decontamination, lab personnel will complete the attached “Equipment Release Form” indicating that the equipment is properly decontaminated and ready to be moved. The form should be affixed to the equipment in a visible location.

5. ROLES AND RESPONSIBILITES

5.1 Principal Investigator (PI)

The Principal Investigator is responsible for ensuring the equipment is de- energized and decontaminated according to the requirements of the chemical, biological, and radiological safety programs, guidelines and protocols prior to vacating the lab. The PI is required to provide OEHS with information about any potential hazards associated with the equipment or remaining in the space.

5.2 Designee of the PI

The PI may delegate tasks to lab staff and colleagues appropriate to their level of training, knowledge, and abilities. However, in all cases, it remains the PI's ultimate responsibility to assure tasks are completed satisfactorily according to the guidelines and protocols.

5.3 Environmental Health and Safety

EHS is responsible for providing safety and regulatory advice to the PI, the department and the move contractor (if applicable). OEHS may inspect equipment and verifies decontamination is completed. If equipment is being moved, EHS will be available during the move and will respond to issues that may develop.

5.4 Radiation Safety Office

The Radiation Safety Technician in collaboration with the Chair of the Radiation Safety Committee will provide radiation safety and regulatory advice to the PI, the department and the move contractor. The Radiation Safety Technician inspects equipment and verifies that decontamination is complete.

5.5 Moving Contractor (if applicable)

The move contractor is responsible for only moving equipment that has been properly decontaminated and verified with an Equipment Release Form.

6. REFERENCES

American National Standard for Laboratory Decommissioning ANSI/AIHA Z9.11-2008

7. EQUIPMENT AND MATERIALS

Decontamination equipment and supplies as well as appropriate personal protective equipment.

8. TRAINING

Basic laboratory safety training for anyone involved in decontamination.

9. DEFINITIONS

- OEHS: Office of Environmental Health and Safety
- UMass Boston: UMass Boston shall include the campus at 100 Morrissey Boulevard

10. RECORDKEEPING

OEHS shall maintain a copy of the Lab Equipment Decontamination Forms

11. ATTACHMENTS

- Equipment Release Form

	Zehra Schneider Graham OEHS Director	09/11/2019
Approved by signature	Name, Title	Date

Equipment Decontamination Release Form

Equipment Description ______________________________________

Manufacturer, _____________________________________

Model#, _____________________________________

Serial # _____________________________________

Current Location (Bldg. Room) ______________________________________

Equipment Contact Name ______________________________________

Phone number _______________________________

Email _______________________________

This equipment has been used with the following materials:

- Chemicals (list high risk chemicals or "normal)

____

- Biological Agents (list biological agents used)

____

- Radioactive Materials (list isotopes used)

____

This equipment has never been used with radioactive materials, chemicals, or biological agents

Principal Investigator's Agreement

I certify that my staff and I have adequately cleaned and decontaminated this equipment.

Principal Investigator's Signature	Date

Instructions

This form should be completed after the equipment is cleaned and decontaminated following the "Laboratory Equipment Decontamination" SOP. The signed form should then be affixed to the equipment.

Appendix E – Glove Selection

The internet resources provided will help you select the best glove and provide the most protection. For chemical mixtures or multiple hazards, pick the glove with the highest resistance to the most toxic substance or consider a double-glove protocol. If you are in doubt, do not hesitate to call the manufacturer's representative for technical assistance or OEHS.

Choosing the right protective glove for the job is critical to safe handling of animals as well as hazardous and toxic chemicals and other laboratory tasks. Match the individual glove by manufacturer and style to the required task and exposure particulars. No single glove will protect against all harmful substances. Nor will one glove suit all applications. No matter which glove is used, they all can potentially leak or become punctured or torn. No glove can offer 100% protection either, as permeation and degradation take their toll during use. Remember if you get anything on your gloves they should be changed immediately to avoid spreading contamination.

Sample Resources:

- Ansell
- Kimberly Clark
- Microflex
- Saf-T-Gard
- North Safety

Adapted from "All Hands on Deck: a primer on protective gloves" by Vince McLeod, CIH; ALN; *2010-06-24;* https://www.laboratoryequipment.com/article/2010/06/all-hands-deck-primer-protective-gloves.

Appendix F – MWRA Sewer Use Discharge Permit

Part B: Discharge Limitations

The permittee shall comply with the most stringent of the EPA National Categorical Pretreatment Standards, State or Local requirements, or the limits and prohibitions contained in 360 C.M.R. I 0.023 and I 0.024. If the National Categorical Pretreatment Standards includes a monthly, weekly or production-based limit, that limit must be met in addition to the most stringent of the maximum for one day and daily average limits.

Most Stringent Limitations

Sample Location: 0101,0102,0103,0204

The MWRA has determined that the sample location(s) are not subject to the National Categorical Pretreatment Standards as set by the EPA. MWRA limits apply as the most stringent limits.

MWRA Discharge Limitations

The Permittee shall comply with the Specific Discharge Limitations/Local Limits contained in the MWRA Sewer Use Rules and Regulations, 360 C.M.R. 10.024, and listed below, at all sample locations where these limits are designated as the most stringent limits.

Pollutant	Daily Maximum Limit (me/I)
1,1-Dichloroethylene	0.3
Acrolein	0.15
Antimony (Total)	10.0
Arsenic (Total)	0.5
Benzene	0.3
Cadmium (Total)	0.1
Chromium (+6)	0.5
Chromium (Total)	1.0
Copper (Total)	1.0
Cyanide (Total)	0.5
Each Toxic Organic (Unless Elsewhere Limited In 360 CMR 10.000)	1.0
Formaldehyde	9.0
Hexachlorobutadiene	Prohibited

Lead (Total)	0.2
Mercury {Total)	Prohibited
Nickel {Total)	1.0
PCB's	Prohibited
Pesticides	Prohibited
Phenol	5.0
Selenium {Total)	5.0
Silver (Total)	2.0
TIO	5.0
Vinyl Chloride (Chloroethylene)	0.02
Zinc (Total)	1.0

Pollutant	Instantaneous Limit (DEG C)
Temperature	82

Pollutant	Instantaneous Limit (S.U.)
pH	Must remain between 5.5 – 12.0 standard units

Pollutant	Instantaneous Limit (mg/l)
Oil and Grease	300

The permittee shall comply with the limits and prohibitions set forth in Part B according to the sample type required by the Sampling and Reporting Schedules of Part A.

Specific Prohibitions

The permittee shall comply with all the Specific Prohibitions contained in the MWRA Sewer Use Regulations, 360 C.M.R. 10.023.

No Person shall discharge, or cause or allow to be discharged, directly or indirectly, into the Authority Sewerage System, any of the following:

1) Groundwater, storm water, surface water, roof or surface runoff, tidewater, or subsurface drainage, except construction site dewatering in a combined sewer area when permitted by the Authority and municipality.
2) Non-contact Cooling Water, non-contact industrial process water, uncontaminated Contact Cooling Water and uncontaminated industrial process water, except:
   a) as permitted by the Authority when the discharger has taken all reasonable efforts to eliminate and minimize the flow, there is not reasonable access to a storm sewer, surface water, or another disposal alternative, and the amount to be discharged will not have an actual or potential adverse impact on the sewer system, the treatment plant, the quality of the receiving water, or the Authority1s ability to meet its obligations under any law, regulation, permit, or order; and
   b) cooling tower blowdown.
3) Fuel oil, crude oil, lubricating oil, or any other oil or grease of hydrocarbon or petroleum origin except:
   a) in compliance with the limit for fats, wax, oil and grease in 360 CMR 10.023(10);
   b) in compliance with the prohibitions and limits in 360 CMR 10.024;
   c) when discharged:
      i) incidental to an industrial process in Industrial Waste authorized to be discharged by a permit issued by the Authority;
      ii) incidental to the appropriate use of a gas/oil separator that is in compliance with 360 CMR 10.016 when a permit is not required by 360 CMR 10.000; or
      iii) in de minimis amounts and not from the disposal of waste, used, excess, or unwanted oil or grease when neither a permit nor a gas/oil separator are required by 360 CMR 10.000; and
   d) otherwise in compliance with 360 CMR 10.000.
4) Any liquid, solid or gas including, but not limited to, gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, and methyl ethyl ketone, which by reason of its nature or quantity is, or may be sufficient either alone or by interaction with other substances to create a fire or explosion hazard or to be otherwise injurious to a Municipal Sewerage System, the Authority Sewerage System, Treatment System, or to Receiving Waters, including:
   a) Wastewater with a closed cup flashpoint of less than 140 degrees Fahrenheit (60 degrees Centigrade) using the test methods specified in 40 CFR 261.21, and measured at the point of indirect discharge to the Authority Sewerage System, or at such other place as the Authority determines; or
   b) Any Pollutant which causes an exceedance of 10 percent of the lower explosive limit as measured by an explosimeter at the point of discharge to the sewer or at any point within the Sewer.
5) Any noxious or malodorous liquid, gas, or solid or any other pollutant which either singly or by interaction with other Waste causes or contributes to the creation of a public nuisance, makes it dangerous for personnel or equipment to enter the Sewer for purposes of maintenance, repair,

inspection, sampling, or any other similar activity, or which results in the presence of toxic gases, vapors, or fumes within the Authority Sewerage System or Municipal Sewer in a quantity that may cause acute worker health and safety problems.

6) Any Water or Wastewater with a pH lower than 5.5 or higher than 12.0 or with any corrosive or injurious property which may cause damage or be hazardous to the Sewer, the Sewerage System, the Treatment System, or any person. If a Person continuously measures the pH of its wastewater by a properly located, installed, calibrated, maintained, and operated pH measurement system, the pH of the wastewater shall be maintained as required by the Authority, except excursions below a pH of 5.5 are permitted subject to the following limitations:
   a) The total time during which the pH values are below 5.5 shall not exceed seven hours in any calendar month;
   b) No individual excursion from the range of required pH values shall exceed 60 minutes; and
   c) The excursion may not be below a pH of 5.0.

   For purposes of360 CMR 10.023(6), an excursion is an unintentional and temporary incident in which the pH value of discharged wastewater is below the range required by the Authority. The Authority may, by permit or order, reduce the permissible excursion times or eliminate the right to an excursion, as it deems appropriate, based on the treatment system, flow, sewer system needs, and discharge history of the Person.

7) Any water or Wastewater, not otherwise governed by 360 CMR 10.000, containing pollutants at levels which may adversely affect the Authority's ability to process and/or dispose of its Wastewater Residuals in an environmentally sound and economic manner in accordance with applicable state and federal requirements.
8) Any solid or viscous substance in an amount or size which obstructs or may obstruct the flow in any Sewers, or which causes or may cause an interference including but not limited to: sand, mud, metal, glass, wood, plastics, Improperly Shredded Garbage, rubber, latex, lime or other slurries, grease, animal guts or tissues, bones, hair, hides or fleshings, entrails, feathers, ashes, cinders, stone or marble dust, straw, shavings, grass clippings, rags, spent grains, spent hops, tar, asphalt residues, residues from refining or processing fuel or lubrication oil, or glass grinding or polishing Wastes.
9) Any liquid or vapor with a temperature higher than 180 degrees Fahrenheit (82 degrees Centigrade) unless the MWRA approves an alternative temperature limit; however, in no case may any Person discharge heat in such quantity that it causes the temperature at the Authority's Sewerage Treatment Facility to exceed 104 degrees Fahrenheit (40 degrees Centigrade).
10)
   a) In the Metropolitan Sewerage Service Area, waters or Wastes containing fats, wax, oil, and grease, in excess of 300 mg/I (based on the materials recovered in the applicable EPA approved procedure, unless otherwise authorized or required by the Authority and EPA), or containing any substance which may solidify or become viscous at temperatures between 32°F (0°C) and 180°F (82°C). Waters or Wastes containing such substances, excluding normal household Waste, shall exclude all visible floating oils, fats and greases. The use of chemical, biological, or physical means to bypass or to release fats, wax, oil, and grease into the sewer is prohibited. If a Person is unable to comply with the 300 mg/I requirement after treatment, the Authority may increase

the limit on a case by case basis if the Authority and appropriate Municipality are satisfied that such increase will not contribute to nuisance conditions or an adverse impact on the Sewerage System, Receiving Waters, or the Authority's Wastewater Residuals program. In no circumstance will the Authority increase the limit to allow a discharge of more than 300 mg/I of oil or grease of hydrocarbon or petroleum origin, including fuel oil, crude oil, and lubricating oil. The Authority may apply a monetary charge to any increase in the 300 mg/I limit to recover the costs it reasonably expects to incur as a result of the increase.

b) In the Clinton Sewerage Service Area, waters or Wastes containing fats, wax, oil, and grease in excess of 100 mg/I (based on the materials recovered in the applicable EPA approved procedure, unless otherwise authorized or required by the Authority and EPA), or containing any substance which may solidify or become viscous at temperatures between 32°F (0°C) and 180°F (82°C). Waters or Wastes containing such substances, excluding normal household Waste, shall exclude all visible floating oils, fats and greases. The use of chemical, biological, or physical means to bypass or to release fats, wax, oil, and grease into the sewer is prohibited. If a Person is unable to comply with the 100 mg/I requirement after treatment, the Authority may increase the limit on a case by case basis if the Authority and appropriate Municipality are satisfied that such increase will not contribute to nuisance conditions or an adverse impact on the Sewerage System, Receiving Waters, or the Authority's Wastewater Residuals program. In no circumstance will the Authority increase the limit to allow a discharge of more than 100 mg/I of oil or grease of hydrocarbon or petroleum origin, including fuel oil, crude oil, and lubricating oil. The Authority may apply a monetary charge to any increase in the 100 mg/I limit to recover the costs it reasonably expects to incur as a result of the increase.

11) Waste or Wastewater discharged through a Bypass, unless such discharge through the Bypass was approved in advance by the Authority, or the discharge through the Bypass is allowed by 40 CFR 403.17 and the Person using the Bypass provided to the Authority the notices required by 40 CFR 403.I7.
12) Any radioactive Waste or isotope with a half-life or concentration in excess of any limit established by federal or state law.
13) Any Sludge, except from a water treatment plant owned and operated by a municipality, or by a water district created by a special or general act of the Massachusetts Legislature, and when specifically permitted by the Authority pursuant to 360 CMR I 0.057.
14) Any substance, including dye water or any vegetable tanning solution, which causes turbidity or discoloration such that the color of the wastewater at the Authority Sewage Treatment Facility changes noticeably.
15) Any Slug.
16) Any Hazardous Waste or any Wastewater which results from the treatment of Hazardous Waste, and is discharged to the Authority Sewerage System by dedicated pipe, truck, rail, or by other method.
17) Septage containing Hazardous Waste, Septage from haulers other than those permitted under 360 CMR I0.000, or Septage discharged at a location not designated as a Septage discharge location in the Municipal permit issued by the Authority to the Municipality where the discharge took place.

18) Any substance containing pathogenic organisms in such quantities as determined by local, state and/or federal law as hazardous to the public health, or the environment, including but not limited to any "infectious or Physically Dangerous Medical or biological Waste" as defined and identified by the Massachusetts Department of Public Health in its regulations entitled "Storage and Disposal of Infectious or Physically Dangerous Medical or Biological Waste, State Sanitary Code Chapter VIII,'1 at 105 CMR 480.010, and whose disposal via the municipal Sewerage System or via a septic system is prohibited by I05 CMR 480.200.
19) Any filter backwash not specifically authorized to be discharged by a permit issued to the discharger by the Authority; any filter backwash that is not treated to meet the limits and prohibitions of 360 CMR 10.000; or, any filter backwash which causes or contributes to a violation of360 CMR 10.021 through 10.025.
20) Any trucked or hauled pollutants except at discharge points designated by the Authority in a permit issued by the Authority for the discharge.
21) Wastes or Wastewater from outside the Authority Sewerage District, unless the wastes or wastewater is discharged with the Authority's approval and pursuant to the Authority policy for sewer connections serving property partially located in a non-Authority community or for requests for sewer service to locations outside MWRA's sewer service area, including, where necessary, a general or special law authorizing the discharge from a location outside the MWRA sewer service area.
22) Oxygen-demanding pollutants (BOD etc.), released in a flow rate and/or pollutant concentration which, either singly or by interaction with other pollutants, will cause interference with the POTW.

Boston Water and Sewer Commission Regulations

Boston Water and Sewer Commission has established regulations which apply to dischargers into Boston's city sewers; these regulations may be more stringent than the MWRA regulations, and the permittee should contact Boston Water and Sewer Commission to ensure that it is in compliance with these requirements.

The Permittee shall comply with the following Boston Water and Sewer Commission Regulations:

2) Grease traps approved by the Boston Water and Sewer Commission are required on building sewers into which significant amounts of animal or vegetable fat, oil or grease are discharged, so that a discharge concentration does not exceed 100 milligrams per liter.
3) Any garbage containing particles larger than one-half inch (1.27 centimeters) in any dimension or particles which will not be carried freely in the wastewater system are prohibited.

Dilution Prohibition

The attempt to achieve compliance with the discharge limitations of these regulations by dilution, including increased use of process water, as a substitution for adequate treatment is prohibited.

Appendix G – Basic Standard Operating Procedures

Basic Standard Operating Procedures for the Handling of Hazardous Chemicals in the Laboratory

1. General
    a. Do not pipette by mouth
    b. Food, Drink, Cosmetics
        i. Do not eat, drink, smoke, or apply cosmetics in the laboratory
        ii. Do not store food in the laboratory refrigerator
    c. Sharps/Broken Glass
        i. Do not leave exposed needles or micropipettes on the bench or in washing facilities
        ii. Broken glass should be disposed of separately from other solid waste in labeled containers to prevent injury to cleaning personnel
    d. Chemical Spills
        i. In the event of a chemical spill or any other emergency situation, warn occupants, turn of ignition sources, leave the lab and close the door, and phone 911
    e. Housekeeping
        i. Decontaminate, clean, or sanitize workspace and personal protective equipment on a regular basis
        ii. In the event of malfunctioning protective or building related equipment, call OEHS
        iii. Keep all egress pathways and doors free of obstructions. Hallways outside of laboratories should not be used for storage
    f. Working Alone
        i. Avoid working with hazardous chemicals alone, at night, and/or in isolation
    g. Access to Laboratories
        i. Laboratories must be locked when unoccupied. Not that specific access limitations apply in the case of certain classes of laboratories
    h. Electrical
        i. Ensure that all hose connections are secure, and that electrical and other connections pose minimal risk of accident
        ii. Access to electrical equipment shut-offs (e.g. plugs, electrical panels) must be maintained free from obstructions to allow immediate access in an emergency. All receptacle outlets in laboratory spaces must be polarized and grounded
        iii. Electrical extension cords may not be used as substitutions for fixed receptacle outlets. Cords used for 110/120 volt services shall be UL listed standard heavy duty three wire equipped with a polarized three prong plug
        iv. Electrical extension cords are visible and inspected frequently for damage and/or defects. Cords should not cross aisles and should not be wrapped around fixtures such as lights or piping
    i. Emergency Deluge Showers/Drench Hoses/Eye Wash Stations

i. Keep area under deluge showers clear of **any** possible obstruction. Flush drench hoses and eye wash at least monthly until the water stream runs clear. Ensure that showers are inspected semi-annually
ii. Ensure proper and continuing drainage (e.g. in washing and rinsing sinks)

j. Fire Extinguishers
    i. Fire extinguishers must be immediately accessible and clear of any obstruction. They must be fully charged and wall mounted. All fire extinguishers located in laboratories are visually inspected monthly. Annually all fire extinguishers are maintained by a service contractor.
k. Emergency Contact
    i. Clearly label the equipment, bench, entry door, or other prominent location with the name and 24-hour contact number of the individual carrying out the unattended operation.

2. Personal Protection/Hygiene
    a. Assess the potential hazard posed by each chemical in every procedure. Select work practices, control devices and personal protective equipment which minimize the risk of exposure. In particular: When working with chemicals which pose a hazard to the eyes, or whenever you are in the vicinity of such chemicals such that an exposure could occur as a result of any foreseeable accident, you must wear chemical splash resistant goggles.
    b. Attire
        i. Wear a lab coat or apron, cover legs and feet (no sandals or open-toed shoes), and confine loose clothing and long hair
    c. Gloves
        i. Remember that gloves are short-term protection. Wear disposables, discard on contamination, wash your hands and re-glove
        ii. Remove Barrier Protection (e.g. gloves, lab coats or aprons, protective foot and head gear) before leaving the laboratory
3. Hazardous Materials Handling and Storage
    a. Open Containers
        i. Do not leave open containers of caustics, corrosives, or highly toxic substances on the bench. All waste containers **must** be closed at all times pursuant to Section V.D. of this plan
    b. Labels
        i. Clearly label any containers of any substance which will remain at worksite in your absence. The label must include the name of the substance, the major health and physical hazards of the substance, and your name
    c. Chemical Storage
        i. Segregate chemicals by hazard class. Store incompatible chemicals away from each other
    d. Containers
        i. Check the integrity of containers frequently, particularly those that contain waste material

e. Cylinder Storage
    i. All cylinders must be secured by straps, chains, or special floor stabilizers. Store in well-ventilated areas and place protective caps on when not in use. Cylinders should not be stored in areas that are considered primary egress routes (call OEHS if you have questions). Do not store empty and full cylinders together. Ensure that flammable gases and oxidizing gases are stored away from each other.
f. Disposal of Chemicals
    i. OEHS picks up materials from all laboratories on campus upon request. Until materials are picked up, they should be stored with appropriate labels and checked frequently