Laboratory Chemical Hygiene Plan

A Policy and Procedures Manual
**Emergency Phone Numbers**

<table>
<thead>
<tr>
<th>Service</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambulance / Fire / Police</td>
<td>(617) 373-3333 or use SafeZone app 911 (satellite locations, including Burlington and Nahant)</td>
</tr>
<tr>
<td>University Health and Counseling Services</td>
<td>(617) 373-2772</td>
</tr>
<tr>
<td>Office of Academic and Research Safety</td>
<td>(617) 373-2769</td>
</tr>
<tr>
<td>Chemical /Infectious /Radiological Emergencies</td>
<td>(617) 373-3333 911 at satellite locations, including Burlington and Nahant.</td>
</tr>
<tr>
<td>Poison Information Center</td>
<td>(800) 222-1222</td>
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Section 1. CHEMICAL HYGIENE PLAN

1.1 INTRODUCTION

The Occupational Safety and Health Administration's (OSHA) laboratory health standard (Occupational Exposures to Hazardous Chemicals in Laboratories (CFR 1910.1450)) requires employers of laboratory employees to implement exposure control programs and convey chemical health and safety information to laboratory employees working with hazardous materials. Specific provisions of the standard require:

1. laboratory chemical hood evaluations;
2. establishment of standard operating procedures for routine and "high hazard" laboratory operations;
3. research protocol safety reviews;
4. employee exposure assessments;
5. medical consultations/exams;
6. employee training;
7. labeling of chemical containers; and,
8. the management of chemical safety information sheets (Safety Data Sheets) and other safety reference materials.

The standard's intent is to ensure that laboratory employees are apprised of the hazards of chemicals in their work area, and that appropriate work practices and procedures are in place to protect laboratory employees from chemical health and safety hazards.

The standard operating procedures (laboratory practices, engineering controls, and use of personal protective equipment) recommended in this manual identify the safeguards that should be taken when working with hazardous materials. These safeguards will protect laboratory workers from unsafe conditions in the vast majority of situations. There are instances, however, when the physical and chemical properties, the proposed use, the quantity used for a particular purpose or the toxicity of a substance will be such that either additional, or fewer, controls might be appropriate to protect the laboratory worker. Professional judgment is essential in the interpretation of these standard operating procedures, and individual laboratories may modify these procedures to meet their specific uses and operational needs.

This document outlines how Northeastern University is complying with each of the elements in OSHA's Laboratory Standard. An official copy of the Chemical Hygiene Plan is located in the Office of Academic and Research Safety, 320 Renaissance Park.

1.2 CHEMICAL HYGIENE RESPONSIBILITIES

Responsibility for chemical health and safety rests at all levels including the:
President of the University, who has ultimate responsibility for chemical hygiene within the University and must, along with other officials, provide continuing support for chemical safety.

Provost Office: The Provost serves as the chief academic officer of the university, reporting directly to the President as the Senior Vice President for Academic Affairs. He/she is responsible for all academic programs offered by the university and for personnel engaged in carrying out that function. He/she provides leadership in curricular, instructional, and faculty development matters and governs the budgeting, administering, evaluating, and planning of the academic aspects of university life. The Provost designates the Vice Provost for Research to oversee a number of key programs for the development and administration of research and teaching initiatives. The Vice Provost of Research appoints an administrative officer to the Laboratory Safety Committee to represent research administration.

College Deans report to the Provost. Deans that oversee departments or research centers that operate laboratories shall appoint a representative for the college to the Laboratory Safety Committee.

Senior Vice President for Administration oversees key administrative operations of the University including Facility Services. The Vice President of Facilities Services oversees key facility maintenance and building service operations that impact laboratory operations. The VP of Facility Services shall appoint a representative to the Laboratory Safety Committee.

Northeastern Chief of Police oversees campus wide public safety programs including fire safety and emergency response. The Northeastern Chief of Police shall appoint a representative to the Laboratory Safety Committee.

The Northeastern University Laboratory Safety Committee (LSC) reports directly to the President of the University. The Committee is charged with formulating policy and making recommendations related to use of hazardous materials in laboratories.

The secretary shall be the NU Chemical Hygiene Officer from the Office of Academic and Research Safety.

Decisions will be made by majority vote.

Office of Academic and Research Safety (OARS) reports to the Senior Vice President and General Counsel.

A) Responsibility:

The Office of Academic and Research Safety (OARS) is charged with the responsibility for control, review, monitoring and advice with respect to exposure to chemical, radiological, and biological agents used in research and teaching. The office provides oversight and control of physical hazards in the workplace, including general and laboratory safety, and chemical waste disposal.

B) Authority:
The Office of Academic and Research Safety has the authority to stop any activity which is immediately hazardous to life or health. Its primary function however, is to act in an advisory capacity to the individual units, and to help them provide a safe and healthy workplace.

C) Resources:

The Office of Academic and Research Safety has professional staff that can be called upon for advice and help on occupational safety and environmental health problems. This staff offers the following services relating to chemical hygiene for the University:

- Evaluate and implement safety policies and review new and existing equipment and operating practices to minimize hazards to the University community and visitors from fire, electricity, hazardous materials, explosion, pressure and machinery.
- Conduct accident investigations and suggest remedial measures and procedures.
- Hazardous waste disposal services are provided for chemical, biological and radioactive materials.
- Train and assist in conducting special accident prevention programs are available as required.
- Audits reviewing chemical health and safety in the laboratory.

All members of the University should feel free to consult with the OARS involving potential toxic chemical, microbiological or radiation exposure.

OARS's services are available both in emergency situations and in an advisory capacity to answer questions from anyone at the University. However, procedures for safe use and disposal of chemicals or radioactive substances start in the laboratory; therefore students, post-doctoral fellows and technicians must be informed about their responsibilities and the procedures to be followed by the principal investigator. In the event of an emergency situation, please call Public Safety at (617) 373-3333 or use the SafeZone app. Dial 911 at satellite locations, including Burlington and Nahant.

The NU Chemical Hygiene Officer is a professional staff member of the Office of Academic and Research Safety and is designated by the Director of the Office of Academic and Research Safety. The NU Chemical Hygiene Officer oversees and manages chemical hygiene for the entire University. These duties are as follows:

- Develop and implement a University wide Chemical Hygiene Plan to ensure consistent and well documented program procedures and policy decisions.
- Work with department chairs and Department Safety Officers to maintain compliance with the Chemical Hygiene Plan. Special attention will be given to the safe procurement, use, and disposal of chemicals.
- Assist principal investigators with arranging training sessions for all laboratory workers, including supervisors, faculty, principal investigators, teaching assistans, students, visiting scholars, etc. All Training is managed through the OARS Laboratory Management Platform.
- Assist principal investigators with laboratory safety audits. Assistance with documentation (record keeping) of audits and all employee training sessions will also be provided as necessary.
In addition, the NU Chemical Hygiene Officer will be responsible for knowing the contents of the relevant regulation (Occupational Exposures to Hazardous Chemicals in Laboratories, 29 CFR 1910.145) and conduct any required updating of the Chemical Hygiene Plan as regulations require.

The NU Chemical Hygiene Officer can be reached by calling the Office of Academic and Research Safety at (617) 373-2769 or at oars@northeastern.edu.

**Northeastern University Departments and Research Centers** that are required to implement the Chemical Hygiene Plan are as follows:

- Division of Laboratory Animal Medicine (DLAM)
- Barnett Institute
- Biology
- Center for Drug Discovery
- Chemical Engineering
- Chemistry and Chemical Biology
- Civil and Environmental Engineering
- Electrical and Computer Engineering
- Office of Academic and Research Safety
- Earth and Environmental Sciences
- Facilities
- Kostas Nanomanufacturing Center
- Kostas Research Institute
- Marine Science Center (Nahant)
- Mechanical and Industrial Engineering
- New England Center for Tissue Inflammation
- Pharmaceutical Sciences
- Physical Therapy
- Physics
- Psychology
- College of Professional Studies

Each of these departments conduct laboratory work as defined in the OSHA Laboratory Standard.

A Laboratory is a facility where the laboratory use of hazardous chemicals occurs.

Any department at Northeastern University not listed above will also be required to implement the Chemical Hygiene Plan if laboratory work is conducted.

The Department Chairperson is responsible for chemical hygiene in the department/unit. A list of active researchers is present on the OARS laboratory management platform and can be accessed at any time by the department chairperson.
The Department Safety Officer has the responsibility of assisting faculty, staff and students serving as a conduit in facilitating, promoting, maintaining a safe work environment and compliance with the regulatory requirements. The DSO works closely with Principal Investigators (PI’s) and Laboratory Instructors (LI’s) of Record who have the ultimate responsibility for safety in their individual research and teaching laboratories. The Department Safety Officer has the following duties:

- Help to ensure that all work in their department or unit is conducted in accordance with the Chemical Hygiene Plan.
- Assist OARS with disseminating information and raising awareness related to Chemical Hygiene in their department units.
- Assist department or unit faculty with requirements of the Chemical Hygiene Plan as necessary.
- Coordinate with department faculty and staff to ensure all laboratory personnel receive adequate training.
- Follow up with PI’s and LI’s on violations identified by OARS.
- Conduct periodic self-assessments of teaching laboratories that are under their charge.
- Assist PI’s and LI’s in periodic self-assessments of laboratories.
- Inform students, faculty, and staff of safety and environmental program requirements per OARS and ensure that they are followed.
- Help PI’s and LI’s develop procedures for responding to emergencies and assessing hazards.
- Review procedures with OARS for responding to emergencies and assessing hazards.
- Contribute to the Laboratory Safety Committee by being an active member.
- Work with PI’s and LI’s implement recommendations of OARS.

The Principal Investigator, or Instructor-in-Charge of teaching and research laboratories manages chemical hygiene in his or her laboratory, working closely with the Department Safety Officer (DSO) and the Office of Academic and Research Safety office to ensure compliance. The Faculty Investigator or Instructor-in-Charge is responsible for:

- Informing employees (laboratory workers) working in their laboratory of the potential hazards associated with the use of chemicals in the laboratory and instructing them in safe laboratory practices, adequate controls, and procedures for dealing with accidents involving hazardous chemicals.
- Developing an understanding of the current requirements regulating hazardous substances used in his/her laboratory (see OARS website) and maintaining compliance with these requirements.
- Selecting and employing laboratory practices and engineering controls that reduce the potential for exposure to hazardous chemicals to the appropriate level.
- Working with OARS and the LSC, to recognize special hazards not covered in the Chemical Hygiene Plan and develop Standard Operating Procedure (SOP) for particularly hazardous substances or alternative procedures. The SOP shall include a description of the alternative controls that will be used. A 3 ring binder visual in the laboratory book shelves with “Standard Operating Procedures for Special Hazards” on the spine and cover is the recommended practice. Researchers can also store a digital copy of their standard operating
Northeastern University

procedures in the documents section of their lab profile on the OARS laboratory management platform.

- Ensuring that all lab personnel have access to protective equipment and clothing necessary for the safe performance of their jobs.
- Working closely and efficiently with the NU Chemical Hygiene Officer to correct work practices and conditions that may result in exposure or release of toxic chemicals.
- Supervising the performance of their staff and authorized personnel to help ensure the required chemical hygiene rules are adhered to in the laboratory.
- Contacting the NU Chemical Hygiene Officer prior to using particularly hazardous substances when special handling conditions are needed if you exceed threshold quantities of a substance that are on the Particularly Hazardous Chemical list located in Appendix A.
- Ensuring that, in case of job transfer or termination, workers shall properly dispose of or transfer all chemicals to another responsible party before leaving. The NU decommissioning procedure should be followed and completed prior to leaving the University.
- When necessary, consulting with OARS to arrange workplace air samples, swipes or other tests to determine the amount and nature of airborne and/or surface contamination, inform employees of the results, and use data to aid in the evaluation and maintenance of appropriate laboratory conditions.
- Report promptly to the NU Chemical Hygiene Officer incidents that cause (1) personnel to be seriously exposed to hazardous chemicals or materials, such as through the inoculation of a chemical through cutaneous penetration, ingestion of a chemical, or probable inhalation of a chemical, or that (2) constitute a danger of environmental contamination.
- Ensuring that co-op students, undergraduate students, high school students, and visitors are directly supervised when present in the laboratory.
- Maintaining a list of authorized personnel who are allowed to work in their laboratories by using the OARS Laboratory Management Platform.

**Laboratory worker**, who is responsible for:

- Wearing all appropriate Personal Protective Equipment when working in the laboratory.
- Being aware of the hazards of the materials she/he is around or working with, and handling those chemicals in a safe manner.
- Planning and conducting each operation in accordance with established chemical hygiene procedures.
- Developing good chemical hygiene habits (chemical safety practices and procedures).
- Reporting unsafe conditions to his/her supervisor, the Principal Investigator or the Department Safety Officer.
- In consultation with principal investigator, properly dispose or transfer all chemicals to another responsible party before job transfer or termination.

The principal investigator or instructor-in-charge share responsibility with the laboratory worker for collecting, labeling and storing chemical hazardous waste properly, as well as informing visitors entering their laboratory of the potential hazards and safety rules/precautions.
Student is responsible for:

- Attending required training sessions and following all standard operating procedures of working in a laboratory.
- Wearing personal protective equipment as directed by the principal investigator.
- At a minimum, wearing safety glasses at all times when working in the laboratory.
- Reporting to the teaching assistant, faculty member, or Department Safety Officer/laboratory supervisor any accidents that result in the exposure to toxic chemicals, and/or any action or condition that may exist which could result in an accident.

1.3 DEFINITIONS

1.3.1 Laboratory Definition

For the purposes of this OSHA standard a laboratory is defined as a facility in which hazardous chemicals (defined below) are handled or manipulated in reactions, transfers, etc. in small quantities (containers that are easily manipulated by one person) on a non-production basis. Typically, multiple chemical procedures are used.

1.3.2 Hazardous Chemical Definition

The OSHA Laboratory Health Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical or a health hazard. The standard applies to all hazardous chemicals regardless of the quantity.

A chemical is a physical hazard if there is scientifically valid evidence that it is a combustible liquid, a compressed gas, an explosive, an organic peroxide, an oxidizer or pyrophoric, flammable, or reactive.

A chemical is a health hazard if there is statistically significant evidence, based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Classes of health hazards include:

- Carcinogens
- reproductive toxins
- sensitizers
- hepatotoxins (liver)
- agents that act on the hematopoietic system (blood)
- agents that damage the lungs, skin, eyes, or mucus membranes
- Irritants
- Corrosives
- neurotoxins (nerve)
- nephrotoxins (kidney)
A chemical is considered a carcinogen or potential carcinogen, if it is listed in any of the following publications (OSHA uses the term "select" carcinogen):

- National Toxicology Program, Annual Report on Carcinogens (latest edition)
- International Agency for Research on Cancer, Monographs (latest edition)

A chemical is considered hazardous, according to the OSHA standard, if it is listed in any of the following:

- OSHA, 29 CFR 1910.1000 Table Z-1 through Z-3
- Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment, ACGIH (latest edition)
- The Registry of Toxic Effects of Chemical Substances, NIOSH (latest edition)

Over 600,000 chemicals are considered hazardous by the OSHA definition.

In most cases, the chemical container's original label will indicate if the chemical is hazardous. Look for key words like caution, hazardous, toxic, dangerous, corrosive, irritant, carcinogen, etc. Containers of hazardous chemicals acquired or manufactured before 1985 may not contain appropriate hazard warnings.

If you are not sure a chemical you are using is hazardous, review the Safety Data Sheet for the substance or contact your supervisor.

### 1.4 HAZARD IDENTIFICATION

Some laboratories may synthesize or develop new chemical substances on occasion. If the composition of the substance is known and will be used exclusively in the laboratory, the laboratory worker must label the substance with its full chemical name and determine, to the best of his/her abilities, the hazardous properties (e.g., corrosive, flammable, reactive, toxic, etc.) of the substance. This can often be done by comparing the structure of the new substance with the structure of similar materials with known hazardous properties. If the chemical produced is of unknown composition, it must be assumed to be hazardous, and appropriate precautions taken.

If a chemical substance is produced for another user outside this facility, the laboratory producing the substance is required to provide as much information as possible regarding the identity and known hazardous properties of the substance to the receiver of the material.

### 1.5 TRAINING & INFORMATION

#### 1.5.1. Chemical Safety Training
All faculty, staff, and graduate students who work in any laboratory where hazardous chemicals are stored or used must complete the required safety training awareness programs appropriate for the operations conducted in that laboratory. As a minimum, all personnel must complete the Laboratory Safety Program Orientation and Fundamentals of Laboratory Safety training offered through OARS. All personnel completing the latter training must then participate in refresher training at a minimum of annually. Other safety awareness training may include Hazardous Waste Management, Radiation Safety, and Biological Safety. The principal investigator of the laboratory is responsible to ensure that all laboratory personnel complete the required training. In addition, principal investigators must ensure that co-op students, undergraduate students, high school students, and visitors are sufficiently informed and aware of potential hazards in the lab and receive appropriate safety awareness training.

Our training program for laboratory workers consists of two parts: 1) introduction to the fundamentals of laboratory safety and to information not specific to the individual worksite to be conducted by the Office of Academic and Research Safety, and 2) site specific elements of training to be conducted by the Principal Investigator. The training and information will be provided when an employee is initially assigned to a laboratory where hazardous chemicals are present, and also prior to assignments involving new hazardous chemicals and/or new laboratory work procedures (note training schedule and online options).

The training and information program will describe the:

1. physical and health hazards of various classes of laboratory chemicals handled;
2. methods/procedures for safely handling and detecting the presence or release of hazardous chemicals present in the laboratory;
3. appropriate response in the event of a chemical emergency (spill, overexposure, etc.);
4. chemical safety policies; and
5. applicable details of the Chemical Hygiene Plan (such as the standard operating procedures for using chemicals).

When an employee is to perform a non-routine task presenting hazards for which he or she has not already been trained, the employee's supervisor will be responsible for discussing with the employee the hazards of the task and any special measures (e.g., personal protective equipment or engineering controls) that should be used to protect the employee.

Every laboratory worker should know the location and proper use of needed or necessary protective clothing and equipment, and emergency equipment/procedures. Information on protective clothing and equipment is contained in Section 2.3 of this manual.

1.5.2. **Underage Personnel**

Any person under the age of 16 will generally not be allowed to work in a laboratory where hazardous processes take place, or hazardous chemicals are stored or used. The NU Chemical Hygiene Officer must approve any exceptions to this requirement. For laboratories that utilize radioactive materials, no one under the age of 18 is allowed to work in the laboratory. Underage personnel, including high school
students or visitors, must be directly supervised by faculty, staff or graduate students at all times. No key or key access should be granted to underage personnel

1.5.3. Chemical Safety Information Sources

There are numerous sources of chemical safety information. These sources include:

1. special health and safety reference literature available in the Snell Library and the Office of Academic and Research Safety;
2. the labels found on containers of hazardous chemicals;
3. the substance's Safety Data Sheet; and
4. laboratory signs.

In addition, your supervisor is available to provide safety information. Each of these sources is now discussed in greater detail.

1.5.3.1. Safety Reference Literature

The Office of Academic and Research Safety maintains a library of reference materials addressing chemical health and safety issues. One of the references contains all applicable chemical workplace exposure standards and recommended exposure levels. Another reference contains a copy of OSHA's laboratory safety standard and its appendices. Safety Data Sheets received from suppliers are available in your laboratory or a central area designated by your department. SDS’s can be accessed from your BioRAFT homepage: https://northeastern.bioraft.com/.

1.5.3.2. Container Labeling

All containers of hazardous chemicals that could pose a physical or health hazard to an exposed employee must have a label attached. Labels on newly purchased hazardous chemicals will include:

1. the common name of the chemical;
2. the name, address and emergency phone number of the company responsible for the product; and
3. an appropriate hazard warning.

The warning may be a single word - "danger", "warning" and "caution" - or may identify the primary hazard, both physical (i.e., water reactive, flammable or explosive) and health (i.e., carcinogen, corrosive, or irritant).

Most labels will provide you with additional safety information to help you protect yourself while working with this substance. This includes protective measures to be used when handling the material, clothing that should be worn, first aid instructions, storage information and procedures to follow in the event of a fire, leak or spill.

If you find a container with no label, report it to your supervisor. You should also report labels that are torn or illegible so that the label can be replaced immediately. Existing labels on new containers of
hazardous chemicals should never be removed or defaced, except when empty. If you use secondary working containers that will take more than one work shift to empty, or if there is a chance that someone else will handle the container before you finish it, you must label it. This is part of your responsibility to help protect co-workers.

Read the label each time you use a newly purchased chemical. It is possible the manufacturer may have added new hazard information or reformulated the product since your last purchase, and thus altered the potential hazards you face while working with the product.

All employees involved in unpacking chemicals are responsible for inspecting each incoming container to ensure that it is labeled with the information outlined above. The principal investigators or Department Safety Officer/laboratory supervisors should be notified if containers do not have proper labels (see laboratory chemical labeling requirements).

1.5.3.3. Safety Data Sheets

A Safety Data Sheet, often referred to by its acronym SDS (formerly MSDSs or Material Safety Data Sheets), is an essential component of the Globally Harmonized System of classification and labeling of chemicals (GHS). An SDS is a detailed informational document prepared by the manufacturer or importer of a hazardous chemical to communicate the hazards of chemical products. The SDS also describes the physical and chemical properties of the product. Information included in a Safety Data Sheet aids in the selection of safe products, helps employers and employees understand the potential health and physical hazards of a chemical and describes how to respond effectively to exposure situations. Safety Data Sheets can be accessed through your BioRAFT homepage, even if you are not in a lab group. All laboratory personnel within a research group must be able to access the sheets electronically at all time, or they will be required to keep hard copies of SDS’s for each chemical they use or store in the laboratory.

The information contained in the SDS is largely the same as the MSDS, except now the SDSs are required to be presented in a consistent user-friendly, 16-section format. It is useful to review this information to increase your ability to use a Safety Data Sheet.

All Safety Data Sheets should have a specified 16-section format, include the following information:

Section 1, Identification includes:

- GHS product identifier.
- Any other common names or synonyms by which the substance is known.
- The supplier name, address, phone number, and emergency phone number.
- Recommended use of the chemical and any restrictions on use.

Section 2, Hazard(s) Identification includes:

- The hazard classification of the chemical (e.g., flammable liquid,).
- Signal word ("Danger" or "Warning").
- Hazard statement(s).
• Pictograms consisting of a graphical symbol, representing distinct hazards. The nine different pictograms are detailed on the Hazard Communication page on our website.
• Precautionary statement(s).
• Description of any hazards not otherwise classified.
• A statement describing how much (percentage) of the mixture consists of ingredient(s).

Section 3, Composition/Information on Ingredients includes:

• Chemical name and identity.
• Common name, synonyms, and concentration ranges of all ingredients in case of a mixture.
• Chemical Abstracts Service (CAS) number and other unique identifiers.
• Impurities and stabilizing additives, which are themselves classified and which contribute to the classification of the chemical.

Section 4, First-Aid Measures includes

• Necessary first-aid instructions by relevant routes of exposure (e.g., inhalation…).
• Description of the symptoms or effects, and any symptoms that are acute or delayed.
• Recommendations for immediate medical care and special treatment needed.

Section 5, Fire-Fighting Measures includes:

• Recommendations of suitable extinguishing equipment.
• Advice on specific hazards that develop from the chemical during the fire.
• Recommendations on special protective equipment or precautions for firefighters.

Section 6, Accidental Release Measures includes:

• Use of personal precautions and protective equipment to prevent the contamination of skin, eyes, and clothing.
• Emergency procedures, including instructions for evacuations, consulting experts when needed, and appropriate protective clothing.
• Methods and materials used for containment and spill cleanup procedures.

The statements on the Safety Data Sheet are very general; more specific information is available from your supervisor or the Department Safety Officer/Laboratory Supervisor.

Section 7, Handling and Storage includes:

• Precautions for safe handling, including handling incompatible chemicals.
• Conditions for safe storage, including any incompatibilities.
• Specific storage requirements (e.g., ventilation requirements).

Section 8, Exposure controls/personal protection includes:
• OSHA Permissible Exposure Limits (PELs), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and any other exposure limit used or recommended by the supplier.
• Appropriate engineering controls (e.g., use local exhaust ventilation…).
• Personal protective measures to prevent illness or injury from exposure to chemicals, such as personal protective equipment (PPE).

This section normally describes worst case conditions; therefore, the extent to which personal protective equipment is required is task dependent. Contact your supervisor or Department Safety Officer/Laboratory Supervisor for specific instructions if you are unsure.

**Section 9.** Physical and chemical properties lists the chemical’s characteristics.

- Appearance (physical state, color, etc.)
- Upper/lower flammability or explosive limits
- Odor
- Vapor pressure
- Vapor density
- pH
- Relative density
- Melting point/freezing point
- Solubility
- Initial boiling point and boiling range
- Flash point
- Evaporation rate
- Flammability (solid, gas)
- Auto-ignition temperature
- Viscosity

**Section 10.** Stability and reactivity includes:

- Reactivity of the chemical or mixture.
- Chemical stability of the substance or mixture.
- Possibility of hazardous reactions and description of the conditions under which hazardous reactions may occur.
- Conditions to avoid while in storage and being handled (e.g., temperature).
- Stabilizers that may be needed to maintain chemical stability.
- Classes of incompatible materials with the chemical.
- Known or anticipated hazardous decomposition products

**Section 11.** Toxicological information includes:

- Various toxicological (health) effects and the available data used to identify those effects.
• Routes of exposure (inhalation, ingestion, skin and eye contact).
• Acute and chronic effects from short- and long-term exposure.
• The numerical measures of toxicity (e.g., the LD50).
• The symptoms associated with exposure to the chemical.
• Indication of whether the chemical is listed in the National Toxicology Program (NTP) Report on Carcinogens (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs (latest editions) or found to be a potential carcinogen by OSHA.

Section 12, Ecological information

• Impact of the chemical(s) if it were released to the environment.
• Data from toxicity tests performed on aquatic and/or terrestrial organisms.
• A potential for the chemical to persist and degrade in the environment.
• Results of tests of bioaccumulation potential.

Section 13, Disposal considerations includes;

• Appropriate disposal containers to use.
• Appropriate disposal methods to employ.
• The physical and chemical properties that may affect disposal activities.
• Language discouraging sewage disposal.
• Any special precautions for landfills or incineration activities.

Section 14, Transport information

• UN number (e.g., four-figure identification number of the substance).
• UN proper shipping name.
• Transport hazard class(es).
• Packing group number, if applicable, based on the degree of hazard.
• Environmental hazards (e.g., identify if it is a marine pollutant according to the International Maritime Dangerous Goods Code (IMDG Code)).
• Guidance on transport in bulk (according to Annex II of MARPOL 73/78).

Section 15, Regulatory information of the chemical or mixtures includes:

• OSHA regulations.
• Department of Transportation regulations.
• Environmental Protection Agency regulations.
• Consumer Product Safety Commission regulations.

Section 16, Other information, includes.

• The date of preparation or last revision.
• Other useful information.

1.5.3.4. Laboratory Signs

Prominent signs of the following types should be posted in each laboratory:

• NFPA hazardous warning information and telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers;
• Signs identifying locations of safety showers, eyewash stations, other safety and first aid equipment, and exits;
• Warnings at areas or equipment where special or unusual hazards exist; and
• Laboratory posting for Prohibited Wastewater Discharges.
• Laboratory posting for Hazardous Waste Satellite Accumulation Area.
• Exposure response labels

1.6 CHEMICAL EXPOSURE ASSESSMENT

Regular environmental or employee exposure monitoring of airborne concentrations is not usually warranted or practical in laboratories because chemicals are typically used for relatively short time periods and in small quantities. However, sampling may be appropriate when a highly toxic substance is either used regularly (3 or more separate handling sessions per week), used for an extended period of time (greater than 3 to 4 hours at a time), or used in especially large quantities. Notify the NU Chemical Hygiene Officer if you are using a highly toxic substance in this manner.

The exposures to laboratory employees who suspect and report that they have been overexposed to a toxic chemical in the laboratory, or are displaying symptoms of overexposure to toxic chemicals, will also be assessed. The assessment will initially be qualitative and, based upon the professional judgment of the NU Chemical Hygiene Officer, may be followed up by specific quantitative monitoring. A memo, or report, documenting the assessment will be sent to the employees involved and their supervisors within fifteen days of receipt of the results. A copy will be stored in a central exposure records file maintained by the Office of Academic and Research Safety.

Individual concerns about excessive exposures occurring in the laboratory should be brought to the attention of your supervisor or the NU Chemical Hygiene Officer immediately.

1.7 MEDICAL CONSULTATION & EXAMINATION

Northeastern University will provide employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, whenever an employee:

• develops signs or symptoms associated with excessive exposure to a hazardous chemical used in their laboratory;
• is exposed routinely above the action level (or in the absence of an action level, the applicable OSHA workplace exposure limit) of an OSHA regulated substance;
• may have been exposed to a hazardous chemical during a chemical incident such as a spill, leak, explosion or fire.

*Individuals with life threatening emergencies must dial Public Safety at (617) 373-3333 or use the SafeZone app for emergency transport to the hospital. Dial 911 at satellite locations, including Burlington and Nahant. If the incident involves a chemical exposure, please bring a copy of the safety data sheet (SDS) with you to the hospital for the chemical involved. All accidents resulting in injuries, which require medical treatment (including first aid) should be reported immediately to your supervisor and the Office of Academic and Research Safety. Medical examination/consultation visits for students (non-life threatening and not involving hazardous materials) will be handled by the University Health and Counseling Services (UHCS). Appointments can be arranged by contacting the UHCS staff at (617) 373-2772. Medical exams and consultations shall be done by or under the direct supervision of a licensed physician at no cost to the employee.*

Where medical consultations or examinations are provided, the examining physician shall be provided with the following information:

1. the identity of the hazardous chemical(s) to which the employee may have been exposed;
2. the exposure conditions; and
3. the signs and symptoms of exposure the laboratory employee is experiencing, if any.

1.8 CHEMICAL (FUME) HOOD EVALUATION

Every laboratory ventilation hood used for the control of air contaminants shall be tested once per year to assure that adequate airflow is being maintained to provide continued protection against employee over-exposure to hazardous materials. The Office of Academic and Research Safety is responsible for performing this testing. Laboratory hood airflow shall be considered adequate when the average face velocity equals a minimum of a 100 feet/minute and a maximum of 125 feet/minute with the hood sash at operational height provided by the manufacturer. Other local exhaust ventilation, such as instrument vents, will also be tested. The criteria for minimal acceptable flow shall be determined by the Office of Academic and Research Safety. Results of laboratory ventilation tests shall be recorded and maintained by the Office of Academic and Research Safety.

1.9 RESPIRATORY PROTECTION PROGRAM

Northeastern University attempts to minimize employee respiratory exposure to potentially hazardous chemical substances through engineering methods (such as local exhaust ventilation) or administrative control. It is recognized, however, that for certain situations or operations, the use of these controls may not be feasible or practical. Under these circumstances, or while such controls are being instituted, or in emergency situations, the use of personal respiratory protective equipment may be necessary. A sound and effective program is essential to assure that the personnel using such equipment are adequately protected.

Northeastern University has adopted a written plan for using respirators. This plan outlines organizational responsibilities for the following respirator program components: exposure assessment; respirator
selection; medical approval and surveillance; fit testing; user training; inspection/repair; cleaning/disinfection; and storage. Each of these program components is required by OSHA's respiratory protection standard (29 CFR 1910.134) in all situations where respirators are used. If you are using a respirator and are not included in the respirator protection program, or have questions concerning the use of respirators or any of the program components, contact your supervisor or the NU Chemical Hygiene Officer.

1.10 RECORDKEEPING

All exposure assessments and occupational medical consultation/examination reports will be maintained in a secure area in accordance with OSHA's medical records rule (29 CFR 1910.20). Individuals may obtain copies or read their reports by making a request in writing to the Office of Academic and Research Safety (exposure assessment records) or the University Health and Counseling Services (occupational medical records).

1.11 RESEARCH PROTOCOL CHEMICAL SAFETY REVIEW AND REGISTRATION

Under some circumstances a particular chemical substance and associated laboratory operation, procedure or activity may be considered sufficiently hazardous to public health, safety or the environment to require prior approval from the Office Academic and Research Safety before research begins. This approval process will ensure that safeguards are properly set up and that personnel are adequately trained in the procedures. A list of chemicals and threshold quantities requiring review and approval is located in Appendix A. Laboratory employees anticipating use of these materials in a manner requiring review must submit a *Standard Operating Procedure for Acutely Toxic Materials, Reproductive Toxic Materials, Target Organ Toxics, and Carcinogens (Appendix E)* to the Office of Academic and Research Safety to initiate the review.

The NU Chemical Hygiene Officer may visit the laboratory, conduct a survey of facility controls and review the research protocol. The NU Chemical Hygiene Officer will consult with safety experts as needed to conduct a risk assessment and may submit a report identifying required work practices/controls for conducting the procedure in a safe manner. However, in the event that a recommendation to prohibit the research procedure is made, work will not be allowed to start. Any additional review of the protocol will need to be made to the Laboratory Safety Committee.
Section 2. STANDARD OPERATING PROCEDURES FOR WORKING WITH CHEMICALS

2.1 BEST PRACTICES/PROCEDURES FOR HANDLING LABORATORY CHEMICALS

2.1.1. General Guidelines

Carefully read the label before using a chemical. The manufacturer or supplier’s Safety Data Sheet (SDS) will provide special handling information. Be aware of the potential hazards existing in the laboratory and the appropriate safety precautions. Know the location and proper use of emergency equipment, the appropriate procedures for responding to emergencies, and the proper methods for storage, transport and disposal of chemicals within the facility.

Do not work alone in the laboratory with hazardous chemicals or hazardous equipment. If you must work alone or in the evening, let someone else know and have them periodically check on you.

Anyone considering running an experiment unattended should consider the possible hazards that could occur as a result of failures, malfunctions, operational methods, environments encountered, maintenance error and operator error (see Unattended Equipment Fact Sheet).

Label all secondary chemical containers with appropriate identification and hazard information (see Section I, Container Labeling).

Use only those chemicals for which you have the appropriate exposure controls (such as a chemical fume hood) and administrative programs/procedures (training, restricted access, etc.). Always use adequate ventilation with chemicals. Operations using large quantities (500 milliliters) of volatile substances with workplace standards at or below 50 ppm should be performed in a chemical fume hood.

Use hazardous chemicals and all laboratory equipment only as directed or for their intended purpose.

Inspect equipment or apparatus for damage before adding a hazardous chemical. Do not use damaged equipment.

Inspect personal protective apparel and equipment for integrity or proper functioning before use.

Malfunctioning or unguarded laboratory equipment should be labeled or tagged “out of service” so that others will not inadvertently use it before repairs are made.

Handle and store laboratory glassware with care. Do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals or fragments should implosion occur.

Do not purchase or dispense more of a hazardous chemical than is needed for immediate use.
2.1.2. Supervision

1. Departments that utilize and maintain teaching/research laboratories and workshops on campus; or conduct related activities at off campus sites; are responsible for implementing applicable safety programs to ensure that these work areas in full compliance with regulatory requirements.

2. To ensure that liability risk is properly managed, qualified supervisors must fulfill their inherit responsibilities to ensure that all activities with hazardous materials and/or in potentially hazardous work environments are done in compliance with environmental/occupational health regulations.

3. Qualified supervisors need to be Northeastern University employees who actively participate in the applicable safety programs by attending safety training/awareness sessions. They are assigned responsibility and authority from their department to conduct routine safety audits of work areas, provide oversight of all activities in assigned work areas, and take necessary action to abate unsafe activities or conditions. Qualified supervisors can include faculty, staff, and graduate students.

4. Visitors, high school and undergraduate students, and any other ‘non-employee’ must be properly supervised at all times when working in laboratories and workshops. Please check Northeastern Policy Page to review current Policy on Restricted Access and Lab Supervision.

5. Everyone who is allowed access to a laboratory or workshop must be provided with the applicable safety awareness information by the area/project supervisor or must attend a training session provided by the department or the Office of Academic and Research Safety.

6. Departments must ensure that proper supervision is provided during Northeastern University affiliated activities conducted off campus. Do not work alone in the laboratory with hazardous chemicals or hazardous equipment. If you must work alone or in the evening let someone else know and have them periodically check on you.

2.1.3. Personal Hygiene

After working with potentially hazardous materials, remove contaminated personal protective equipment, such as lab coats and disposable gloves. Then, wash your hands. If a sink is not readily available, a waterless hand cleaner may be suitable until a hand washing sink can be used. Please note: wearing potentially contaminated gloves or other personal protective equipment outside the designated laboratory space can result in exposures to items and surfaces in public and common areas. Never touch any door handles, light switches, or telephones with any gloves or other personal protective equipment. Even if your gloves are not contaminated, recognize that other people do not know this. They will assume that your gloves are contaminated.

If you need to transport research samples, stock chemicals, or other hazardous materials between laboratories, utilize some type of secondary containment or laboratory cart so you will not need to wear gloves or other personal protective equipment. If a protocol requires wearing of gloves outside of the laboratory, it must receive approval of the relative safety committee.
If you need to transport research samples, stock chemicals, or other hazardous materials to a room WITHIN your laboratory (i.e. shared lab, imbedded autoclave facility), you can use the “one glove policy”. The “one glove policy” will allow personnel to remove one of their gloves to open doors with their clean hand and transport the hazardous materials using the gloved hand. Please note: Doorknobs, light switches or telephones should never come in contact with contaminated gloves or lab coats.

Always avoid direct contact with any chemical. Keep chemicals off your hands, face and clothing, including shoes. Never smell, inhale or taste a hazardous chemical. Wash hands thoroughly with soap and water after handling any chemical. To minimize the risk of exposure, smoking, drinking, eating, and/or the application of cosmetics is forbidden in laboratories or shops where hazardous chemicals are used. A designated area for eating may be set aside in areas that are physically separated from the laboratory or shop. Never pipette by mouth. Use a pipette bulb or other mechanical pipette filling device.

2.1.4. **Housekeeping**

- Keep floors clean and dry.
- Keep all aisles, hallways, and stairs clear of all chemicals. Stairways and hallways should not be used as storage areas.
- Keep all work areas, and especially work benches, clear of clutter and obstructions.
- All working surfaces should be cleaned regularly.
- Access to emergency equipment, utility controls, showers, eyewashes and exits should never be blocked.
- Wastes and broken glassware should be kept in the appropriate containers and labeled properly.
- Any unlabeled containers must be labeled if it is not under your supervision or at the end of each working day.

2.2 **WHEN TO REVIEW SAFETY PROCEDURES BEFORE BEGINNING WORK**

Sometimes laboratory workers should review safety procedures beginning their work even if it seems like a familiar task. Hazards may exist that are not fully recognized. Certain indicators (procedural changes) should cause the employee to stop and review the safety aspects of their procedure. These indicators include:

- A new procedure, process or test, even if it is very similar to older practices.
- A change or substitution of any of the ingredient chemicals in a procedure.
- A substantial change in the amount of chemicals used (scale up of experimental procedures); one should review safety practices if the volume of chemicals used increases by 200%.
- A failure of any of the equipment used in the process, especially safeguards such as chemical hoods.
- Unexpected experimental results (such as a pressure increase, increased reaction rates, unanticipated byproducts). When an experimental result is different from the predicted, a review of how the new result impacts safety practices should be made.
- Chemical odors, illness in the laboratory staff that may be related to chemical exposure or other indicators of a failure in engineered safeguards.
The occurrence of any of these conditions should cause the laboratory employee to pause, and evaluate the safety implications of these changes or results. Then make changes as necessary and proceed cautiously. OARS can help consult with any procedures for requirements and best practices.

2.3 PROTECTIVE CLOTHING AND LABORATORY SAFETY EQUIPMENT

2.3.1. General Consideration - Personal Protective Clothing/Equipment

Personal protective clothing and equipment should be selected carefully and used in situations where engineering and administrative controls cannot be used or while such controls are being established. These devices are viewed as less protective than other controls because they rely heavily on each employee's work practices and training to be effective. The engineering and administrative controls, which should always be considered first when reducing or eliminating exposures to hazardous chemicals, include:

- **Substitution** of a less hazardous substance
- **Scaling down size of experiment**
- **Substitution** of less hazardous equipment or process (e.g., safety cans for glass bottles)
- **Isolation** of the operator or the process
- **Local and general ventilation** (e.g., use of fume hoods)

The Safety Data Sheet (SDS) will list the personal protective equipment (PPE) recommended for use with the chemical. The SDS addresses worst case conditions. Therefore, all the equipment shown may not be necessary for a specific laboratory scale task.

Your supervisor or the NU Chemical Hygiene Officer can assist you in determining which personal protective devices are required for each task. Remember, there is no harm in being overprotected. Appropriate personal protective equipment will be provided to employees.

2.3.2. Protection of Skin and Body

Skin and body protection involve wearing protective clothing over all parts of the body, which could become contaminated with hazardous chemicals. PPE should be selected on a task basis, and checked to ensure it is in good condition prior to use (e.g., no pinholes in gloves).

2.3.2.1. Normal clothing worn in the laboratory

Even when there is no immediate danger to the skin from contact with a hazardous chemical, it is still prudent to select clothing to minimize exposed skin. Laboratory personnel should wear long sleeved shirts and full-length pants, and avoid short sleeved shirts, short trousers, or skirts. A laboratory coat should be worn over street clothes and should be laundered regularly. The laboratory coat is intended to prevent contact with dirt, chemical dust, and minor chemical splashes or spills. If it becomes contaminated, it should be removed immediately, and the affected skin surface should be washed thoroughly. The university has a laboratory coat program in which, researchers can receive clean lab coats and drop off used/dirty coats to be laundered at central locations in each research building. Closed toed shoes must be
worn in the laboratory at all times. Sandals and perforated shoes are not appropriate. In addition, long hair and loose clothing should be confined. Use of appropriate clothing and personal protective equipment will be strictly enforced when personnel are in laboratories that are actively handling hazardous chemicals.

2.3.2.2. Protective clothing and equipment

Additional protective clothing may be required for some types of procedures, or with specific substances, such as when carcinogens, cryogens or large quantities of corrosives, oxidizing agents or organic solvents are handled. PPE may include impermeable aprons, face shield and gloves, or plastic-coated coveralls, shoe covers, and arm sleeves. Protective sleeves should always be considered when wearing an apron. These garments can either be washable or disposable in nature, but they should never be worn outside the laboratory. The choice of garment depends on the degree of protection required, and the areas of the body that may become contaminated. Rubberized aprons, plastic coated coveralls, shoe covers, and arm sleeves offer much greater resistance to permeation by chemicals than laboratory coats and, therefore, provide additional time to react (remove the garment and wash affected area) if contaminated.

For work where contamination is possible, special attention must be given to sealing all openings in the clothing. Tape can be utilized for this purpose. In these instances, caps should be worn to protect hair and scalp from contamination.

Chemical resistant gloves should be worn whenever the potential for contact with corrosive, cryogenic, toxic substances, or substances of unknown toxicity. Gloves should be selected on the basis of the materials being handled, the particular hazard involved, and their suitability for the operation being conducted. Gloves should be checked for integrity before each use. Gloves should be washed prior to removal whenever possible to prevent skin contamination. Non-disposable gloves should be replaced periodically, depending on frequency of use, and their resistance to the substances handled.

Protective garments are not equally effective for every hazardous chemical. Some chemicals will "breakthrough" the garment in a very short time. Therefore, garment and glove selection is based on the specific chemical utilized. General selection criteria is as follows:

*S - Superior E - Excellent G - Good F - Fair NR - Not Recommended*

<table>
<thead>
<tr>
<th>CHEMICAL FAMILY</th>
<th>BUTYL RUBBER</th>
<th>NEOPRENE</th>
<th>PVC (VINYL)</th>
<th>NITRILE</th>
<th>NATURAL LATEX</th>
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</thead>
<tbody>
<tr>
<td>Acetates</td>
<td>G</td>
<td>NR</td>
<td>NR</td>
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<table>
<thead>
<tr>
<th>Substance</th>
<th>G</th>
<th>E</th>
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<tr>
<td>Acids, inorganic</td>
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<tr>
<td>Acids, organic</td>
<td>E</td>
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<tr>
<td>Acetonitrile, Acrylonitrile</td>
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<td>E</td>
<td>G</td>
<td>S</td>
<td>E</td>
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<td>NR</td>
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<td>F</td>
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<td>E</td>
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<td>Ethers</td>
<td>G</td>
<td>F</td>
<td>NR</td>
<td>E</td>
<td>NR</td>
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<td>Halogens (liquids)</td>
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<td>F</td>
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<td>NR</td>
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<td>Inks</td>
<td>G</td>
<td>E</td>
<td>E</td>
<td>S</td>
<td>F</td>
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<tr>
<td>Ketones</td>
<td>E</td>
<td>G</td>
<td>NR</td>
<td>NR</td>
<td>G</td>
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<td>Nitro compounds (Nitrobenzene, Nitromethane)</td>
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<td>NR</td>
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<td>Compound</td>
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<tr>
<td>Oleic Acid</td>
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<td>F</td>
<td>E</td>
<td>NR</td>
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<td>NR</td>
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<td>G</td>
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<td>F</td>
<td>G</td>
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<td>NR</td>
<td>F</td>
<td>F</td>
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</tr>
</tbody>
</table>

*Not recommended for Acetaldehyde, use Butyl Rubber*

<table>
<thead>
<tr>
<th>Glove Material</th>
<th>Intended Use</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latex exam style</td>
<td>Incidental Contact</td>
<td>-Good for biological and water-based materials</td>
<td>-Poor for organic solvents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-User acceptability</td>
<td>-Hard to detect puncture holes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Latex allergy issues</td>
</tr>
<tr>
<td>Nitrile exam style</td>
<td>Incidental Contact</td>
<td>-Good for solvents, oils, greases, some acids and bases</td>
<td>-May be slightly more expensive than latex</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Clear indication of tears</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-User acceptability</td>
<td></td>
</tr>
<tr>
<td>Utility style</td>
<td>Extended Contact</td>
<td>-Good for solvents, oils, greases, some acids and bases</td>
<td>-Not effective for halogenated and aromatic hydrocarbons</td>
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<tr>
<td>Nitrile-Solvex</td>
<td>Extended Contact</td>
<td>-Can be washed and reused</td>
<td></td>
</tr>
<tr>
<td>Neoprene-utility</td>
<td>Extended Contact</td>
<td>-Good for acids, bases, alcohols, fuels, peroxides, hydrocarbons,</td>
<td>-Poor for halogenated and aromatic hydrocarbons</td>
</tr>
<tr>
<td>style</td>
<td></td>
<td>and phenols</td>
<td></td>
</tr>
<tr>
<td>Butyl rubber</td>
<td>Extended Contact</td>
<td>-Good for ketones and esters</td>
<td>-High cost</td>
</tr>
<tr>
<td>utility gloves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver Shield-</td>
<td>Extended Contact</td>
<td>-Good for most chemicals</td>
<td>-Lack of dexterity</td>
</tr>
<tr>
<td>Teflon</td>
<td></td>
<td></td>
<td>-Very expensive</td>
</tr>
</tbody>
</table>
Contact the NU Chemical Hygiene Officer for personal protection equipment selection assistance or information.

2.3.2.3. One-Glove Policy

If you need to transport research samples, stock chemicals, or other hazardous materials to a room WITHIN your laboratory (i.e. shared lab, imbedded autoclave facility), you can use the “one glove policy”. The “one glove policy” will allow personnel to remove one of their gloves to open doors with their clean hand and transport the hazardous materials using the gloved hand. Please note: Doorknobs, light switches or telephones should never come in contact with contaminated gloves or lab coats.

2.3.3. Protection of the Eyes

Eye protection is required for all personnel and any visitors present in locations where chemicals are handled and a chemical splash hazard exists.

Safety glasses, goggles, and goggles with face shield should be worn in the laboratory based upon the physical state, the operation, and the level of toxicity of the chemical used. Safety glasses effectively protect the eye from solid materials (dusts and flying objects), but are less effective at protecting the eyes from chemical splash to the face. Goggles should be worn in situations where bulk quantities of chemicals are handled and chemical splashes to the face are possible. Goggles form a liquid-proof seal around the eyes, protecting them from a splash. When handling highly reactive substances or large quantities of hazardous chemicals, corrosives, poisons, or hot chemicals, goggles with face shield should be worn.

Contact lenses can increase the risk of eye injury if worn in the laboratory - particularly if they are of the gas permeable variety. Gases and vapors can be concentrated under such lenses and cause permanent eye damage. Chemical splashes to the eye can get behind all types of lenses. Once behind a lens the chemical is difficult to remove with a typical eye wash. For these reasons it is recommended that contact lenses not be worn in laboratories.

Eye and face injuries are prevented by the use of the following:

<table>
<thead>
<tr>
<th>COMPARISON CHART -- EYE PROTECTION DEVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Northeastern University 29
<table>
<thead>
<tr>
<th>Goggles</th>
<th>Excellent</th>
<th>Excellent</th>
<th>Poor</th>
<th>Fair</th>
<th>Poor</th>
<th>Fair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glasses (no shields)</td>
<td>Good</td>
<td>Poor</td>
<td>Excellent</td>
<td>Poor</td>
<td>Poor</td>
<td>Good to very good</td>
</tr>
<tr>
<td>Glasses (shields)</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Face shield (various sizes)</td>
<td>Excellent</td>
<td>Good to excellent</td>
<td>Excellent (if adequate thickness)</td>
<td>Good to excellent</td>
<td>Depends on type and length</td>
<td>Fair</td>
</tr>
</tbody>
</table>


### 2.3.4. Protection of the Respiratory System

Inhalation hazards can be controlled using ventilation or respiratory protection. Check the label and SDS for information on a substance's inhalation hazard and special ventilation requirements. When a potential inhalation hazard exists, a substance's label or SDS contains warnings such as:

- Use with adequate ventilation
- Avoid inhalation of vapors
- Use in a fume hood
- Provide local ventilation

Take appropriate precautions before using these substances. Controlling inhalation exposures via engineering controls (ventilation) is always the preferred method (See Section 2.3.5.1). As with other personal protective equipment, respiratory protection relies heavily on employee work practices and training to be effective.

**Use of Respirators**
Respirators are designed to protect against specific types of substances in limited concentration ranges. Respirators must be selected based on the specific type of hazard (toxic chemical, oxygen deficiency, etc.), the contaminant's anticipated airborne concentration, and required protection factors.

Types of respiratory protective equipment include:

- Particle-removing air purifying respirators
- Gas and vapor-removing air purifying respirators
- Atmosphere supplying respirators

Respirators are not to be used except in conjunction with a complete respiratory protection program as required by OSHA. If your work requires the use of a respirator, contact your supervisor or the NU Chemical Hygiene Officer. See Section 1.9 for additional information.

2.3.5. Laboratory Safety Equipment

2.3.5.1. Chemical (Fume) Hoods

In the laboratory, the chemical hood is the primary means of controlling inhalation exposures. Hoods are designed to retain vapors and gases released within them, protecting the laboratory employee's breathing zone from the contaminant. This protection is accomplished by having a curtain of air (approximately 100 linear feet per minute) move constantly through the face (open sash) of the hood. Chemical hoods can also be used to isolate apparatus or chemicals that may present physical hazards to employees. The closed sash on a hood serves as an effective barrier to fires, flying objects, chemical splashes, spattering, small implosions, and explosions. Hoods can also effectively contain spills, which might occur during dispensing procedures particularly if trays are placed in the bottom of the hoods.

When using a chemical fume hood, keep the following principles of safe operation in mind:

- Keep all chemicals and apparatus at least six inches inside the hood.
- Hoods are not intended for storage of chemicals. Materials stored in them should be kept to a minimum. Stored chemicals should not block vents or alter air flow patterns.
- Keep the hood sash at a minimum height (4 to 6 inches) when not manipulating chemicals or adjusting apparatus within the hood.
- When working in front of a fume hood, make sure the sash opening is appropriate. This can be achieved by lining up to arrows placed on the sash door and hood frame. This sash opening will ensure an adequate air velocity through the face of the hood.
- Do not allow objects, such as paper, to enter the exhaust ducts. This can clog ducts and adversely affect their operation.

Follow the chemical manufacturer's or supplier's specific instructions for controlling inhalation exposures with ventilation (chemical fume hood) when using their products. These instructions are located on the products SDS and/or label. However, it should be noted that these ventilation recommendations are often intended for non-laboratory work environments and must be adapted to suit the laboratory environment, as well as the specific procedure or process.
If specific guidance is not available from the chemical manufacturer or supplier, or if the guidance is inappropriate for the laboratory environment, contact the NU Chemical Hygiene Officer and/or review the hood use guidelines in the table below. These guidelines are based on information readily available on a chemical's SDS:

1. Applicable workplace exposure standards [Threshold Limit Values (TLV) or Permissible Exposure Limits (PEL)];
2. Acute and chronic toxicity data (LD\textsubscript{50} and specific organ toxicity); and
3. Potential for generating airborne concentrations (vapor pressure).

These terms are defined in the glossary at the back of this manual. The guidelines outlined in the table below should not be considered as necessary or appropriate in every case, but as reasonable "rules of thumb".

### Guidelines for Chemical (Fume) Hood Use

It may be appropriate to use a hood when handling the type of substance listed in Column 1 if the exposure standard or toxicological criteria in Column 2 applies.

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type Substance &amp; Handling Procedure</td>
<td>Exposure Standard or Toxicity of Substance</td>
</tr>
<tr>
<td>Substance handled is solid, liquid or gaseous and when other effective controls are not being used.</td>
<td>TLV or PEL &lt; 5 ppm (vapor) or &lt; 0.2 mg/M\textsuperscript{3} (particulate) or oral LD\textsubscript{50} &lt; 10 mg/Kg (rat or mouse) (see note 1 below) or chemicals handled are respiratory sensitizers.</td>
</tr>
<tr>
<td>Substance handled is liquid or gaseous and it is handled in large quantities (greater than 500 milliliters) or the procedure used could release the substance to the laboratory atmosphere (heating) or you may be exposed to the substance (handling it in open containers) for an extended period of time (greater than 2 hrs. per day).</td>
<td>TLV or PEL &gt;5 but &lt; 50 ppm or substances handled are toxic to specific organ systems, carcinogens or reproductive toxins with a vapor pressure exceeding 25 mm Hg at 25°C. or oral LD$_{50}$ &gt;10 but &lt; 500 mg/Kg (rat or mouse) (\text{see note 1 below})</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Substance handled is a solid and the particle size of the material is small (respirable) or consistency of the material is &quot;light and fluffy&quot; and the procedure used may generate airborne particulates.</td>
<td>TLV or PEL &gt;0.2 but &lt; 2 mg/M$^3$ or oral LD$_{50}$ &gt;10 but &lt; 50 mg/Kg (rat or mouse) (\text{see note 1 below})</td>
</tr>
</tbody>
</table>

Note 1: The oral LD$_{50}$ hood use criteria has been included because it is often the only toxicological data available on a Safety Data Sheet. The species of animals most often used in these acute toxicity tests are the rat and/or the mouse. The LD$_{50}$ criterion outlined in the table is a reasonable "rule of thumb" for materials that require control due to their acute toxicity characteristics. LD$_{50}$ data should only be used if other criteria are unavailable.

### 2.3.5.2. Eyewashes and Safety Showers

Whenever chemicals have the possibility of damaging the skin or eyes, an emergency supply of water must be available. All laboratories in which bulk quantities of hazardous chemicals are handled and could contact the eyes or skin resulting in injury should have access to eyewash stations and safety showers. As with any safety equipment, these can only be useful if they are accessible, therefore:

- Keep all passageways to the eyewash and shower clear of any obstacle (even a temporarily parked chemical cart).
- The eyewash should be checked weekly by the laboratory personnel to be certain that water flows through it.
- Showers should be checked weekly by the laboratory personnel to assure that access is not restricted and that the pull chain/bar is within reach.
- The flow through the safety showers should be tested periodically to ensure sufficient flow (approximately 30 gallons per minute).
The Office of Academic and Research Safety will check eyewashes and showers twice yearly to supplement the above work, which is to be conducted by personnel associated with the lab group.

2.3.5.3. Fire Safety Equipment

Fire safety equipment easily accessible in the laboratory must include a fire extinguisher (type ABC) and may include fire hoses, fire blankets, and automatic extinguishing systems.

2.4 CHEMICAL INVENTORY REQUIREMENTS; CHEMICAL PROCUREMENT, DISTRIBUTION, STORAGE

2.4.1a All Northeastern University Labs, shops and studios are required to routinely maintain accurate Chemical Inventories utilizing the university’s chemical inventory management system, ChemTracker, located within the BioRAFT Platform. SEE APPENDIX G for detail regarding these requirements. Contact your college safety officer, department safety officer or OARS for assistance.

2.4.1b. Procurement

Before a new substance that is known or suspected to be hazardous is received, information on proper handling, storage, and disposal should be known to those who will handle it. It is the responsibility of the supervisor to ensure that the laboratory facilities in which the substance will be handled are adequate and that those who will handle the substance have received the proper training.

Consider purchasing safer alternatives to hazardous chemicals. The necessary information on proper handling of hazardous substances can be obtained from the Safety Data Sheets (SDS) that are provided by the manufacturer. SDS can also be obtained electronically from your BioRAFT homepage. Because storage in laboratories is restricted to small containers, ordering small-container lots could avoid hazards associated with repackaging. No container should be accepted without an adequate identifying label as outlined in Section 1.5.3.2 of this manual.

2.4.2. Distribution

When hand-carrying open containers of hazardous chemicals or unopened containers with corrosive or highly acutely or chronically toxic chemicals, place the container in a leak-proof secondary container or a bucket. Rubberized buckets are commercially available and provide both secondary containment as well as "bump" protection. If several bottles must be moved at once, the bottles should be transported on a small cart with a substantial rim to prevent slippage or spills from the cart. Wherever available, a freight elevator should be used to transport chemicals from one floor to another.

2.4.3. Chemical Storage in the Laboratory

Carefully read the label before storing a hazardous chemical. The SDS will provide any special storage information as well as information on incompatibilities. Do not store unsegregated chemicals in alphabetical order. Do not store incompatible chemicals in close proximity to each other.
Separate hazardous chemicals in storage as follows:

Solids:
- Oxidizers
- flammable solids (I.E. red phosphorus, magnesium, lithium)
- water reactives
- others

Liquids:
- acids
- oxidizers
- flammable/combustible
- caustics
- perchloric acid

Gases:
- toxic
- oxidizers and inert
- flammable

Once separated into the above hazard classes, chemicals may be stored alphabetically.

Use approved storage containers and safety cans for flammable liquids. It is preferable to store flammable chemicals in flammable storage cabinets. Flammable chemicals requiring refrigeration must be stored only in the refrigerators and freezers specifically designed for flammable storage. Food and perishable items cannot be stored with hazardous materials.

A good place to store hazardous chemicals is a vented cabinet under the hood. Chemicals of different chemical classes can be segregated by placing them in trays. Do not store chemicals on bench tops or in hoods. Liquids (particularly corrosives or solvents) should not be stored above eye level.

Use secondary containers (one inside the other) for especially hazardous chemicals (carcinogens, etc.). Use spill trays under containers of strong reagents.

Avoid exposure of chemicals while in storage to heat sources (especially open flames) and direct sunlight.

Conduct annual inventories of chemicals stored in the laboratory and dispose of old or unwanted chemicals promptly in accordance with the facility's hazardous chemical waste program.

Ensure that all containers are properly labeled to OSHA Hazcom Global Harmonized Standards:
- Signal Word - The signal word indicates hazard level
- GHS Symbols (Hazard Pictograms)
- Manufacturer Information
- Precautionary Statements/First Aid
- Hazard Statements
2.4.3.1. Chemical Storage - Chemical Stability

Stability refers to the susceptibility of a chemical to dangerous decomposition. The label and SDS will indicate if a chemical is unstable.

Special note: peroxide formers- Ethers, liquid paraffins and olefins form peroxides on exposure to air and light. Peroxides are extremely sensitive to shock, sparks, or other forms of accidental ignition (even more sensitive than primary explosives such as TNT). Since these chemicals are packaged in an air atmosphere, peroxides can form even though the containers have not been opened. Unless an inhibitor was added by the manufacturer, sealed containers of ethers should be discarded after one (1) year. Opened containers of ethers should also be discarded within one (1) year of opening. All such containers should be dated upon receipt and upon opening (see Peroxide fact sheet).

See Section 3.2, Highly Reactive Chemicals and High energy Oxidizers for additional information and examples of materials that may form explosive peroxides.

For additional information on chemical stability, contact your supervisor or the NU Chemical Hygiene Officer.

2.4.3.2. Chemical Storage - Incompatible Chemicals

As a precautionary measure, certain hazardous chemicals should not be mixed or stored with other chemicals due to potential threats of severe reactions that can take place. If hazardous reactive chemicals are not stored appropriately, an extremely toxic reaction product can result. The label and SDS will contain information on incompatibilities. The following table contains examples of incompatible chemicals:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Keep Out of Contact With</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>Chromic acid, nitric acid hydroxyl compounds, ethylene, glycol, perchloric acid, peroxides, permanganates</td>
</tr>
<tr>
<td>Acetone</td>
<td>Concentrated nitric and sulfuric acid mixtures</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Chlorine, bromine, copper, fluorine, silver, mercury</td>
</tr>
<tr>
<td>Material</td>
<td>Safe Fights</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Alkali Metals</td>
<td>Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, the halogens</td>
</tr>
<tr>
<td>Ammonia, anhydrous</td>
<td>Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid</td>
</tr>
<tr>
<td>Ammonium Nitrate</td>
<td>Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials</td>
</tr>
<tr>
<td>Aniline</td>
<td>Nitric acid, hydrogen peroxide</td>
</tr>
<tr>
<td>Arsenical materials</td>
<td>Any reducing agent</td>
</tr>
<tr>
<td>Azides</td>
<td>Acids</td>
</tr>
<tr>
<td>Bromine</td>
<td>Same as chlorine</td>
</tr>
<tr>
<td>Calcium Oxide</td>
<td>Water</td>
</tr>
<tr>
<td>Carbon (activated)</td>
<td>Calcium hypochlorite, all oxidizing agents.</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>Sodium</td>
</tr>
<tr>
<td>Chlorates</td>
<td>Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials</td>
</tr>
<tr>
<td>Chemical</td>
<td>Reaction or Property</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Chromic Acid</td>
<td>Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol, flammable liquids in general</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals</td>
</tr>
<tr>
<td>Chlorine Dioxide</td>
<td>Ammonia, methane, phosphine, hydrogen sulfide</td>
</tr>
<tr>
<td>Copper</td>
<td>Acetylene, hydrogen peroxide</td>
</tr>
<tr>
<td>Cumene Hydroperoxide</td>
<td>Acids, organic or inorganic</td>
</tr>
<tr>
<td>Cyanides</td>
<td>Acids</td>
</tr>
<tr>
<td>Flammable Liquids</td>
<td>Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Fluorine, chlorine, bromine, chromic acid, sodium peroxide</td>
</tr>
<tr>
<td>Hydrocyanic Acid</td>
<td>Nitric acid, alkali</td>
</tr>
<tr>
<td>Hydrofluoric Acid</td>
<td>Ammonia, aqueous or anhydrous</td>
</tr>
<tr>
<td>Substance</td>
<td>Reactive Materials</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hydrogen Peroxide</td>
<td>Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic</td>
</tr>
<tr>
<td></td>
<td>materials, aniline, nitromethane, flammable liquids, oxidizing gases</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>Fuming nitric acid, oxidizing gases, acetylene, ammonia (aqueous or anhydrous),</td>
</tr>
<tr>
<td></td>
<td>hydrogen</td>
</tr>
<tr>
<td>Hypochlorites</td>
<td>Acids, activated carbon</td>
</tr>
<tr>
<td>Iodine</td>
<td>Acetylene, ammonia (aqueous or anhydrous), hydrogen</td>
</tr>
<tr>
<td>Mercury</td>
<td>Acetylene, fulminic acid, ammonia</td>
</tr>
<tr>
<td>Nitrates</td>
<td>Sulfuric acid</td>
</tr>
<tr>
<td>Nitric Acid (concentrated)</td>
<td>Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable</td>
</tr>
<tr>
<td></td>
<td>liquids, flammable gases</td>
</tr>
<tr>
<td>Nitrites</td>
<td>Acids</td>
</tr>
<tr>
<td>Nitroparaffins</td>
<td>Inorganic bases, amines</td>
</tr>
<tr>
<td>Oxalic Acid</td>
<td>Silver, mercury</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Oils, grease, hydrogen; flammable liquids, solids, or gases</td>
</tr>
<tr>
<td>Perchloric Acid</td>
<td>Acetic anhydride, bismuth and its alloys, alcohol, paper, wood</td>
</tr>
<tr>
<td>Compound</td>
<td>Reactants</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Peroxides, organic</td>
<td>Acids (organic or mineral), avoid friction, store cold</td>
</tr>
<tr>
<td>Phosphorus (white)</td>
<td>Air, oxygen, alkalies, reducing agents</td>
</tr>
<tr>
<td>Potassium</td>
<td>Carbon tetrachloride, carbon dioxide, water</td>
</tr>
<tr>
<td>Potassium Chlorate</td>
<td>Sulfuric and other acids</td>
</tr>
<tr>
<td>Potassium Permanganate</td>
<td>Glycerin, ethylene glycol, benzaldehyde, sulfuric acid</td>
</tr>
<tr>
<td>Selenides</td>
<td>Reducing agents</td>
</tr>
<tr>
<td>Silver</td>
<td>Acetylene, oxalic acid, tartaric acid, ammonium compounds</td>
</tr>
<tr>
<td>Sodium</td>
<td>Carbon tetrachloride, carbon dioxide, water</td>
</tr>
<tr>
<td>Sodium nitrite</td>
<td>Ammonium nitrate and other ammonium salts</td>
</tr>
<tr>
<td>Sodium Peroxide</td>
<td>Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural</td>
</tr>
<tr>
<td>Sulfides</td>
<td>Acids</td>
</tr>
</tbody>
</table>
**2.5 CHEMICAL SPILLS & ACCIDENTS**

**2.5.1. General Information**

Try to anticipate the types of chemical spills that can occur in your laboratory and obtain the necessary equipment (spill kits and personal protective equipment) to respond to a minor spill. Learn how to clean up minor spills of the chemicals you use regularly safely. A SDS contains special spill clean-up information and should also be consulted. *Chemical spills should only be cleaned up by knowledgeable and experienced personnel.*

If the spill is too large for you to handle, is a threat to public health, safety or the environment, or involves a highly toxic or reactive chemical, contact assistance immediately:

- Northeastern Police Department, call (617) 373-3333 or use the SafeZone app (24 hours/day). Dial 911 at satellite locations, including Burlington and Nahant.
- The Office of Academic and Research Safety, 617-373-2769 (8:30 a.m. to 5:00 p.m.)

A Contingency Plan is maintained by the Office Academic and Research Safety to handle such spills.

**2.5.2. Cleaning Up Chemical Spills**

If you are cleaning up a small spill yourself, make sure that you are aware of the hazards associated with the materials spilled, have adequate ventilation (open windows, chemical fume hood on) and proper personal protective equipment (minimum - gloves, goggles and lab coat). Consider all residual chemical and cleanup materials (adsorbent, gloves, etc.) as hazardous waste. Place these materials in a sealed container (plastic bags) and store in a satellite accumulation area (preferably a chemical fume hood). Contact the Office of Academic and Research Safety for disposal instructions.

**2.5.3. Minor Chemical Spill**

- Alert people in the immediate area of spill.
- Increase ventilation in the area of spill (open windows, turn on hoods).
- Wear personal protective equipment, including safety goggles, gloves and long-sleeved lab coat.
- Avoid breathing vapors from spill.

| Sulfuric Acid | Potassium chloride, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.) |
| Tellurides | Reducing agents |

• Use appropriate kit to neutralize and absorb inorganic acids and bases. Collect residue, place in container, and dispose as hazardous chemical waste.
• For other chemicals, use appropriate kit or absorb spill with vermiculite, dry sand, diatomaceous earth or paper towels. Collect residue, place in container, and dispose as chemical waste.
• Clean spill area with water.

2.5.4. Major Chemical Spill
• Attend to injured or contaminated persons and remove them from exposure.
• Alert people in the laboratory to evacuate.
• If spilled material is flammable, turn off ignition and heat sources. Place other device (plastic bag) over spilled material to keep substance from volatilizing.
• Call Chemical Spill Emergency Response number (617) 373-3333 or use the SafeZone app. Dial 911 at satellite locations, including Burlington and Nahant.
• Close doors to affected area.
• Have a person with knowledge of the incident and laboratory available to answer questions from responding emergency personnel.

2.5.5. Mercury Spills

Use a vacuum line with an in-line dry trap attached to a tapered glass tube similar to a medicine dropper to pick up mercury droplets. OARS has sponges and other mercury spill clean-up supplies available for laboratory personnel to use to handle mercury spills. Do not use a domestic or commercial vacuum cleaner.

Cover small droplets in inaccessible areas with one of the following:

• Powdered sulfur
• Powdered zinc

Place residue in a labeled container and dispose of as hazardous chemical waste.

2.5.6. Alkali Metal Spills

Smother with powdered graphite, sodium carbonate, calcium carbonate or "Met-L-X". Call the NU Chemical Hygiene Officer for assistance.

2.5.7. White Phosphorus

Smother with wet sand or wet "noncombustible" absorbent. Call the NU Chemical Hygiene Officer for assistance.

2.5.8 Hydrofluoric Acid

• Attend to injured or contaminated persons and remove them from exposure.
If skin contact occurs, immediately remove contaminated clothing and flush off the acid using large quantities of cool water for 5 minutes. Apply calcium gluconate on and around the burn. Massage it in with gloved hands until 15 minutes after the pain has subsided.

If eye contact occurs, flush the eyes with large quantities of cool clean water for 5 minutes while holding the eyelids apart. Then administer calcium gluconate drops.

Restock the first aid kit after usage as soon as possible.

- Call the Office of Academic and Research Safety, x2769 to ensure appropriate trained personnel respond and clean spill.

2.6 PERSONAL CONTAMINATION AND INJURY

2.6.1. General Information

- Know the locations of the nearest safety shower and eyewash.
- Report all incidents and injuries to your supervisor.
- If an individual is contaminated or exposed to a hazardous material in your laboratory, do what is necessary to protect their life and health as well as your own. Determine what the individual was exposed to. The SDS will contain special first aid information.
- Do not move an injured person unless they are in further danger (from inhalation or skin exposure).
- A blanket should be used immediately to protect the victim from shock and exposure.
- Get medical attention promptly by dialing (617) 373-3333 or use the SafeZone app. Dial 911 at satellite locations, including Burlington and Nahant.

2.6.2. Chemicals Spills on the Body

- Quickly remove all contaminated clothing and footwear.
- Immediately flood the affected body area with cold water for at least 15 minutes. Remove jewelry to facilitate removal of any residual material.
- Wash off chemical with water only. Do not use neutralizing chemicals, unguents, creams, lotions or salves.
- Get medical attention promptly by dialing (617) 373-3333 or use the SafeZone app. Dial 911 at satellite locations, including Burlington and Nahant.

It should be noted that some chemicals (phenol, aniline,) are rapidly absorbed through the skin. If a large enough area of skin is contaminated, an adverse health effect (systemic toxicological reaction) may occur immediately to several hours after initial exposure depending on the chemical. If more than 9 square inches of skin area has been exposed to a hazardous chemical, seek medical attention after washing the material off the skin. If the incident involves hydrofluoric acid, seek immediate medical attention. Provide the physician with the chemical name.

2.6.3. Chemical Splash in the Eye
• Irrigate the eyeball and inner surface of eyelid with plenty of cool water for at least 15 minutes. Use eye wash or other water source. Forcibly hold eyelids open to ensure effective wash.
• Check for and remove contact lenses.
• Get medical attention promptly.

2.6.4. Ingestion of Hazardous Chemicals
• Identify the chemical ingested.
• Call for an emergency assistance from NUPD by dialing (617) 373-3333 or use the SafeZone app. Dial 911 at satellite locations, including Burlington and Nahant.
• Call the Poison Information Center by dialing (800) 222-1222.
• Cover the injured person to prevent shock.
• Provide the ambulance crew and physician with the chemical name and any other relevant information. If possible, send the container, SDS or the label with the victim.

2.6.5. Inhalation of Smoke, Vapors and Fumes
• Anyone overcome with smoke or chemical vapors or fumes should be removed to uncontaminated air and treated for shock.
• Do not enter the area if you expect that a life-threatening condition still exists - oxygen depletion, explosive vapors or highly toxic gases (cyanide gas, hydrogen sulfide, nitrogen oxides, carbon monoxide).
• If CPR certified, follow standard CPR protocols.
• Get medical attention promptly.

2.6.6. Burning Chemicals on Clothing
• Extinguish burning clothing by using the drop-and-roll technique or by dousing with cold water, or use an emergency shower if it is immediately available.
• Remove contaminated clothing; however, avoid further damage to the burned area. If possible, send the clothing with the victim.
• Remove heat with cool water or ice packs until tissue around burn feels normal to the touch.
• Cover injured person to prevent shock.
• Get medical attention promptly.

2.6.7. Actions to be Avoided During Emergencies

There are some actions which must not be taken when handling emergencies. These include:

• Do not force any liquids into the mouth of an unconscious person.
• Do not handle emergencies alone, especially without notifying someone that the accident has occurred.
• Do not linger at the accident scene if you are not one of the emergency responders.
2.7 FIRE AND FIRE RELATED EMERGENCIES

If you discover a fire or fire-related emergency such as abnormal heating of material, a flammable gas leak, a flammable liquid spill, smoke, or odor of burning, immediately follow these procedures:

- Notify the Fire Department through NUPD by dialing (617) 373-3333 or use the SafeZone app. Dial 911 at satellite locations, including Burlington and Nahant.
- Activate the building alarm (fire pull station). If not available or operational, verbally notify people in the building.
- Isolate the area by closing windows and doors and evacuate the building.
- Shut down equipment in the immediate area, if possible.
- If trained, use a portable fire extinguisher to:
  - assist oneself to evacuate;
  - assist another to evacuate; and
  - control a small fire, if possible.

Provide the fire/police teams with the details of the problem upon their arrival. Special hazard information you might know is essential for the safety of the emergency responders.

If the fire alarms are ringing in your building:

- You must evacuate the building and stay out until notified to return.
- Move up-wind from the building and stay clear of streets, driveways, sidewalks and other access ways to the building.
- If you are a supervisor, try to account for your employees, keep them together and report any missing persons to the emergency personnel at the scene.

2.8 HAZARDOUS WASTE DISPOSAL PROGRAM

Laboratory hazardous "chemical" waste must be disposed of in accordance with local, state, federal and Northeastern University requirements. These waste management practices are designed to ensure the maintenance of a safe and healthy environment for laboratory employees and the surrounding community without adversely affecting the environment. This is accomplished through regular removal of hazardous waste and disposal of these wastes in compliance with all regulations and policies. Hazardous waste classroom and refresher trainings are available for individuals that are tasked with identifying, handling, collecting, segregating, storing and disposing of hazardous chemical waste. Supplemental guidance documents are available on the hazardous waste section of our Website or by contacting us directly.

Remember:

- Hazardous waste must be disposed of in a timely manner. Personnel managing hazardous waste must be aware that full containers must be removed from the laboratory within three days of dating label.
- Hazardous waste containers must be closed at all times during storage, except when waste is being added.
• All hazardous waste must be properly labeled at the time the waste is first placed in the container.
• Hazardous waste should be accumulated in a designated storage area consistent with applicable regulations. Also, the NU Hazardous Waste Satellite Accumulation Posting must be posted at your designated storage area.
• Hazardous waste regulations require specific training of personnel who generate or handle hazardous waste.
• Do not use sinks or rubbish bins for hazardous waste disposal.
• Generators of hazardous waste are required to incorporate waste minimization into any process that generates hazardous waste.

2.9 Laboratory Closeout Procedures

Laboratories within Northeastern University must be left in a state suitable for new occupants or for renovation activities. The vacating Principal Investigator and Department are responsible for ensuring that the disposal of chemical, biological, radioactive waste materials is properly completed prior to vacating the space. In addition, decontamination of equipment and counters must be done and arrangements made for the removal of unwanted lab equipment, electronics, and furniture. A procedure document and clearance form have been put together to provide guidance.

Section 3. HEALTH AND SAFETY INFORMATION FOR WORK WITH CHEMICALS OF SPECIFIC HAZARD CLASS

3.1 FLAMMABLE LIQUIDS

3.1.1. General Information

Flammable liquids are among the most common of the hazardous materials found in laboratories. They are usually highly volatile and their vapors can ignite and burn when mixed with air at certain ratios. Several common laboratory solvents have a flash point well below room temperature. As with all solvents, their vapor pressure increases with temperature and, therefore, as temperatures increase they become more hazardous.

For a fire to occur, three distinct conditions must exist simultaneously:

1. the concentration of the vapor must be between the upper and lower flammable limits of the substance (the right fuel/air mix);
2. an oxidizing atmosphere, usually air, must be available; and
3. a source of ignition must be present.
Removal of any of these three conditions will prevent the start of a fire. Flammable liquids may form flammable mixtures in either open or closed containers or spaces (such as refrigerators), when leaks or spills occur in the laboratory, or when heated.

Control strategies for preventing ignition of flammable vapors include removing all sources of ignition, or maintaining the concentration of flammable vapors below the lower flammability limit by using local exhaust ventilation, such as a hood. Ignition sources include open flames, hot surfaces, operation of electrical equipment and static electricity. The former strategy is more difficult, because of the numerous ignition sources in laboratories.

The concentrated vapors of flammable liquids are denser than air, and may travel a considerable distance away from a source, such as across laboratories, into hallways, or down elevator shafts or stairways. If the vapors reach a source of ignition, a flame can result that could flash back to the source of the vapor.

The danger presented by flammable liquids can usually be eliminated or minimized by maintaining strict observance of safe handling, dispensing and storing procedures.

3.1.2. Special Handling Procedures

While working with flammable liquids you should wear gloves, protective glasses, and a long-sleeved lab coat. Goggles should be worn if dispensing solvents or performing any operation that could result in a chemical splash.

Large quantities of flammable liquids should be handled in a chemical fume hood or under some other type of local exhaust ventilation. Five-gallon containers must be dispensed to smaller containers in a hood or under local exhaust ventilation.

When dispensing flammable solvents into small storage containers, use metal or plastic containers or safety cans (avoid glass containers). Ensure that metal surfaces or containers through which flammable substances are flowing are properly grounded, discharging static electricity. Free flowing liquids generate static electricity, which can produce a spark and ignite the solvent.

Large quantities of flammable liquids must be handled in areas free of ignition sources (including spark emitting motors and equipment) using non-sparking tools. Remember, vapors are denser than air and can travel back to a distant source of ignition.

Never heat flammable substances by using an open flame. Instead, use any of the following heat sources: steam baths, water baths, oil baths, heating mantles, or hot air baths.

Do not distill flammable substances under reduced pressure.

Store flammable substances away from ignition sources, preferably in flammable storage cabinet. If no flammable storage cabinet is available, store these substances in a cabinet under the hood or bench. Five-gallon containers should only be stored in a flammable storage cabinet or under a hood. Flammable liquids can also be kept inside the hood temporarily. Storage in a chemical fume hood is not preferred because it reduces hood performance by obstructing air flow.
The volume of flammable liquids dispensed in small containers (not including safety cans) in the open areas of laboratories should not exceed 10 gallons. Review the Boston Fire Department restrictions on storage of flammables in the Laboratory Safety section of the OARS Office homepage. Never store glass containers of flammable liquids on the floor.

Oxidizing and corrosive materials should not be stored in close proximity to flammable liquids.

Flammable liquids should not be stored or chilled in domestic refrigerators and freezers but in units specifically designed for this purpose. It is acceptable to store or chill flammable in ultra-low temperature units.

If flammable liquids will be placed in ovens, make sure they are appropriately designed for flammable liquids (no internal ignition sources and/or vented mechanically).

### 3.2 HIGHLY REACTIVE CHEMICALS & HIGH ENERGY OXIDIZERS

#### 3.2.1. General Information

Highly reactive chemicals include those, which are inherently unstable and susceptible to rapid decomposition as well as chemicals that under specific conditions, can react alone, or with other substances in a violent, uncontrolled manner, liberating heat, toxic gases, or leading to an explosion. Reaction rates almost always increase dramatically as the temperature increases. Therefore, if heat evolved from a reaction is not dissipated, the reaction can accelerate out of control and possibly result in injuries or costly accidents.

Air, light, heat, mechanical shock (when struck, vibrated or otherwise agitated), water and certain catalysts can cause decomposition of some highly reactive chemicals, and initiate an explosive reaction. Hydrogen and chlorine react explosively in the presence of light. Alkali metals, such as sodium, potassium and lithium, react violently with water, liberating hydrogen gas. Examples of shock sensitive materials include acetylides, azides, organic nitrates, nitro compounds, and many peroxides.

**Organic peroxides** are a special class of compounds that have unusual stability problems, making them among the most hazardous substances normally handled in laboratories. As a class, organic peroxides are low powered explosives. Organic peroxides are extremely sensitive to light, heat, shock, sparks, and other forms of accidental ignition, as well as to strong oxidizing and reducing materials. All organic peroxides are highly flammable.

Peroxide formers can form peroxides during storage and especially after exposure to the air (once opened). Peroxide forming substances include aldehydes, ethers (especially cyclic ethers), compounds containing benzylic hydrogen atoms, compounds containing the allylic structure (including most alkenes), vinyl and vinylidene compounds.

Examples of shock sensitive chemicals, high energy oxidizers and substances which can form explosive peroxides are listed at the end of this section.
3.2.2. Special Handling Procedures

Before working with a highly reactive material or a high energy oxidizer, review available reference literature to obtain specific safety information. The proposed reactions should be discussed with your supervisor. Always minimize the amount of material involved in the experiment; the smallest amount sufficient to achieve the desired result should be used. Scaling up should be handled with great care, considering the reaction vessel size and cooling, heating, stirring and equilibration rates.

Excessive amounts of highly reactive compounds should not be purchased, synthesized, or stored in the laboratories. The key to safely handling reactive chemicals is to keep them isolated from the substances that initiate their violent reactions. Unused peroxides should not be returned to the original container.

NEVER work alone. All operations where highly reactive and explosive chemicals are used should be performed during the normal work day or when other employees are available either in the same laboratory or in the immediate area.

Perform all manipulations of highly reactive or high energy oxidizers in a chemical fume hood. (Some factors to be considered in judging the adequacy of the hood include its size in relation to the reaction and required equipment, the ability to fully close the sash, and the composition of the sash.)

Make sure that the reaction equipment is properly secured. Reaction vessels should be supported from beneath with tripods or lab jacks. Use shields or guards, which are clamped or secured.

If possible, use remote controls for controlling the reaction (including cooling, heating and stirring controls). These should be located either outside the hood or at least outside the shield.

Handle shock sensitive substances gently, avoid friction, grinding and all forms of impact. Glass containers that have screw-cap lids or glass stoppers should not be used. Polyethylene bottles that have screw-cap lids may be used. Handle water-sensitive compounds away from water sources. Light-sensitive chemicals should be used in light-tight containers. Handle highly reactive chemicals away from the direct light, open flames and other sources of heat. Oxidizing agents should only be heated with fiberglass heating mantles or sand baths.

High energy oxidizers, such as perchloric acid, should only be handled in a wash down hood if the oxidizer will volatilize and potentially condense in the ventilation system. Inorganic oxidizers such as perchloric acid can react violently with most organic materials.

When working with highly reactive compounds and high energy oxidizers, always wear the following personal protection equipment: lab coats, gloves and protective glasses/goggles. During the reaction, a face shield long enough to give throat protection should be worn.

Labels on peroxide forming substances should contain the date the container was received, first opened and the initials of the person who first opened the container. They should be checked for the presence of peroxides before using, and quarterly while in storage (peroxide test strips are available at OARS Office). If peroxides are found, the materials should be decontaminated, if possible, or disposed of. The results of any testing should be placed on the container label. Never distill substances contaminated with peroxides.
Peroxide forming substances that have been opened for more than one year should be discarded. *Never use a metal spatula with peroxides. Contamination by metals can lead to explosive decompositions.*

Store highly reactive chemicals and high energy oxidizers in closed cabinets segregated from the materials with which they react and, if possible, in secondary containers. You can also store them in the cabinet under a hood. Do not store these substances above eye level or on open shelves.

Store peroxides and peroxide forming compounds at the lowest possible temperature. If you use a refrigerator, make sure it is appropriately designed for the storage of flammable substances. Store light-sensitive compounds in the light-tight containers. Store water-sensitive compounds away from water sources.

Shock sensitive materials should be discarded after one year if in a sealed container and within six months of opening unless an inhibitor was added by the manufacturer.

### 3.2.3. List of Shock Sensitive Chemicals

Shock sensitive refers to the susceptibility of the chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated. The following are examples of materials that can be shock sensitive:

<table>
<thead>
<tr>
<th>Acetylides of heavy metals</th>
<th>Heavy metal azides</th>
<th>Picramic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum ophrite explosive</td>
<td>Hexanitrodiethylamine</td>
<td>Picratol</td>
</tr>
<tr>
<td>Amatol</td>
<td>Hexanitrodiethylamine</td>
<td>Picratol</td>
</tr>
<tr>
<td>Ammonal</td>
<td>Hexanitrostilbene</td>
<td>Picric acid</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>Hexogen</td>
<td>Picryl chloride</td>
</tr>
<tr>
<td>Ammonium perchlorate</td>
<td>Hydrazinium nitrate</td>
<td>Picryl fluoride</td>
</tr>
<tr>
<td>Ammonium picrate</td>
<td>Hydrazoic acid</td>
<td>Polynitro aliphatic compounds</td>
</tr>
<tr>
<td>Ammonium salt lattice</td>
<td>Lead azide</td>
<td>Potassium nitroaminotetrazole</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Butyl tetryl</td>
<td>Lead mannite</td>
<td>Silver acetylide</td>
</tr>
<tr>
<td>Calcium nitrate</td>
<td>Lead mononitroresorcinato</td>
<td>Silver azide</td>
</tr>
<tr>
<td>Copper acetylide</td>
<td>Lead picrate</td>
<td>Silver styphnate</td>
</tr>
<tr>
<td>Cyanuric triazide</td>
<td>Lead salts</td>
<td>Silver tetrazene</td>
</tr>
<tr>
<td>Cyclotrimethylenetrinitramine</td>
<td>Lead styphnate</td>
<td>Sodatol</td>
</tr>
<tr>
<td>Cyclotetramethylenenetranitramine</td>
<td>Trimethylethane</td>
<td>Sodium amatol</td>
</tr>
<tr>
<td>Dinitroethyleneurea</td>
<td>Magnesium ophorite</td>
<td>Sodium dinitro-orthocresolate</td>
</tr>
<tr>
<td>Dinitroglycerine</td>
<td>Mannitol hexanitate</td>
<td>Sodium nitrate-potassium</td>
</tr>
<tr>
<td>Dinitrophenol</td>
<td>Mercury oxalate</td>
<td>Sodium picramate</td>
</tr>
<tr>
<td>Dinitrophenolates</td>
<td>Mercury tartrate</td>
<td>Styphnic acid</td>
</tr>
<tr>
<td>Dinitrophenyl hydrazine</td>
<td>Mononitrotoluene</td>
<td>Tetrazene</td>
</tr>
<tr>
<td>Compound</td>
<td>Substituent</td>
<td>Product Name</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Dinitrotoluene</td>
<td>Nitrated carbohydrates</td>
<td>Tetranitrocarbazole</td>
</tr>
<tr>
<td>Dipicryl sulfone</td>
<td>Nitrated glucoside</td>
<td>Tetrytol</td>
</tr>
<tr>
<td>Dipicrylamine</td>
<td>Nitrated polyhydric alcohol</td>
<td>Trimonite</td>
</tr>
<tr>
<td>Erythritol tetranitrate</td>
<td>Nitrogen trichloride</td>
<td>Trinitroanisole</td>
</tr>
<tr>
<td>Fulminate of mercury</td>
<td>Nitrogen triiodide</td>
<td>Trinitrobenzene</td>
</tr>
<tr>
<td>Fulminate of silver</td>
<td>Nitroglycerin</td>
<td>Trinitrobenzoic acid</td>
</tr>
<tr>
<td>Fulminating gold</td>
<td>Nitroglycidie</td>
<td>Trinitrocresol</td>
</tr>
<tr>
<td>Fulminating mercury</td>
<td>Nitroglycol</td>
<td>Trinitro-(meta)-cresol</td>
</tr>
<tr>
<td>Fulminating platinum</td>
<td>Nitroguanidine</td>
<td>Trinitronaphthalene</td>
</tr>
<tr>
<td>Fulminating silver</td>
<td>Nitroparaffins</td>
<td>Trinitrophenetol</td>
</tr>
<tr>
<td>Gelatinized nitrocellulose</td>
<td>Nitronium perchlorate</td>
<td>Trinitrophloroglucinol</td>
</tr>
<tr>
<td>Germane</td>
<td>Nitrourea</td>
<td>Trinitroresorcinol</td>
</tr>
<tr>
<td>Guanyl nitrosamino</td>
<td>Organic amine nitrates</td>
<td>Tritonal</td>
</tr>
<tr>
<td>guanyltetrazene</td>
<td>Organic nitramines</td>
<td>Urea nitrate</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Guanyl nitrosaminoguanylhydrazine</td>
<td>Organic peroxides</td>
<td></td>
</tr>
</tbody>
</table>

3.2.4. List of High Energy Oxidizers

The following are examples of materials that are powerful oxidizing reagents:

<table>
<thead>
<tr>
<th>Ammonium permanganate</th>
<th>Fluorine</th>
<th>Potassium perchlorate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barium peroxide</td>
<td>Hydrogen peroxide</td>
<td>Potassium peroxide</td>
</tr>
<tr>
<td>Bromine</td>
<td>Magnesium perchlorate</td>
<td>Propyl nitrate</td>
</tr>
<tr>
<td>Calcium chlorate</td>
<td>Nitric acid</td>
<td>Sodium chlorate</td>
</tr>
<tr>
<td>Calcium hypochlorite</td>
<td>Nitrogen peroxide</td>
<td>Sodium chlorite</td>
</tr>
<tr>
<td>Chlorine trifluoride</td>
<td>Perchloric acid</td>
<td>Sodium perchlorate</td>
</tr>
<tr>
<td>Chromium anhydride or chromic acid</td>
<td>Potassium bromate</td>
<td>Sodium Peroxide</td>
</tr>
</tbody>
</table>

3.2.5. List of Peroxide Formers

The following are examples of the materials commonly used in laboratories which may form explosive peroxides:
### COMPRESSED GASES

**3.3.1. General Information**

Compressed gases are unique in that they represent both a physical and a potential chemical hazard (depending on the particular gas). Gases contained in cylinders may be from any of the hazard classes described in this section (flammable, reactive, corrosive, or toxic). Because of their physical state (gaseous), concentrations in the laboratory can increase instantaneously if leaks develop at the regulator or piping systems, creating the potential for a toxic chemical exposure or a fire/explosion hazard. Often there is little or no indication that leaks have or are occurring. Finally, the large amount of potential energy resulting from compression of the gas makes a compressed gas cylinder a potential rocket or fragmentation bomb if the tank or valve is physically broken.

**3.3.2. Special Handling Procedures**

The contents of any compressed gas cylinder should be clearly identified. No cylinder should be accepted for use that does not legibly identify its contents by name. Color coding is not a reliable means of identification and labels on caps have no value as caps are interchangeable.
Carefully read the label before using or storing a compressed gas. The SDS will provide any special hazard information.

Transport gas cylinders in carts one or two at a time only while they are secured and capped. All gas cylinders should be capped and secured when stored. Use suitable racks, straps, chains or stands to support cylinders. All cylinders, full or empty, must be restrained and kept away from heat sources. Store as few cylinders as possible in your laboratory.

Use only Compressed Gas Association standard combinations of valves and fittings for compressed gas installations. Always use the correct pressure regulator. Do not use a regulator adaptor.

All gas lines leading from a compressed gas supply should be clearly labeled identifying the gas and the laboratory served.

Place gas cylinders in such a way that the cylinder valve is accessible at all times. The main cylinder valve should be closed as soon as the gas flow is no longer needed. Do not store gas cylinders with pressure on the regulator. Use wrenches or other tools provided by the cylinder supplier to open a valve if available. In no case should pliers be used to open a cylinder valve.

Use soapy water to detect leaks. Leak test the regulator, piping system and other couplings after performing maintenance or modifications, which could affect the integrity of the system.

Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel/gas regulator on an oxygen cylinder.

Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out (172 kPa or 25 psi). Empty cylinders should not be refilled in laboratories unless they are equipped to prevent overfilling.

All gas cylinders should be clearly marked with appropriate tags indicating whether they are in use, full, or empty. Empty and full cylinders should not be stored in the same place.

Cylinders of toxic, flammable or reactive gases should be purchased in the smallest quantity possible and stored/used in a fume hood or under local exhaust ventilation. If at all possible, avoid the purchase of lecture bottles. These cylinders are not returnable and it is extremely difficult and costly to dispose of them. Use the smallest returnable sized cylinder.

Wear safety goggles when handling compressed gases that are irritants, corrosive or toxic.

Try to purchase compressed gas cylinder that can be returned to the manufacturer (see Management of Unwanted Compressed Gases Fact Sheet).

3.3.3. Special Precautions for Hydrogen

Hydrogen gas has several unique properties which make it potentially dangerous to work with. It has an extremely wide flammability range (LEL 4%, UEL 74.5%) making it easier to ignite than most other
flammable gases. Unlike most other gases, hydrogen's temperature increases during expansion. If a cylinder valve is opened too quickly, the static charge generated by the escaping gas may cause it to ignite. Hydrogen burns with an invisible flame. Caution should therefore be exercised when approaching a suspected hydrogen flame. A piece of paper can be used to tell if the hydrogen is burning. Hydrogen embrittlement can weaken carbon steel, therefore cast-iron pipes and fittings must not be used. Those precautions associated with other flammable substances also apply to Hydrogen (see Section 3.1).

3.3.4. Special Precautions for Cryogens

If not handled properly, cryogenic liquids can be hazardous to personnel. By reviewing Cryogens Fact Sheet you will become aware of the conditions that increase the risk of accidents and injuries that can occur when working with cryogenic liquids. You will learn what can make your workplace safe. Along with other normal PPE requirements, use of a face shield and gloves approved for cryogen are required.

3.4 CORROSIVE CHEMICALS

3.4.1. General Information

The major classes of corrosive chemicals are strong acids and bases, dehydrating agents, and oxidizing agents. These chemicals can erode the skin and the respiratory epithelium and are particularly damaging to the eyes. Inhalation of vapors or mists of these substances can cause severe bronchial irritation. If your eyes or skin are exposed to a corrosive, flush the exposed area with water for at least fifteen minutes. Then seek medical treatment.

**Strong acids.** All concentrated acids can damage the skin and eyes and their burns are very painful. Nitric, chromic, and hydrofluoric acids are especially damaging because of the types of burns they inflict. Seek immediate medical treatment if you have been contaminated with these materials (particularly hydrofluoric acid). The Laboratory Safety Committee establishes that all laboratories working with hydrofluoric (HF) acid of any concentration must have calcium gluconate and appropriate training in place in case of an exposure to this material.

**Strong alkalis.** The common bases used in the laboratories are potassium hydroxide, sodium hydroxide, and ammonia. Burns from these materials are often less painful than acids. However, damage may be more severe than acid burns because the injured person, feeling little pain, often does not take immediate action and the material is allowed to penetrate into the tissue. Ammonia is a severe bronchial irritant and should always be used in a well-ventilated area, if possible in a hood.

**Dehydrating agents.** This group of chemicals includes concentrated sulfuric acid, sodium hydroxide, phosphorus pentoxide and calcium oxide. Because much heat is evolved on mixing these substances with water, mixing must be done by adding the agent to water and not the reverse, to avoid violent reaction and spattering. Because of their affinity for water, these substances cause severe burns on contact with skin. Affected areas should be washed promptly with large volumes of water.

**Oxidizing agents.** In addition to their corrosive properties, powerful oxidizing agents such as perchloric and chromic acids (sometimes used as cleaning solutions), present fire and explosion hazards on contact.
with organic compounds and other oxidizable substances. The hazards associated with the use of perchloric acid are especially severe. It should be handled only after thorough familiarization with recommended operating procedures (see the section 3.2.2 on reactives and high energy oxidizers).

3.4.2. Special Handling Procedures

Corrosive chemicals should be used in a chemical fume hood and over plastic trays especially when handled in bulk quantities (> 1 liter) and when dispensing.

When working with bulk quantities of corrosives, wear gloves, face shields, laboratory coats and rubber aprons.

If you are handling bulk quantities on a regular basis, an eyewash should be immediately available and a shower close by. Spill materials - absorbent pillows, neutral absorbent materials or neutralizing materials (all commercially available) should be available in the laboratory.

Store corrosives in cabinets, under the hood or on low shelves, preferably in impervious trays to separate them physically from other groups of chemicals. Keep containers that are not in use, in storage areas and off bench tops.

If it is necessary to move bulk quantities from one laboratory to another or from the stockroom, use a safety carrier (rubber bucket for secondary containment and protection of the container).

3.5 CHEMICALS OF HIGH ACUTE & CHRONIC TOXICITY

3.5.1. General Information

Substances that possess the characteristic of high acute toxicity can cause injury after a single or short term exposure. The immediate toxic effects to human health range from irritation to illness and death. Hydrogen cyanide, phosgene and nitrogen dioxide are examples of substances with high acute toxicity. The lethal oral doses for an average human adult of highly toxic substances range from one ounce to a few drops. The following procedures should be used when the oral LD$_{50}$ of a substance in the rat or mouse is less than 50 milligrams per kilogram body weight for solid materials or non-volatile liquids and 500 mg/kg body weight for volatile liquids or gases. Oral LD$_{50}$ data for the rat or mouse is listed in the substance's SDS. The LD$_{50}$ toxicity test is usually the first toxicological test performed and is a good indicator of a substance's acute toxicity.

Substances that possess the characteristic of high chronic toxicity cause damage after repeated exposure or exposure over long periods of time. Health effects often do not become evident until after a long latency period - twenty to thirty years. Substances that are of high chronic toxicity may be toxic to specific organ systems - hepatotoxins, nephrotoxins, neurotoxins, toxic agents to the hematopoietic system and pulmonary tissue or carcinogens, reproductive toxins, mutagens, teratogens or sensitizers. The definition of each of these categories of toxic substances, and examples of substances, which fall into each of these different categories, can be found in Section 4 of this manual.
Specific acute and chronic toxicity information on the substances used in your laboratory can be found on these substances' SDS. See Section 1.5.3.1 for information on how to obtain/locate SDS’s. If you have additional questions, contact the NU Chemical Hygiene Officer.

3.5.2. Special Handling Procedures

Avoid or minimize contact with these chemicals by any route of exposure. Protect the hands and forearms by wearing gloves and a laboratory coat. Rinse gloves with water prior to removing them.

Use these chemicals in a chemical fume hood or other appropriate containment device if the material is volatile or the procedure may generate aerosols (See guidelines for chemical fume hood use in Section 2.3.5.1). If a chemical fume hood is used, it should be evaluated to confirm that it is performing adequately (a face velocity of at least 100 linear feet per minute (+20%/-0%)) with the sash at the operating height.

Store volatile chemicals of high acute or chronic toxicity in the cabinet under the hood or another vented area. Volatile chemicals should be stored in unbreakable primary or secondary containers or placed in chemically resistant trays (to contain spills). Non-volatile chemicals should be stored in cabinets or in drawers. Do not store these chemicals on open shelves or counters.

Decontaminate work surfaces with wet paper towels after completing procedures. Place the towels in plastic bags and secure. Confirm disposal requirements with the NU Chemical Hygiene Officer.

Volatile chemicals should be transported between laboratories in durable outer containers.

Vacuum pumps used in procedures should be protected from contamination with scrubbers or filters.

If one or more of these substances are used in large quantities, on a regular basis (three or more separate handling sessions per week) or for long periods of time (4-6 hours), a qualitative and potentially quantitative exposure assessment should be performed. Contact the NU Chemical Hygiene Officer to perform this assessment.

Lab personnel of childbearing age should be informed of any known male and female reproductive toxins used in the laboratory. An employee who is pregnant, or planning to become pregnant, and who is working with potential reproductive toxins that might affect the fetus, should contact the NU Chemical Hygiene Officer to evaluate her exposure and inform her personal physician. The NU Chemical Hygiene Officer can assess potential exposures and work with the employee and laboratory supervisor, if necessary, to adjust work practices to minimize the potential risk.

3.6 REGULATED CHEMICALS AND PARTICULARLY HAZARDOUS CHEMICALS

3.6.1. General Information

This section establishes supplemental work procedures to control the handling of substances that are known to exhibit unusual acute or long-term chronic health hazards (carcinogens, reproductive toxins and highly acutely toxic substances). This set of procedures applies (as indicated in Appendix A) to chemical
carcinogens listed and regulated by the Department of Labor, Occupational Safety and Health Administration (OSHA), and of human carcinogens listed by the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP).

Appendix A identifies under what conditions and for what substances the special handling procedures listed below should be used. Please note that a key component in controlling the most hazardous substances is the controlled distribution and use of these substances. In some instances, special authorization is required before purchasing and using these substances.

Appendix A lists the substances and/or procedures that require prior approval of the research protocol before beginning work. See Section 1.11 for the chemical safety protocol review and registration process.

3.6.2. Special Handling Procedures

Use these chemicals only in a chemical fume hood or other appropriate containment device (glove box). If a chemical fume hood is used, it should be evaluated to confirm that it is performing adequately (a face velocity of at least 100 linear feet per minute (+20%/-0%) with the sash at the operating height).

Volatile chemicals should be stored in a vented storage area in an unbreakable, primary or secondary container or placed in a chemically resistant tray (to contain spills). Non-volatile chemicals should be stored in cabinets or in drawers. Do not store these chemicals on open shelves or counters. Access to all of these chemicals should be restricted.

Volatile chemicals should be transported between laboratories in durable outer containers.

All procedures with these chemicals should be performed in designated areas. Other employees working in the area should be informed of the particular hazards associated with these substances and the appropriate precautions that are necessary for preventing exposures. All designated areas should be posted with a sign which reads:

WARNING

DESIGNATED AREA FOR HANDLING THE FOLLOWING

SUBSTANCES WITH HIGH ACUTE/CHRONIC TOXICITY OR ENVIRONMENTAL HAZARD:

[list of substances - identify acute or chronic hazard]

[Example: Benzene - carcinogen]

AUTHORIZED PERSONNEL ONLY

Vacuum pumps used in procedures should be protected from contamination with scrubbers or filters.

Analytical instruments or other laboratory equipment generating vapors and/or aerosols during their operation, should be locally exhausted or vented in a chemical fume hood.
Skin surfaces that might be exposed to these substances during routine operations or foreseeable accidents should be covered with appropriate protective clothing. Gloves should be worn whenever transferring or handling these substances. Consider using full body protection (disposable coveralls) if the potential for extensive personal contamination exists.

All personal protective equipment should be removed when leaving the designated area and decontaminated (washed) or, if disposable, placed in a plastic bag and secured. Call the NU Chemical Hygiene Officer for disposal instructions. Skin surfaces - hands, forearms, face and neck - should be washed immediately.

Work surfaces on which these substances will be handled should be covered with an easily decontaminated surface (such as stainless steel) or protected from contamination with plastic trays or plastic backed paper. Call the NU Chemical Hygiene Officer for decontamination and disposal procedures; these will be substance specific. Materials that will be disposed of should be placed in plastic bags and secured.

Chemical wastes from procedures using these substances should be placed in containers and disposed of as hazardous chemical waste. The wastes should be stored in the designated satellite accumulation area (defined above) until picked up. Sinks and floor drains must be protected from accidental releases or incidental discharges. If it is possible to safely chemically decontaminate all toxic substances to nontoxic materials during or at the end of the procedure, this should be done.

Normal laboratory work should not be conducted in a designated area until it has been decontaminated or determined to be acceptable by the principal investigator or NU Chemical Hygiene Officer.

If one or more of these substances are used in large quantities, on a regular basis (three or more separate handling sessions per week), or for long periods of time (4-6 hours), a qualitative and potentially quantitative exposure assessment should be performed. Contact the NU Chemical Hygiene Officer to have this assessment performed. The NU Chemical Hygiene Officer will determine if it is appropriate to establish an ongoing medical surveillance program.

Laboratory personnel of childbearing age should be informed of any known male and female reproductive toxins used in the laboratory. An employee who is pregnant, or planning to become pregnant, and who is working with potential reproductive toxins that might affect the fetus, should contact the NU Chemical Hygiene Officer to evaluate her exposure and inform her personal physician. The NU Chemical Hygiene Officer can assess potential exposures and work with the employee and laboratory supervisor, if necessary, to adjust work practices to minimize the potential risk.
4.1 CHEMICAL TOXICOLOGY OVERVIEW

4.1.1 Definitions

Toxicology is the study of the nature and action of poisons.

Toxicity is the ability of a chemical substance or compound to produce injury once it reaches a susceptible site in, or on the body.

A material’s hazard potential is the probability that injury will occur after consideration of the conditions under which the substance is used.

4.1.2 Dose-Response Relationships

The potential toxicity (harmful action) inherent in a substance is exhibited only when that substance comes in contact with a living biological system. The potential toxic effect increases as the exposure increases. All chemicals will exhibit a toxic effect given a large enough dose. The toxic potency of a chemical is thus ultimately defined by the dose (the amount) of the chemical that will produce a specific response in a specific biological system.
4.1.3. Routes of Entry into the Body

There are three main routes by which hazardous chemicals enter the body:

- Absorption through the **respiratory tract** via inhalation.
- Absorption through the **skin** via dermal contact.
- Absorption through the **digestive tract** via ingestion. (Ingestion can occur through eating, drinking or smoking with contaminated hands or in contaminated work areas.)

Most exposure standards, such as the Threshold Limit Values (TLV’s) and Permissible Exposure Limits (PEL’s), are based on the inhalation route of exposure. These limits are normally expressed in terms of either parts per million (ppm) or milligrams per cubic meter (mg/m3) concentration in air. If a significant route of exposure to a substance is through skin contact, the SDS, PEL and/or TLV will have a "skin" notation. Examples of substances where skin absorption may be a significant factor include: pesticides, carbon disulfide, carbon tetrachloride, dioxane, mercury, thallium compounds, xylene and hydrogen cyanide.

4.1.4. Types of Effects

**Acute poisoning** is characterized by sudden and severe exposure and rapid absorption of the substance. Normally, a single large exposure is involved. Adverse health effects are sometimes reversible. Examples: carbon monoxide or cyanide poisoning.

**Chronic poisoning** is characterized by prolonged or repeated exposures of a duration measured in days, months or years. Symptoms may not be immediately apparent. Health effects are often irreversible. Examples: lead or mercury poisoning.

A **Local** effect refers to an adverse health effect that takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples: strong acids or alkalis.

A **Systemic** effect refers to an adverse health effect that takes place at a location distant from the body's initial point of contact and presupposes absorption has taken place. Examples: arsenic affects the blood, nervous system, liver, kidneys and skin; benzene affects bone marrow.

**Cumulative poisons** are characterized by materials that tend to build up in the body as a result of numerous chronic exposures. The effects are not seen until a critical body burden is reached. Example: heavy metals.

**Substances in combination:** When two or more hazardous materials are present at the same time, the resulting effect can be greater than the effect predicted based on the additive effect of the individual substances. This is called a **synergistic** or **potentiating effect.** Example: exposure to alcohol and chlorinated solvents; or smoking and asbestos.

4.1.5. Other Factors Affecting Toxicity
Rate of entry and route of exposure: that is, how fast is the toxic dose delivered and by what means.

Age can affect the capacity to repair tissue damage.

Previous exposure can lead to tolerance, increased sensitivity, or make no difference.

State of health, physical condition and lifestyle can affect the toxic response. Pre-existing disease can result in increased sensitivity.

Environmental factors such as temperature and pressure.

Host factors include genetic predisposition and the sex of the exposed individual.

4.1.6. Physical Classifications

Gas applies to a substance, which is in the gaseous state at room temperature and pressure.

A Vapor is the gaseous phase of a material, which is ordinarily a solid or a liquid at room temperature and pressure.

When considering the toxicity of gases and vapors, the solubility of the substance is a key factor. Highly soluble materials, like ammonia, irritate the upper respiratory tract. On the other hand, relatively insoluble materials, like nitrogen dioxide, penetrate deep into the lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body and are cumulative poisons.

An aerosol is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium.

The toxic potential of an aerosol is only partially described by its airborne concentration. For a proper assessment of the toxic hazard, the size of the aerosol's particles must be determined. A particle's size will determine if a particle will be deposited within the respiratory system and the location of deposition. Particles above 10 micrometers tend to deposit in the nose and other areas of the upper respiratory tract. Below 10 micrometers particles enter and are deposited in the lung. Very small particles (<0.2 micrometers) are generally not deposited but exhaled.

4.1.7. Physiological Classifications

Irritants are materials that cause inflammation of the mucous membranes they come in contact with. Inflammation of tissue results from exposure to concentrations far below those needed to cause corrosion. Examples include:

<p>| - Ammonia       | - Alkaline dusts and mists |</p>
<table>
<thead>
<tr>
<th>- Hydrogen chloride</th>
<th>- Hydrogen fluoride</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Halogens</td>
<td>- Ozone</td>
</tr>
<tr>
<td>- Phosgene</td>
<td>- Diethyl/dimethyl sulfate</td>
</tr>
<tr>
<td>- Nitrogen dioxide</td>
<td>- Phosphorus chlorides</td>
</tr>
<tr>
<td>- Arsenic trichloride</td>
<td></td>
</tr>
</tbody>
</table>

Irritants can also cause changes in the mechanics of respiration and lung function. Examples include:

<table>
<thead>
<tr>
<th>- Sulfur dioxide</th>
<th>- Acetic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Formaldehyde</td>
<td>- Formic acid</td>
</tr>
<tr>
<td>- Sulfuric acid</td>
<td>- Acrolein</td>
</tr>
<tr>
<td>- Iodine</td>
<td></td>
</tr>
</tbody>
</table>

Long term exposure to irritants can result in increased mucous secretions and chronic bronchitis.

A **primary irritant** exerts no systemic toxic action either because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. Example: hydrogen chloride.

A **secondary irritant's** effect on mucous membranes is overshadowed by a systemic effect resulting from absorption. Examples include:
Asphyxiants have the ability to deprive tissue of oxygen.

Simple asphyxiants are inert gases that displace oxygen. Examples include:

- Nitrogen
- Nitrous oxide
- Carbon dioxide
- Hydrogen
- Helium

Chemical asphyxiants reduce the body's ability to absorb, transport, or utilize inhaled oxygen. They are often active at very low concentrations (a few ppm). Examples include:

- Carbon monoxide
- Cyanides

Primary anesthetics have a depressant effect upon the central nervous system, particularly the brain. Examples include:

- Halogenated hydrocarbons
- Alcohols

Hepatotoxic agents cause damage to the liver. Examples include:

- Carbon tetrachloride
- Tetrachloroethane
- Nitrosamines

Nephrotoxic agents damage the kidneys. Examples include:
Neurotoxic agents damage the nervous system. The nervous system is especially sensitive to organometallic compounds and certain sulfide compounds. Examples include:

<table>
<thead>
<tr>
<th>- Halogenated hydrocarbons</th>
<th>- Uranium compounds</th>
</tr>
</thead>
</table>

- Trialkyl tin compounds  
- Tetraethyl lead  
- Methyl mercury  
- Carbon disulfide  
- Organic phosphorus insecticides  
- Thallium  
- Manganese

Some toxic agents act on the blood or hematopoietic system. The blood cells can be affected directly or the bone marrow (which produces the blood cells) can be damaged. Examples include:

<table>
<thead>
<tr>
<th>- Nitrites</th>
<th>- Aniline</th>
<th>- Toluidine</th>
</tr>
</thead>
</table>

- Nitrobenzene  
- Benzene

There are toxic agents that produce damage of the pulmonary tissue (lungs) but not by immediate irritant action. Fibrotic changes can be caused by free silica and asbestos. Other dusts can cause a restrictive disease called pneumoconiosis. Examples include:

<table>
<thead>
<tr>
<th>- Coal dust</th>
<th>- Cotton dust</th>
<th>- Wood dust</th>
</tr>
</thead>
</table>

A carcinogen is an agent that can initiate or increase the proliferation of malignant neoplastic cells or the development of malignant or potentially malignant tumors. Known human carcinogens include:
<table>
<thead>
<tr>
<th>Mutagen</th>
<th>Teratogen</th>
<th>Sensitizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Asbestos</td>
<td>- 4-nitrophenyl</td>
<td>- Lead</td>
</tr>
<tr>
<td>- Alpha-naphtylamine</td>
<td>- Methyl chloromethyl ether</td>
<td>- Thalidomide</td>
</tr>
<tr>
<td>- 3,3’-Dichlorobenzidine</td>
<td>- Bis-chloromethyl ether</td>
<td></td>
</tr>
<tr>
<td>- Vinyl chloride</td>
<td>- Inorganic arsenic</td>
<td></td>
</tr>
<tr>
<td>- Ethylene oxide</td>
<td>- 1,2-Dibromo-3-chloropropane (DBCP)</td>
<td></td>
</tr>
<tr>
<td>- N-nitrosodimethylamine</td>
<td>- Coal tar pitch volatiles</td>
<td></td>
</tr>
</tbody>
</table>

A **mutagen** interferes with the proper replication of genetic material (chromosome strands) in exposed cells. If germ cells are involved, the effect may be inherited and become part of the genetic pool passed onto future generations.

A **teratogen** (embryotoxic or fetotoxic agent) is an agent, which interferes with normal embryonic development without causing a lethal effect to the fetus or damage to the mother. Effects are not inherited. Examples include:

- Lead
- Thalidomide

A **sensitizer** is a chemical, which can cause an allergic reaction in normal tissue after repeated exposure to the chemical. The reaction may be as mild as a rash (allergic dermatitis) or as serious as anaphylactic shock. Examples include:

- Epoxies
- Toluene diisocyanate
- Nickel compounds
- Chromium compounds
### 4.2 SOME TARGET ORGAN EFFECTS

The following is a categorization of target organ effects that may occur from chemical exposure. Signs and symptoms of these effects and examples of chemicals which have been found to cause such effects are listed.

<table>
<thead>
<tr>
<th>Toxins</th>
<th>Target organ effect</th>
<th>Signs and symptoms</th>
<th>Example chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatotoxins</td>
<td>Cause liver damage</td>
<td>Jaundice; liver enlargement</td>
<td>Nitrosamines, chloroform, toluene, perchloroethylene, cresol, dimethylsulfate</td>
</tr>
<tr>
<td>Nephrotoxins</td>
<td>Cause kidney damage</td>
<td>Edema; proteinuria</td>
<td>Halogenated hydrocarbons, uranium, chloroform, mercury, dimethylsulfate</td>
</tr>
<tr>
<td>Neurotoxins</td>
<td>Affect the nervous system</td>
<td>Narcosis; behavior changes; decreased muscle coordination</td>
<td>Mercury, carbon disulfide, benzene, carbon tetrachloride, lead, mercury, nitrobenzene</td>
</tr>
<tr>
<td>Hematopoietic toxins</td>
<td>Decrease blood function</td>
<td>Cyanosis; loss of consciousness</td>
<td>Carbon monoxide, cyanides, nitrobenzene, aniline, arsenic, benzene, toluene</td>
</tr>
<tr>
<td>Pulmonary toxins</td>
<td>Irritate or damage the lungs</td>
<td>Cough; tightness in chest, shortness of breath</td>
<td>Silica, asbestos, ozone, hydrogen sulfide, chromium, nickel, alcohols</td>
</tr>
<tr>
<td>Reproductive toxins</td>
<td>Affect the reproductive system</td>
<td>Birth defects; sterility</td>
<td>Lead, dibromodichloropropene</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Skin hazards</td>
<td>Affect the dermal layer of the body</td>
<td>Defatting of skin; rashes; irritation</td>
<td>Ketones, chlorinated compounds, alcohols, nickel, phenol, trichloroethylene</td>
</tr>
<tr>
<td>Eye hazards</td>
<td>Affect the eye or vision</td>
<td>Conjunctivitis, corneal damage</td>
<td>Organic solvents, acids, cresol, quinones, hydroquinone, benzyl chloride, butyl alcohol, bases</td>
</tr>
</tbody>
</table>

### 4.3 OCCUPATIONAL HEALTH STANDARDS

**TLV:** The **threshold limit value** is a recommended occupational exposure guideline published by the American Conference of Governmental Industrial Hygienists. TLV's are expressed as parts of vapor or gas per million parts of air by volume (ppm) or as approximate milligrams of particulate per cubic meter or air (mg/M³). The TLV is the average concentration of a chemical that most people can be exposed to for a working lifetime with no ill effects. The TLV is an advisory guideline. If applicable, a **ceiling concentration** (C) that should not be exceeded or a skin absorption notation (S) will be indicated with the TLV.

**PEL:** The **permissible exposure limit** is a legal standard issued by OSHA. Unless specified, the PEL is a time weighted average (TWA).

**TWA:** Most exposure standards are based on **time weighted averages**. The TWA is the average exposure over an eight (8) hour work day. Some substances have Ceiling (C) limits. Ceiling limits are concentrations that should never be exceeded.

The SDS will list the occupational health standard(s) for the hazardous chemical or each component of a mixture.
Section 5. GLOSSARY OF TERMS

**ACGIH** - The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLV's) for hundreds of chemicals, physical agents, and biological exposure indices.

**ACUTE** - Short duration, rapidly changing conditions.

**ACUTE EXPOSURE** - An intense exposure over a relatively short period of time.
ANSI - The American National Standards Institute is a voluntary membership organization (run with private funding) that develops consensus standards nationally for a wide variety of devices and procedures.

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

BOILING POINT - The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. The boiling point is usually expressed in degrees Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.

"C" OR CEILING - A description usually seen in connection with ACGIH exposure limits. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value-Ceiling. (See also THRESHOLD LIMIT VALUE).

CARCINOGEN - A substance or physical agent that may cause cancer in animals or humans.

C.A.S. NUMBER - Identifies a particular chemical by the Chemical Abstracts Service, a service of the American Chemical Society that indexes and compiles abstracts of worldwide chemical literature called Chemical Abstracts.

cc - Cubic centimeter, a volumetric measurement which is also equal to one milliliter (ml).

CHEMICAL - As broadly applied to the chemical industry, an element or a compound produced by chemical reactions on a large scale for either direct industrial and consumer use or for reaction with other chemicals.

CHEMICAL REACTION - A change in the arrangement of atoms or molecules to yield substances of different composition and properties. (see REACTIVITY)

CHRONIC - Persistent, prolonged or repeated conditions.

CHRONIC EXPOSURE - A prolonged exposure occurring over a period of days, weeks, or years.

COMBUSTIBLE - According to the DOT and NFPA, combustible liquids are those having a flash point at or above 100°F (37.8°C), or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances, and must be handled with caution. Substances such as wood, paper, etc., are termed "Ordinary Combustibles".

CONCENTRATION - The relative amount of a material in combination with another material. For example, 5 parts of (acetone) per million (parts of air).

CORROSIVE - A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.
CUBIC METER (m$^3$) - A measure of volume in the metric system.

CUTANEOUS - Pertaining to or affecting the skin.

DECOMPOSITION - The breakdown of a chemical or substance into different parts or simpler compounds. Decomposition can occur due to heat, chemical reaction, decay, etc.

DERMAL - Pertaining to or affecting the skin.

DERMATITIS - An inflammation of the skin.

DILUTION VENTILATION - See GENERAL VENTILATION.

DOT - The United States Department of Transportation is the federal agency that regulates the labeling and transportation of hazardous materials.

DYSPNEA - Shortness of breath; difficult or labored breathing.

OARS – Office of Academic and Research Safety.

EPA - The Environmental Protection Agency is the governmental agency responsible for administration of laws to control and/or reduce pollution of air, water, and land systems.

EPA NUMBER - The number assigned to chemicals regulated by the Environmental Protection Agency (EPA).

EPIDEMIOLOGY - The study of disease in human populations.

ERYTHEMA - A reddening of the skin.

EVAPORATION RATE - The rate at which a material is converted to vapor (evaporates) at a given temperature and pressure when compared to the evaporation rate of a given substance. Health and fire hazard evaluations of materials involve consideration of evaporation rates as one aspect of the evaluation.

°F - Degrees, Fahrenheit; a temperature scale.

FLAMMABLE LIQUID - According to the DOT and NFPA, a flammable liquid is one that has a flash point below 100°F. (See FLASH POINT)

<table>
<thead>
<tr>
<th>Classes of Flammable Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable Solvent Class</td>
</tr>
</tbody>
</table>

Northeastern University
<table>
<thead>
<tr>
<th>Class</th>
<th>Temperature 1</th>
<th>Temperature 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1A</td>
<td>&lt; 100°F</td>
<td>&lt; 73°F</td>
</tr>
<tr>
<td>Class 1B</td>
<td>&gt;= 100°F</td>
<td>&lt; 73°F</td>
</tr>
<tr>
<td>Class 1C</td>
<td>&gt;= 100°F</td>
<td>Between 73 and 100°F</td>
</tr>
</tbody>
</table>

**FLASH POINT** - The lowest temperature at which a liquid or a solid emits vapor sufficient to form an ignitable mixture with air near the surface of the liquid or the solid, and burn when a source of ignition (sparks, open flames, cigarettes, etc.) is present. Two tests are used to determine the flash point: open cup and closed cup. The test method is indicated on the SDS after the flash point.

**g** - See GRAM.

**GENERAL VENTILATION** - Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition (See LOCAL EXHAUST VENTILATION).

**g/Kg** - See GRAMS PER KILOGRAM.

**GRAM (g)** - A metric unit of weight. One ounce equals 28.4 grams.

**GRAMS PER KILOGRAM (g/Kg)** - This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 grams (of substance) per kilogram of body weight (of the experimental animal).

**HAZARDOUS MATERIAL** - Any substance or compound that has the capability of producing adverse effects on the health and safety of humans.

**IGNITABLE** - A solid, liquid or compressed gas that has a flashpoint of less than 140°F. Ignitable material may be regulated by the EPA as a hazardous waste, as well.

**INCOMPATIBLE** - The term applied to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

**INGESTION** - Taking a substance into the body through the mouth, such as food, drink, medicine, or unknowingly as in contaminated hands or cigarettes, etc.
**INHALATION** - Breathing in of an airborne substance that may be in the form of gases, fumes, mists, vapors, dusts, or aerosols.

**INHIBITOR** - A substance that is added to another to prevent or slow down an unwanted reaction or change.

**IRRITANT** - A substance that produces an irritating effect when it contacts skin, eyes, nose, or respiratory system.

**Kg** - See KILOGRAM.

**KILOGRAM (Kg)** - A unit of weight in the metric system equal to 2.2 pounds.

**L** - See LITER.

**LC\textsubscript{50}** - See LETHAL CONCENTRATION\textsubscript{50}.

**LD\textsubscript{50}** - See LETHAL DOSE\textsubscript{50}.

**LEL** - See LOWER EXPLOSIVE LIMIT.

**LETHAL CONCENTRATION\textsubscript{50}** - The concentration of an air contaminant (LC\textsubscript{50}) that will kill 50 percent of the test animals in a group during a single exposure.

**LETHAL DOSE\textsubscript{50}** - The dose of a substance or chemical that will (LD\textsubscript{50}) kill 50 percent of the test animals in a group within the first 30 days following exposure.

**LFL** - See LOWER EXPLOSIVE LIMIT.

**LITER (L)** - A measure of capacity. One quart equals 0.9 liters.

**LOCAL EXHAUST VENTILATION** - (Also known as exhaust ventilation.) A ventilation system that captures and removes the contaminants at the point where they are being produced before they escape into the workroom air. The system consists of hoods, ducts, a fan and possibly an air cleaning device. Advantages of local exhaust ventilation over general ventilation include: it removes the contaminant rather than dilutes it; it requires less air flow and thus is more economical over the long term; and the system can be used to conserve or reclaim valuable materials. However, the system must be properly designed with the correctly shaped and placed hoods, and correctly sized fans and ductwork.

**LOWER EXPLOSIVE LIMIT (LEL)** - (Also known as Lower Flammable Limit). The lowest concentration of a substance that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn. (See also UEL).

**m\textsuperscript{3}** - See CUBIC METER.
MELTING POINT - The temperature at which a solid changes to a liquid. A melting range may be given for mixtures.

mg - See MILLIGRAM.

mg/Kg - See MILLIGRAMS PER KILOGRAM.

mg/m³ - See MILLIGRAMS PER CUBIC METER.

MILLIGRAM (mg) - A unit of weight in the metric system. One thousand milligrams equal one gram.

MILLIGRAMS PER CUBIC METER - Units used to measure air (mg/m³) concentrations of dusts, gases, mists, and fumes.

MILLIGRAMS PER KILOGRAM - This indicates the dose of a substance (mg/kg) given to test animals in toxicity studies. For example, a dose may be 2 milligrams (of substance) per kilogram of body weight (of the experimental animal).

MILLILITER (ml) - A metric unit used to measure volume. One milliliter equals one cubic centimeter. One thousand milliliters equal one liter.

ml - See MILLILITER.

MSHA - The Mine Safety and Health Administration; a federal agency that regulates the mining industry in the safety and health area.

MUTAGEN - Anything that can cause a change (or mutation) in the genetic material of a living cell.

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

NFPA - The National Fire Protection Association is a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 704, NFPA Hazard Rating System. This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

NIOSH - The National Institute of Occupational Safety and Health is a federal agency that among its various responsibilities, trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

NU - Northeastern University.

ODOR THRESHOLD - The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

ORAL - Having to do with the mouth.
OSHA - The Occupational Safety and Health Administration - a federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.

OXIDATION - The process of combining oxygen with some other substance to a chemical change in which an atom loses electrons.

OXIDIZER - Is a substance that gives up oxygen easily to stimulate combustion of organic material.

OXYGEN DEFICIENCY - An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% v/v oxygen at sea level.

PEL - See PERMISSIBLE EXPOSURE LIMIT.

PERMISSIBLE EXPOSURE LIMIT (PEL) - An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short term exposure limit (STEL), or a ceiling (C). The PEL's are found in Tables Z-1, Z-2, or Z-3 of OSHA regulations 1910.1000. (See also TLV).

PERSONAL PROTECTIVE EQUIPMENT (PPE) - Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are respirators, gloves, and chemical splash goggles.

POLYMERIZATION - A chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction with an uncontrolled release of energy.

ppm - Parts (of vapor or gas) per million (parts of air) by volume.

REACTIVITY - A substance's susceptibility to undergo a chemical reaction or change that may result in dangerous side effects, such as explosions, burning and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on a SDS.

RESPIRATOR - A device that is designed to protect the wearer from inhaling harmful contaminants.

RESPIRATORY HAZARD - A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some bodily function impairment.

SENSITIZER - A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

SHORT TERM EXPOSURE LIMIT - Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times
throughout the day with at least one hour between exposures. Also the daily TLV-TWA must not be exceeded.

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

STEL - Short Term Exposure Limit.

SUBSTANCE - Any chemical entity.

SYNONYM - Another name by which the same chemical may be known.

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

TERATOGEN - An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.

THRESHOLD LIMIT VALUE - Airborne concentrations of substances devised by the ACGIH that represent conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLV's are advisory exposure guidelines, not legal standards that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLV's: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL) and Ceiling (TLV-C). (See also PEL.)

TIME WEIGHTED AVERAGE - The average time, over a given work period (e.g., 8-hour work day), of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the time period. Represented as TLV-TWA.

TLV - See THRESHOLD LIMIT VALUE.

TOXICITY - The potential for a substance to exert a harmful effect on humans or animals and a description of the effect and the conditions or concentrations under which the effect takes place.

TRADE NAME - The commercial name or trademark by which a chemical is known. One chemical may have a variety of trade names depending on the manufacturers or distributors involved.

TWA - See TIME WEIGHTED AVERAGE.

UEL - See UPPER EXPLOSIVE LIMIT.

UFL - See UPPER EXPLOSIVE LIMIT.

UNSTABLE LIQUID - A liquid that, in its pure state or as commercially produced, will react vigorously in some hazardous way under shock conditions (e.g., dropping), certain temperatures, or pressures.
UPPER EXPLOSIVE LIMIT - Also known as Upper Flammable Limit. Is the highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically, above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is 1ppm and the UEL is 5ppm, then the explosive range of the chemical is 1ppm to 5ppm. (see also LEL).

VAPOR - The gaseous form of substances that are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with low boiling points will evaporate.
Appendix A. LABORATORY CHEMICAL HYGIENE PLAN

Chemicals Requiring Prior Approval

I. Acutely Toxic Gases

The pressurized hazardous gases identified below have been classified as particularly hazardous and require prior approval for purchasing of new materials, or handling and storage of existing material. See Section 1.11, Research Protocol Review, for the approval procedure.

Pressurized Gases Requiring Review

<table>
<thead>
<tr>
<th>Compound</th>
<th>Exempt Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsine and gaseous derivatives</td>
<td>None</td>
</tr>
<tr>
<td>Chloropicrin in gas mixtures</td>
<td>None</td>
</tr>
<tr>
<td>Cyanogen chloride</td>
<td>None</td>
</tr>
<tr>
<td>Cyanogen</td>
<td>None</td>
</tr>
<tr>
<td>Diborane</td>
<td>None</td>
</tr>
<tr>
<td>Germane</td>
<td>None</td>
</tr>
<tr>
<td>Hexaethyltetraphosphate</td>
<td>None</td>
</tr>
<tr>
<td>Hydrogen cyanide</td>
<td>None</td>
</tr>
</tbody>
</table>
II. Regulated Chemicals & Chemicals with High Chronic Toxicity

The substances listed in the table below (titled "Regulated Chemicals & Chemicals with High Chronic Toxicity Requiring Special Procedures") when stored or handled in quantities exceeding the exempt quantities must be stored and handled according to the special procedures outlined in Section 3.6.2. If it is not possible to utilize these procedures the proposed alternative procedures must be reviewed and approved by the NU Chemical Hygiene Officer prior to initiating the research. See Section 1.11, Research Protocol Chemical Safety Review and Registration, for the approval procedure. If you are using any of these substances in quantities less than the exempt amount, use the procedures outlined in Section 3.5.2, Chemicals of High Acute or Chronic Toxicity.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Exempt Quantity</th>
<th>OSHA Regulated Substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-Acetoxy-2-acetylaminofluorene</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

(See Note 1 Below)
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Rating</th>
<th>Carcinogenicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Acetylaminofluorene</td>
<td>2</td>
<td>Y</td>
</tr>
<tr>
<td>Acrylonitrile</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>Aflatoxins</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>o-Aminoazotoluene</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4-Aminodiphenyl</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>2-Aminofluorene</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Asbestos</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>Arsenic and arsenic compounds</td>
<td>2</td>
<td>Y</td>
</tr>
<tr>
<td>Azathiopurine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Benz[a]anthracene</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>Benzidine</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>Benzo[a]pyrene</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Chemical Name</td>
<td>Frequency</td>
<td>Status</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td>Bromoethyl methanesulfonate</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1,4-Butanediol dimethanesulfonate (myleran)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Chlorambucil</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N,N-bis(2-chloroethyl)-2-naphthylamine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>bis-Chloromethyl ether</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cycasin</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cyclophosphamide</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Diazomethane</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Dibenzo[a,h]anthracene</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1,2-Dibromo-3-chloropropane</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>Chemical Name</td>
<td>Code</td>
<td>Indicator</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>------</td>
<td>-----------</td>
</tr>
<tr>
<td>3,3'-Dichlorobenzidine (&amp; its salts)</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>Diepoxybutane</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4-Dimethylaminoazobenzene</td>
<td>2</td>
<td>Y</td>
</tr>
<tr>
<td>7,12-Dimethylbenz[a]anthracene</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3,3'-Dimethylbenzidine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1,1-Dimethylethlenimine</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1,1-Dimethylhydrizine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1,2-Dimethylhydrizine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1,4-Dinitrosopiperazine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>p-Dioxane</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ethylene dibromide</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ethyleneimide</td>
<td>2</td>
<td>Y</td>
</tr>
<tr>
<td>Ethyl methanesulfonate</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Chemical Name</td>
<td>No.</td>
<td>Status</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----</td>
<td>--------</td>
</tr>
<tr>
<td>Ethylene oxide</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>Ethionine</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ethylenimine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>Hexavalent chromium and chromium compounds</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hydrazine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Hydroxy-2-acetylaminofluorene</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Lead and lead compounds</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>Mercury and Mercury salts</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>3'-Methyl-4-aminoazobenzene</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Methyl chloromethyl ether</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3-Methylcholanthrene</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4,4'-Methylene bis(2-chloroaniline)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Chemical Name</td>
<td>Code</td>
<td>(1)</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>------</td>
<td>-----</td>
</tr>
<tr>
<td>Methylhydrazine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Methyl mercury</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Methyl methanesulfonate</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1-Methyl-3-nitro-1-nitrosoguanidine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>alpha-Naphthylamine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>beta-Naphthylamine</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4-Nitrobiphenyl</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>N-[4-(5-nitro-2-furyl)-2-thiazoyl]-formamide</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4-Nitroquinoline-1-oxide</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Nitrosodiethylamine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Nitrosodimethylamine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Nitrosodi-n-butylamine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Nitrosodi-n-propylamine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Compound</td>
<td>Code</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>N-Nitroso-N-ethylurea</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Nitroso-N-ethylurethane</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Nitroso-N-methylurea</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Nitroso-N-methylurethane</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>N-Nitrosopiperidine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Polychlorinated biphenyls</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Procarbazine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1,3-Propane sulfone</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>beta-Propiolactone</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Propylenimine</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Thorium dioxide</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>m-Toluenediamine</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Uracil mustard</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For Laboratory Storage</td>
<td>For Laboratory Use</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>&lt;1 liter or 1000 grams</td>
<td>&lt;50 milliliters or 50 grams</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>&lt;0.1 liter or 100 grams</td>
<td>&lt;5 milliliters or 5 grams</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

Note 1 - The exempt quantities are defined as:
Appendix B. LIST OF CARCINOGENS

The following are substances either known to be human carcinogens or which may reasonably be anticipated to be carcinogens (suspect carcinogens). The latest delisted substances as reported from the 14th Annual Report on Carcinogens, National Toxicology Program (2016) are also included.

"Known carcinogens" are defined as those substances for which the evidence from human studies indicates that there is a causal relationship between exposure to the substance and human cancer.

Substances which are "suspect carcinogens" are defined as those for which there is limited evidence of carcinogenicity in humans or sufficient evidence of carcinogenicity in experimental animals.


Carcinogens Listed in the Fourteenth Report

Bold entries indicate new or changed listings in the Fourteenth Report on Carcinogens

Part A. Known to be Human Carcinogens.

Aflatoxins
Alcoholic Beverage Consumption
4-Aminobiphenyl
Analgesic Mixtures Containing Phenacetin (see Phenacetin and Analgesic Mixtures Containing Phenacetin)
Aristolochic Acids
Arsenic and Inorganic Arsenic Compounds
Asbestos
Azathioprine
Benzene
Benzidine (see Benzidine and Dyes Metabolized to Benzidine)
Beryllium and Beryllium Compounds
Bis(chloromethyl) Ether and Technical-Grade Chloromethyl Methyl Ether
1,3-Butadiene
1,4-Butanediol Dimethanesulfonate
Cadmium and Cadmium Compounds
Chlorambucil
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (see Nitrosourea Chemotherapeutic Agents)
Chromium Hexavalent Compounds
Coal Tars and Coal-Tar Pitches
Coke-Oven Emissions
Cyclophosphamide
Cyclosporin A
Diethylstilbestrol
Dyes Metabolized to Benzidine (Benzidine Dye Class) (see Benzidine and Dyes Metabolized to Benzidine)
**Epstein-Barr Virus** (see Viruses: Eight Listings)
Erionite
Estrogens, Steroidal
Ethylene Oxide
Formaldehyde
Hepatitis B Virus (see Viruses: Eight Listings)
Hepatitis C Virus (see Viruses: Eight Listings)
**Human Immunodeficiency Virus Type 1** (see Viruses: Eight Listings)
Human Papillomaviruses: Some Genital-Mucosal Types (see Viruses: Eight Listings)
**Human T-Cell Lymphotrophic Virus Type 1** (see Viruses: Eight Listings)
Kaposi Sarcoma–Associated Herpesvirus (see Viruses: Eight Listings)
Melphalan
**Merkel Cell Polyomavirus** (see Viruses: Eight Listings)
Methoxsalen with Ultraviolet A Therapy
Mineral Oils: Untreated and Mildly Treated
Mustard Gas
2-Naphthylamine
Neutrons (see Ionizing Radiation)
Nickel Compounds (see Nickel Compounds and Metallic Nickel)
Radon (see Ionizing Radiation)
Silica, Crystalline (Respirable Size)
Solar Radiation (see Ultraviolet Radiation Related Exposures)
Soots
Strong Inorganic Acid Mists Containing Sulfuric Acid
Sunlamps or Sunbeds, Exposure to (see Ultraviolet Radiation Related Exposures)
Tamoxifen
2,3,7,8-Tetrachlorodibenzo-p-dioxin
Thiotepa
Thorium Dioxide (see Ionizing Radiation)
Tobacco Smoke, Environmental (see Tobacco-Related Exposures)
Tobacco Smoking (see Tobacco-Related Exposures)
Tobacco, Smokeless (see Tobacco-Related Exposures)
α-Toluidine
**Trichloroethylene**
Ultraviolet Radiation, Broad-Spectrum (see Ultraviolet Radiation Related Exposures)
Vinyl Chloride (see Vinyl Halides [selected])
Wood Dust
X-Radiation and Gamma Radiation (see Ionizing Radiation)
Part B. Reasonably Anticipated to Be Human Carcinogens

- Acetaldehyde
- 2-Acetylaminofluorene
- Acrylamide
- Acrylonitrile
- Adriamycin
- 2-Aminoanthraquinone
- o-Aminoazoxytoluene
- 1-Amino-2,4-dibromoanthraquinone
- 2-Amino-3,4-dimethylimidazo[4,5-f]quinoline (see Heterocyclic Amines [Selected])
- 2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline (see Heterocyclic Amines [Selected])
- 1-Amino-2-methylanthraquinone
- 2-Amino-3-methylimidazo[4,5-f]quinoline (see Heterocyclic Amines [Selected])
- 2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (see Heterocyclic Amines [Selected])
- Amitrole
- o-Anisidine and Its Hydrochloride
- Azacitidine
- Basic Red 9 Monohydrochloride
- Benz[a]anthracene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Benzo[b]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Benzo[j]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Benzo[k]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Benzo[a]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Benzotrichloride
- 2,2-Bis(bromomethyl)-1,3-propanediol (Technical Grade)
- Bis(chloroethyl) Nitrosourea (see Nitrosourea Chemotherapeutic Agents)
- Bromodichloromethane
- 1-Bromopropane
- Butylated Hydroxyanisole
- Captafol
- Carbon Tetrachloride
- Ceramic Fibers (Respirable Size)
- Chloramphenicol
- Chlorendic Acid
- Chlorinated Paraffins (C12, 60% Chlorine)
- Chloroform
- 1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (see Nitrosourea Chemotherapeutic Agents)
- 3-Chloro-2-methylpropene
- 4-Chloro-o-phenylenediamine Chloroprene
- p-Chloro-o-toluidine and Its Hydrochloride
- Chlorozotocin (see Nitrosourea Chemotherapeutic Agents)
- Cisplatin

**Cobalt and Cobalt Compounds That Release Cobalt Ions In Vivo** (see Cobalt-Related Exposures)
Cobalt–Tungsten Carbide: Powders and Hard Metals (see Cobalt-Related Exposures)

- p-Cresidine
- Cumene
- Cupferron
- Dacarbazine
- Danthron
- 2,4-Diaminoanisole Sulfate
- 2,4-Diaminotoluene
- Diazoaminobenzene
- Dibenz[a,h]acridine (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Dibenz[a,j]acridine (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Dibenz[a,h]anthracene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- 7H-Dibenzo[c,g]carbazole (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Dibenzo[a,e]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Dibenzo[a,h]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Dibenzo[a,i]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- Dibenzo[a,l]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
- 1,2-Dibromo-3-chloropropane
- 1,2-Dibromoethane
- 2,3-Dibromo-1-propanol
- 1,4-Dichlorobenzene
- 3,3'-Dichlorobenzidine and Its Dihydrochloride
- Dichlorodiphenyltrichloroethane
- 1,2-Dichloroethane
- Dichloroethylene
- 1,3-Dichloropropene (Technical Grade)
- Diepoxybutane
- Diesel Exhaust Particulates
- Di(2-ethylhexyl) Phthalate
- Diethyl Sulfate
- Diglycidyl Resorcinol Ether
- 3,3'-Dimethoxybenzidine (see 3,3'-Dimethoxybenzidine and Dyes Metabolized to 3,3'-Dimethoxybenzidine)
- 4-Dimethylaminoazobenzene
- 3,3'-Dimethylbenzidine (see 3,3'-Dimethylbenzidine and Dyes Metabolized to 3,3'-Dimethylbenzidine)
- Dimethylcarbamoyl Chloride
- 1,1-Dimethylhydrazine
- Dimethyl Sulfate
- Dimethylvinyl Chloride
- 1,6-Dinitropyrene (see Nitroarenes [Selected])
- 1,8-Dinitropyrene (see Nitroarenes [Selected])
- 1,4-Dioxane
- Disperse Blue 1
Northeastern University

Dyes Metabolized to 3,3′-Dimethoxybenzidine (3,3′-Dimethoxybenzidine Dye Class) (see 3,3′-Dimethoxybenzidine and Dyes Metabolized to 3,3′-Dimethoxybenzidine)

Dyes Metabolized to 3,3′-Dimethylbenzidine (3,3′-Dimethylbenzidine Dye Class) (see 3,3′-Dimethylbenzidine and Dyes Metabolized to 3,3′-Dimethylbenzidine)

Epichlorohydrin
Ethylene Thiourea
Ethyl Methanesulfonate
Furan
Glass Wool Fibers (Inhalable), Certain
Glycidol
Hexachlorobenzene
Hexachloroethane
Hexamethylphosphoramide
Hydrazine and Hydrazine Sulfate
Hydrazobenzene
Indeno[1,2,3-cd]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Iron Dextran Complex
Isoprene
Kepone
Lead and Lead Compounds
Lindane, Hexachlorocyclohexane (Technical Grade), and Other Hexachlorocyclohexane Isomers
2-Methylaziridine
5-Methylchrysene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
4,4′-Methylenebis(2-chloroaniline)
4,4′-Methylenebis(N,N-dimethyl)benzenamine
4,4′-Methylenedianiline and Its Dihydrochloride
Methyleugenol
Methyl Methanesulfonate
N-Methyl-N′-Nitro-N-Nitrosoguanidine (see N-Nitrosamines: 15 Listings)
Metronidazole
Michler’s Ketone
Mirex
Naphthalene
Nickel, Metallic (see Nickel Compounds and Metallic Nickel)
Nitrilotriacetic Acid
α-Nitroanisole
Nitrobenzene
6-Nitrochrysene (see Nitroarenes [Selected])
Nitrofen
Nitrogen Mustard Hydrochloride
Nitromethane
2-Nitropropane
1-Nitropyrene (see Nitroarenes [Selected])
4-Nitropyrene (see Nitroarenes [Selected])
N-Nitrosodi-n-butylamine (see N-Nitrosamines: 15 Listings)
N-Nitrosodiethanolamine (see N-Nitrosamines: 15 Listings)
N-Nitrosodiethylamine (see N-Nitrosamines: 15 Listings)
N-Nitrosodimethylamine (see N-Nitrosamines: 15 Listings)
N-Nitrosodi-n-propylamine (see N-Nitrosamines: 15 Listings)
N-Nitroso-N-ethylurea (see N-Nitrosamines: 15 Listings)
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone (see N-Nitrosamines: 15 Listings)
N-Nitroso-N-methylurea (see N-Nitrosamines: 15 Listings)
N-Nitrosomethylvinylamine (see N-Nitrosamines: 15 Listings)
N-Nitrosomorpholine (see N-Nitrosamines: 15 Listings)
N-Nitrosomononocotine (see N-Nitrosamines: 15 Listings)
N-Nitrosopiperidine (see N-Nitrosamines: 15 Listings)
N-Nitrosopyrrolidine (see N-Nitrosamines: 15 Listings)
N-Nitrososarcosine (see N-Nitrosamines: 15 Listings)
o-Nitrotoluene
Norethisterone
Ochratoxin A
4,4′-Oxydianiline
Oxymetholone
Pentachlorophenol and By-products of Its Synthesis
Phenacetin (see Phenacetin and Analgesic Mixtures Containing Phenacetin)
Phenazopyridine Hydrochloride
Phenolphthalein
Phenoxybenzamine Hydrochloride
Phenyltoin and Phenytoin Sodium
Polybrominated Biphenyls
Polychlorinated Biphenyls
Procarbazine and Its Hydrochloride
Progesterone
1,3-Propane Sultone
β-Propiolactone
Propylene Oxide
Propylthiouracil
Reserpine
Riddelliine
Safrole
Selenium Sulfide
Streptozotocin (see Nitrosourea Chemotherapeutic Agents)
Styrene
Styrene-7,8-oxide
Sulfonate
Tetrachloroethylene
Tetrafluoroethylene
Tetranoitromethane
Thioacetamide
4,4′-Thiodianiline
Thiourea
Toluene Diisocyanates
Toxaphene
2,4,6-Trichlorophenol
1,2,3-Trichloropropane
Tris(2,3-dibromopropyl) Phosphate
Ultraviolet Radiation A (see Ultraviolet Radiation Related Exposures)
Ultraviolet Radiation B (see Ultraviolet Radiation Related Exposures)
Ultraviolet Radiation C (see Ultraviolet Radiation Related Exposures)
Urethane
Vinyl Bromide (see Vinyl Halides [Selected])
4-Vinyl-1-cyclohexene Diepoxide
Vinyl Fluoride (see Vinyl Halides [Selected])
Appendix C. OSHA's LABORATORY HEALTH STANDARD

"Occupational Exposures to Hazardous Chemicals in Laboratories"

29 CFR 1910.1450

The Laboratory Health Standard requires laboratories to develop procedures which help to ensure that occupational exposure to hazardous chemicals in the laboratory environment is reduced or minimized.

OSHA summarizes the intent of the standard in the preamble:

"The new standard differs from many OSHA health standards in that it does not establish new exposure limits, but sets other performance provisions designed to protect laboratory workers from potential hazards in their work environment. By permitting a greater degree of flexibility to laboratories in developing and implementing employee safety and health programs, OSHA expects benefits to result from increased worker awareness of potential risks, improved work practices, appropriate use of existing personal protective equipment and greater use of engineering controls. Given the flexibility to design and implement innovative measures to reduce employee exposure to hazardous substances, employers also will reap rewards in terms of lower insurance premiums, lower property damage costs, lower turnover costs, less absenteeism and, in general, increased productivity. Finally, the potential decrease in acute and chronic health problems will result in overall benefits to society through the associated reduction in medical and productivity costs."

This quote summarizes the basic goals and approach of the Laboratory Health Standard. It is primarily a performance-oriented standard, allowing individual laboratories to tailor their approaches to meeting the requirements of the standard to their individual circumstances.

The text of the standard, including the appendices, is included for reference purposes into this Chemical Hygiene Plan.

Link to Federal Standard: [Occupational Exposures to Hazardous Chemicals in Laboratories](#)
Appendix D. LABORATORY SAFETY REFERENCE MATERIAL

The following are good chemical safety and general laboratory safety references. Those with a CALL #, are available through the Snell Library.

1. Corp author OSHA, Employer rights and responsibilities following an OSHA inspection, Washington, DC: The Administration, Latest Received: Year 2002 [CALL # L 35.2: EM 7/3].
7. Corp author OSHA, All about OSHA. Washington, DC: US Dept. of Labor, Occupational Safety and Health Administration, Identity 000001, L 35.2:OC 1/2/ LIB HAS, Latest Received: 2000, [CALL # L 35.2: OC 1/2].
13. Corp author OSHA, OSHA inspections. Washington, DC: US Dept. of Labor, Occupational Safety and Health Administration, [CALL # L 35.2: IN 7].


72. American Conference of Governmental Industrial Hygienists. *Threshold Limit Values and Biological Exposure Indices*. ACGIH, P.O. Box 1937, Cincinnati, OH 45201.


Appendix E. ACUTELY TOXIC CHEMICAL STANDARD OPERATING PROCEDURES

For certain hazards and classes of chemicals not covered under the General Standard Operating Procedures for Working with Chemicals, principal investigators and department safety officers/laboratory supervisors must develop their own site specific standard operating procedures. These site specific standard operating procedures must be kept in this appendix, a binder visible in the laboratory or electronically saved to the laboratory BioRAFT profile. Refer to the university’s standard operating procedure template:

Standard Operating Procedure

Acutely Toxic Materials, Reproductive Toxic Materials, Target Organ Toxics, and Carcinogens

This is a Standard Operating Procedure (SOP) template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol is added to the protocol section and 3) SOP has been signed and dated by the PI and relevant lab personnel.

Print or save a copy and insert into your Lab-Specific Chemical Hygiene Plan.

Section 1 – Lab-Specific Information

<table>
<thead>
<tr>
<th>Chemical(s) covered by this SOP:</th>
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</thead>
<tbody>
<tr>
<td>Building/Room(s) covered by this SOP:</td>
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</tr>
<tr>
<td>Department:</td>
<td>Click here to enter a date.</td>
</tr>
<tr>
<td>Principal Investigator Name:</td>
<td>Click here to enter a date.</td>
</tr>
<tr>
<td>Principal Investigator Signature:</td>
<td>Click here to enter text.</td>
</tr>
</tbody>
</table>

Important Definitions

- **Acutely Toxic Material**: Substances that may be fatal or cause damage to target organs as the result of a single exposure or exposure of short duration. Acute toxins are quantified by substance’s LD50 or LC50.
- **Carcinogen**: A chemical is considered to be a carcinogen if:
  a. It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or
  b. It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (Latest edition); or
  c. It is regulated by OSHA as a carcinogen.
- **Immediately Dangerous to Life and Health (IDLH)**: The airborne concentration of a contaminant that poses an immediate threat to life and health likely to cause death of immediate or delayed permanent adverse health effects or prevent escape from such an environment.
• **Lethal Concentration-50 (LC50):** The concentration of a substance that, when administered to a group of experimental animals, will kill 50% of the group in a specified time.

• **Lethal Dose-50 (LD50):** The amount of a substance that, when administered to a group of experimental animals, will kill 50% of the group in a specified time.

• **Permissible Exposure Limit (PEL):** The maximum amount or concentration of a chemical that a worker may be exposed to under OSHA regulations. PELs are based on an 8-hour time weighted average (TWA) exposure.

• **Reproductive Toxic Material:** Substances that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogens).

• **Target Organ Toxic Material:** Substances that pose adverse health effects to specific organs such as the liver, kidneys, lungs, etc.

• **Toxic Chemical:** A chemical falling within any of the following categories:
  
  a. A chemical that has a median lethal dose (LD50) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
  
  b. A chemical that has a median lethal dose (LD50) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
  
  c. A chemical that has a median lethal concentration (LC50) in air of more than 200 parts per million but not more than 2,000 parts per million of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter 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.

**Section 2 – Hazards**

These substances are highly toxic by inhalation, ingestion, or skin absorption. Many acutely toxic chemicals are also carcinogenic and may have other hazards such as target organ effect, pose an environmental hazard, and/or corrosivity, etc. Make sure that all of the potential hazards are clearly understood before handling any toxic chemical.

**Section 3 – Engineering Controls and Personal Protective Equipment (PPE)**

**Engineering Controls:** Use of acutely toxic materials must be conducted in a properly functioning chemical fume. The chemical fume hood must be approved for use by the Office of Academic and Research Safety (OARS).

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended. It is critical that the glove being worn is resistant to the particular acutely toxic chemical. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.
**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Flame resistant lab coats must be worn when handling volumes greater than 1 liter. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If toxic materials are being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact OARS at oars@northeastern.edu so a respiratory protection analysis can be performed.

**Section 4 – Special Handling and Storage Requirements**

- Designate storage area for acutely toxic chemicals and post the area with a “Caution, Carcinogen, Reproductive Toxins, or Extremely Toxic Chemicals” label (example shown on previous page).
- Suitable storage locations include lab cabinets, desiccators, glove boxes, flammable storage cabinets that do not contain incompatible chemicals (primarily strong acids), or non-domestic refrigerators or freezers.
- Store acutely toxic materials in secondary containment at all times as a precautionary measure.
- Make a current copy of the SDS for the specific acutely toxic chemical(s) being used available to all personnel working in the laboratory at all times.
- Keep the amount of acutely toxic material stored in the lab at a minimum.
- Dispose of any expired or unnecessary materials as hazardous waste.
- Label all acutely toxic materials clearly with the original manufacturer’s label, which should have the chemical name, hazard labels, and pictograms. The label should not be defaced in any way.
- Do not over purchase; only purchase what can be safely stored and used in the laboratory.
- Avoid contact with skin, eyes, and inhalation.
- Keep away from sources of ignition.
- Keep containers tightly closed. Store in a cool, dry, and well-ventilated area away from incompatible substances such as strong acids.

**Section 5 – Spill and Accident Procedures**

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and use the SafeZone app or dial NUPD at 617-373-3333. Dial 911 at satellite locations, including Burlington and Nahant. If personnel have become exposed and need medical assistance, dial NUPD at 617-373-3333. Dial 911 at satellite locations, including Burlington and Nahant. If the spill is minor and does not pose a threat to personnel (i.e. in a chemical fume hood), locate the nearest spill kit and use the included materials to contain the spill as necessary, and contact OARS at 617-373-2769 during normal business hours (Monday – Friday, 8 AM – 5 PM) for spill cleanup assistance (dial NUPD at 617-373-3333 if spill occurs after hours and assistance is needed).

**Section 6 – Waste Disposal Procedures**

All acutely toxic chemical waste must be collected for proper waste disposal by OARS (sink disposal is not permitted). Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). No toxic materials are permitted to be poured down the drain. Submit a Hazardous Waste Pick-up Request to arrange for disposal by OARS.
Section 7 – Protocol/Procedure (Additional lab protocol to be added here)

#1

THIS STANDARD OPERATING PROCEDURE (SOP) IS FOR:

Generic use of specific chemical or class of chemicals with similar hazards
Examples: carbon tetrachloride, rotenone, tamoxifen, etc..

Please provide vendor, generic chemical name, trade name, dosages/concentrations used, total stock volume on hand.

#2

PROCESS OR EXPERIMENT DESCRIPTION

Provide a brief description of your process or experiment, including its purpose. Do not provide a detailed sequential description as this will be covered by section #5 of this template. Indicate the frequency and duration below. [PRECEDING GUIDANCE TEXT MAY BE DELETED.]

Frequency:

- □ one time
- □ daily
- □ weekly
- □ monthly
- □ other:________________

Duration per Experiment

__________ minutes; or _______ hours

#3

SAFETY LITERATURE REVIEW & HAZARD SUMMARY

[FOLLOWING GUIDANCE TEXT MAY BE DELETED]

1. List all physical and health hazards associated with the materials and procedures used in this SOP. Examples of potential hazards include: toxicity, reactivity, flammability, corrosivity, pressure, etc.

2. List all references you are using for the safe and effective design of your process or experiment, including safety literature and peer-reviewed journal articles.

- Furr, A. Keith. *CRC Handbook of Laboratory Safety*.
- Hall, Stephen K. *Chemical Safety in the Laboratory*.
### STORAGE REQUIREMENTS

Describe special handling and storage requirements for hazardous chemicals in your laboratory, especially for highly reactive/unstable materials, highly flammable materials, and corrosives.

### STEP-BY-STEP OPERATING PROCEDURE

[FOLLOWING GUIDANCE TEXT MAY BE DELETED]

1. For each step’s description, include any step-specific hazard, personal protective equipment, engineering controls, and designated work areas in the left hand column.

   a. Guidance on Engineering and Ventilation Controls – Review safety literature and peer-reviewed journal articles to determine appropriate engineering and ventilation controls for your process or experiment.
   b. Guidance on Personal Protective Equipment - Respiratory protection is generally not required for lab research, provided the appropriate engineering controls are employed.
   c. Designated work area(s) - Required whenever carcinogens, highly acutely toxic materials, or reproductive toxins are used. The intent of a designated work area is to limit and minimize possible sources of exposure to these materials. The entire laboratory, a portion of the laboratory, or a laboratory fume hood or bench may be considered a designated area.

2. Describe the possible risks involved with failure to follow a step in the SOP in the right hand column.

<table>
<thead>
<tr>
<th>Step-by-Step Description of Your Process or Experiment</th>
<th>Potential Risks if Step is Not Done or Done Incorrectly (if any)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Don personal protective equipment.</td>
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<tr>
<td>□ appropriate street clothing (long pants, close-toed shoes)</td>
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<tr>
<td>□ gloves; indicate type: _______________________________</td>
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<tr>
<td>□ safety goggles □ safety glasses □ face shield</td>
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<tr>
<td>□ mask/respirator</td>
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</tr>
</tbody>
</table>
2. Check the location/accessibility/certification of the safety equipment that serves your lab:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>STATUS</th>
</tr>
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</table>
| Laboratory Fume Hood/Glove Box or other Ventilation Control         | Location: ___________
|                                                                      | *Check sticker to ensure that hood was certified within last 12 months.* |
| Eyewash/Safety Shower                                               | Location: ___________
|                                                                      | *Ensure that it is accessible, not blocked.* |
| First Aid Kit                                                       | Location: ___________
| Chemical Spill Kit                                                  | Location: ___________
| Fire Extinguisher                                                   | Location: ___________
| Telephone:                                                          |         |
| Fire Alarm Manual Pull Station                                      | Location: ___________

3. Describe the next step in the procedure.

4. Describe the next step in the procedure.

5. Dispose of hazardous solvents, solutions, mixtures, and reaction residues as hazardous waste.

6. Clean up work area and lab equipment.
   *Describe specific cleanup procedures for work areas and lab equipment that must be performed after completion of your process or experiment. For carcinogens and reproductive toxins, designated areas must be immediately wiped down following each use.*

7. Remove PPE and wash hands.
EMERGENCY PROCEDURES

Health-Threatening Emergencies (ex: fire, explosion, health-threatening hazardous material contact/spill or release, compressed gas leak, or valve failure)

IF THERE IS A MAJOR SPILL:
1. Attend to injured or contaminated persons and remove them from exposure.
2. Alert people in the laboratory to evacuate.
3. If spilled material is flammable, turn off ignition and heat sources. Place other device (plastic bag) over spilled material to keep substance from volatilizing.
4. Call NUPD at 617-373-3333. Dial 911 at satellite locations, including Burlington and Nahant.
5. Close doors to affected area.
6. Have a person with knowledge of the incident and laboratory available to answer questions from responding emergency personnel.
7. Once personal safety is established, call OARS at 617-373-2769.
8. Provide local notifications:
   - Identify the area management staff that must be contacted and include their work and home numbers. This must include the principal investigator and may include the lab safety officer, department safety officer, facilities manager, and/or business manager.

If personnel exposed or injured:
1. Remove the injured/exposed individual from the area, unless it is unsafe to do so because of the medical condition of the victim or the potential hazard to rescuers.
2. Call NUPD at 617-373-3333 if immediate medical attention is required. Dial 911 at satellite locations, including Burlington and Nahant.
3. Administer first aid as appropriate.
4. Flush contamination from eyes/skin using the nearest emergency eyewash/shower for a minimum of 15 minutes. Remove any contaminated clothing.
5. Bring individual to the emergency room/employee health with copies of SDSs for all chemicals the victim was exposed to.
6. Call OARS at 617-373-2769 to report the exposure.

B. Non-Health Threatening Emergencies

For students with non-health threatening injuries and exposures:

Call the Northeastern University Health and Counseling Services at 617-373-2772 for more information and to schedule an appointment.

For staff/faculty with non-health threatening injuries and exposures:

Contact your health care provider for more information and to schedule an appointment.

C. Small Spills/Local Cleanup:
In the event of a minor spill or release that can be cleaned up by local personnel using readily available equipment (absorbent, Spill Kit):

1. Alert people in the immediate area of spill.
2. Increase ventilation in the area of spill (open windows, turn on hoods).
3. Wear personal protective equipment, including safety goggles, gloves and long-sleeved lab coat.
4. Avoid breathing vapors from spill.
5. Use appropriate kit to neutralize and absorb inorganic acids and bases. Collect residue, place in container, and dispose as hazardous chemical waste.
6. For other chemicals, use appropriate kit or absorb spill with vermiculite, dry sand, diatomaceous earth or paper towels. Collect residue, place in container, and dispose as chemical waste.
7. Clean spill area with water.

D. Building Maintenance Emergencies (e.g., power outages, plumbing leaks):

Call Facilities 617-373-2754

---

### WASTE DISPOSAL

Describe the quantities of waste you anticipate generating and appropriate waste disposal procedures. Include any special handling or storage requirements for your waste. Contact Andrew Sullivan at 617-373-6030 for questions and additional guidance.

---

### TRAINING REQUIREMENTS

**General Training (check all that apply):**

- [ ] Laboratory Safety Program Orientation
- [ ] Fundamentals of Laboratory Safety
- [ ] Other: __________________________

Depending on the hazardous materials and processes you will be working with in this SOP, additional safety training may be required by the University, such as Biosafety.

---

**Location Where Records Maintained:**

---

**Laboratory-specific training (check all that apply):**

- [ ] Review of SDS for other chemicals involved in process/experiment
- [ ] Review of this SOP
NOTE: Any deviation from this SOP requires approval from Principal Investigator.

Section 8 – Documentation of Training (signature of all users is required)

Prior to conducting any work with acutely toxic materials, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

I have read and understand the content of this SOP:
<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
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Appendix F.

NORTHEASTERN UNIVERSITY PLAN FOR LABORATORY SAFETY MANAGEMENT

The Northeastern University plan for laboratory safety management is designed to ensure the safe conduct of all activities in research and teaching laboratories. Principal areas include Chemical Hygiene and Safety, Biosafety, Radiation Safety and Diving Safety.

Primary responsibility for laboratory safety resides in the academic division, starting with the Principal Investigator or Laboratory Director and includes the Department Safety Officer (DSO), the Department Chair, the College Dean, and the Provost. Responsibilities include oversight of laboratory safety management policy and practice as well as written guidance on progressive disciplinary action for failure to comply with laboratory safety policy.

The Office of Academic and Research Safety (OARS) is charged with monitoring laboratory personnel, facilities, and operations in relation to applicable federal, state and local regulations. OARS activities include periodic compliance auditing through inspections and safety awareness training and education. Additional activities include collaboration on laboratory safety policy development and facilitation of effective compliance programs by the research investigators. OARS is responsible for communicating the results of its inspections to management and for closure of laboratories where appropriate.

In addition, a special role is played by four safety committees which are constituted by the Provost’s Office to provide technical expertise in reviewing research protocols, to provide guidance and assistance to OARS and the academic division in implementing policy, and as a peer group, to help correct violations.

The responsibilities of individuals and units are described in more detail below.

Responsibilities of Investigators and Directors in Charge of Laboratories

Individuals with overall responsibility for teaching and research laboratories must take appropriate steps to implement safety and environmental programs in their laboratories. Responsibilities include ensuring that:

- All personnel (faculty, staff, students) using the laboratory receive required safety and environmental training.
- Chemicals and other hazardous substances are safely stored, used, and properly discarded.
- Personal protective equipment assessments are performed and documented.
- Safety equipment is used properly and maintained appropriately.
- Supervision of graduate and undergraduate students in laboratories
- Periodic self-assessments of the laboratory are performed.
Laboratory Safety Management Plan

- Laboratory personnel are held accountable for matters of environmental, health and safety. (A qualified laboratory employee may assist a supervisor carry out his or her responsibilities, but the supervisor remains responsible for laboratory conditions.)

Prior to final approval of a leave or sabbatical, a faculty member in charge of a research laboratory must designate one individual working in the laboratory to be responsible for overseeing the laboratory and complying with all health, safety, and environmental requirements. A graduate student may not be designated to fulfill this responsibility. A colleague knowledgeable about the specific safety requirements and in physical proximity to the laboratory should be designated subject to the approval of the Department Chair or Department Safety Officer.

**Responsibilities of Departmental Safety Officers** (previously designated as Chemical Hygiene Officer)

The DSO bears significant responsibility for promoting and maintaining a safe, healthy, and environmentally sound workplace in their respective units. Specific duties include:

- Following up on violations identified by OARS.
- Identifying personnel or property at risk of exposure to safety or environmental concerns.
- Conducting periodic self-assessments of laboratories that are under their charge.
- Informing students, faculty, and staff of safety and environmental program requirements per OARS and assuring that they are followed.
- Reviewing procedures for responding to emergencies and assessing hazards.
- Commission and decommissioning of department laboratories in compliance with OARS procedures.
- Implementing recommendations of OARS.

**Responsibilities of Department Chairs**

Department Chairs are responsible for environmental health and safety programs in their departments. The Chairs with laboratory space or activities that fall under the purview of the four committees appoint the DSO to help implement laboratory safety policies and procedures. Responsibilities include:

- Maintaining up-to-date lists of personnel working in their departments.
- Directing action to correct violations by department faculty, staff, and students brought to the Chair’s attention.
- Coordinating departmental responses to new regulations and inspections.
- Conveying information about safety and environmental issues appropriately to department faculty, staff, students and DSOs.
Responsibilities of Faculty, Staff and Students

Every individual is responsible for conducting his or her activities at Northeastern University in accord with all applicable governmental, University, and departmental policies and regulations.

Laboratory Safety Management Plan

Failure to abide by established environmental, health, and safety procedures, to participate in training, and to report hazards and violations are subject to the applicable disciplinary processes.

Responsibilities of the Office of Academic and Research Safety

OARS is responsible to provide laboratory personnel with guidance and technical support in implementing safety and environmental programs. OARS plays a quality assurance role by giving PIs, DSOs, Chairs, and other administrators timely and accurate information on the status of implementation programs and program trends. OARS supports efforts to address laboratory program deficiencies and assists the safety committees by:

- Advising the Principal Investigators or Laboratory Directors, DSOs, Chairs, and other administrators on the development of appropriate safety and environmental programs that conform with established policies, regulations, and standards.
- Providing training, technical assistance, and related services.
- Developing self-assessment tools for use by laboratory personnel and providing guidance in the use of these tools.
- Maintaining appropriate documentation of environmental and safety policies and programs, including records of training, inspections, and hazardous waste disposal.
- Conducting periodic audits and inspections of research and teaching laboratories.

ADDITIONAL PLAN ELEMENTS

1. Safety Awareness

OARS is responsible for online, safety awareness training sessions. This training program should be updated on a regular basis. Safety and environmental classroom and online training courses are offered online through the OARS website via BioRAFT, the Laboratory Safety Management Platform.

OARS is responsible for a training profile that outlines required safety training programs for the appropriate areas of research interest for each academic department. Each semester, OARS should post and update classroom training schedules in advance to ensure trainees have adequate time to register. Online courses are available 24/7/365.

The PI or Laboratory Director is responsible for ensuring that all personnel in the laboratory receive the appropriate safety training to perform the tasks assigned to them.
Working through the Provost’s Office, OARS will engage the relevant DSO, Department Chair, or College Dean in communicating to all faculty, staff and students regarding mandatory safety requirements if they work with hazardous materials or in hazardous environments.

2. Laboratory Compliance Inspections

Central to the effort to ensure safe practices in laboratories is the need to carry out regular inspections. PIs, Laboratory Directors, and DSOs should conduct periodic self-assessment inspections in their laboratories. OARS is responsible for campus-wide, periodic laboratory inspections.

Efforts should be made to streamline reports of inspections and expedite notification, thereby facilitating mitigation efforts by the responsible supervisor. Once safety inspections have been conducted, findings should be sent to research investigators and other responsible individuals. If necessary, reports could be provided to the Provost’s Office.

3. Designation of Safety Officers

Department or College Safety Officers serve as a department or college resource on environmental, health, safety matters. They coordinate needed services and related safety activities with OARS. Periodic reviews of the performance of the DSOs should be carried out by OARS, the relevant Safety Committee, and the Provost’s Office. After consultation with OARS, the Provost’s Office approves a list of individuals who are appropriate for these positions in September for appointment by November 1 of each year.

4. Safety Committees

The Provost’s Office has direct oversight of the four safety committees that oversee research and teaching laboratories that involve hazardous materials or conditions; they are as follows:

- Laboratory Safety
- Diving Control Board (underwater diving safety at Nahant)
- Institutional Biological Safety
- Radiation Safety

On an annual basis, the Provost’s Office reviews the performance of each safety committee. The Provost’s Office will make de novo appointments from the colleges/departments where needed. In addition, the Provost’s Office has direct oversight of appointments made to the Institutional Animal Care and Use Committee and the Institutional Review Board (human subjects).

Facility Services oversees safety work groups that perform safety reviews on occupational and environmental safety programs for physical plant activities.

5. Response to violations
As described below, notices of laboratory violations should be sent by OARS to the Principal Investigator or Laboratory Director of the laboratory in which the violation exists and to the Department Chair or Dean of the responsible individual’s unit.

Copies should also be sent to the alternate contact whose name appears with the responsible individual on the emergency door sign of the laboratory; the Department Safety Officer; the Dean of the College of multi-unit Colleges; the Vice Provost for Research; and the Provost. A faculty member on sabbatical who would otherwise receive the violation notice shall also be notified.

The PI or Laboratory Director has primary responsibility for ensuring that violations are corrected promptly and appropriately. The Department Chair shall ensure that the PI or Laboratory Director has addressed the violation.

OARS will monitor the response actions required by the violation notice. If a written response documenting an adequate abatement action is not received within five days, then a second notice will be sent to the PI or Laboratory Director with copies to the Department Chair, the Dean, the Vice Provost for Research, and the Provost. If a third notice is required, then another inspection may be scheduled. If the violation is still not corrected, then OARS will determine whether closure of the laboratory is appropriate or whether other sanctions are needed.

At any time in the process, OARS or the Provost’s Office can refer the violation to the appropriate Safety Committee. The Safety Committee is authorized to interview the violator and request explanations for the violation.

The list of available sanctions is as follows:

1. For individuals, access to the laboratory may be restricted for a period of time or until the violation is corrected.
2. The laboratory may be closed to all users until the violation is corrected.
3. For individuals, the supervisor (Department Chair, Dean, or Provost) can issue a reprimand.
4. Repeat violations may result in suspension without pay.
5. Other actions as specified in the Faculty Handbook.

The appropriate sanction will be recommended by the relevant Safety Committee.
Appendix G

CHEMICAL INVENTORY MANAGEMENT IN LABORATORIES
April 2022

INTRODUCTION

The purpose of this document is to assist laboratory and studio supervisors in determining which hazardous chemicals must be tracked and updated in the ChemTracker module in BioRAFT, the Northeastern University laboratory safety risk management platform.

Each laboratory that uses or stores hazardous materials must maintain an online inventory within the ChemTracker. These inventories are required for several purposes including, but not limited to, meeting regulatory requirements that require accurate and updated chemical inventories, hazard communication and awareness, maintaining maximum hazardous chemical storage limits as mandated by the fire code, and to facilitate hazard communication efforts with external emergency response personnel. In addition, there is also an ability to share and recycle chemicals within ChemTracker, providing cost savings for lab groups and minimizing generation of hazardous wastes.

SCOPE

This document covers all laboratories and art studios at Northeastern University using or storing hazardous chemicals in a designated laboratory/studio location.

This document does not cover inventory management of biohazardous materials or radioactive materials due to their management in the NU (Northeastern University) Biosafety Program (IBC (Institutional Biosafety Committee) module in BioRAFT) and Radiation Safety Program (managed by the NU Radiation Safety Officer). To learn requirements associated with the inventory management of these materials, please contact OARS or visit the OARS website.

It does not cover non-laboratory or non-studio locations such as Facilities Management and Intercollegiate Athletics. However, the exclusion of these types of physical locations are not exempt from compliantly managing the inventories of chemicals used. For more information on inventory requirements for non-laboratory locations, contact the OARS office.

RESPONSIBILITIES
All applicable Principal Investigators, Teaching Faculty, and Laboratory/Studio Supervisors are required to maintain an accurate electronic chemical inventory in the ChemTracker module of BioRAFT. Hazardous materials must be entered or removed from the electronic inventory within one week of receipt, consumption, or disposal of a chemical. In addition, personnel responsible for laboratory management must ensure that all information uploaded to ChemTracker is accurate and correctly represents the active inventory.

HAZARDOUS MATERIALS TO BE INCLUDED ON THE INVENTORY

1. CHEMICALS
   a. Flammable Liquids
   b. Combustible Liquids
   c. Flammable Solids
   d. Compressed gases
   e. Liquified gases
   f. Cryogenic Fluids
   g. Corrosives
   h. Oxidizers
   i. Organic Peroxides
   j. Pyrophoric Materials
   k. Metals
   l. Toxic Materials and Poisons
   m. Carcinogenic Materials
   n. Irritants and Sensitizers
   o. Reactive (Unstable) Materials
   p. Water Reactive Materials
   q. Explosives, Blasting Agents, Detonators
   r. Other materials as identified here

ITEMS NOT REQUIRED TO BE INCLUDED IN THE INVENTORY

1. Retail products used for routine household-like activities (e.g., cleansers or dish soap; however, do include bleach used in laboratory processes)
2. Latex paints and oil-based paints
3. Materials to be expended within 48 hours (e.g., working solutions, working stock)
4. Non-hazardous materials such as buffers
5. Growth media
6. Enzyme preparations

❖ The absence of the requirement to inventory a material does not automatically exclude the material from meeting regulated disposal requirements. For questions concerning
the proper disposal of materials such as paints and other questionable materials, please contact the OARS office.

REQUIRED INFORMATION FOR EACH INVENTORY ENTRY

1. Chemical Name
2. CAS Number
3. Chemical Hazard
4. Chemical Synonym
5. Physical State
6. Specific Location (Bench, shelf, flammable cabinet, acid cabinet, base cabinet)
   a. If your lab has multiple storage cabinets, identifying the specific cabinet the material is stored in is required to meet Boston Fire Code requirements.
      i. For example: Lab XYZ has three flammable liquid storage cabinets. The cabinets are named and labeled as FLSC 1, FLSC 2, and FLSC 3. BioRAFT inventory would reflect the cabinet name where the inventoried material is stored.
7. Date Received
8. Expiration Date, when necessary to manage the risk associated with material instability over time
   a. For example: Class A peroxide has been purchased for XYZ. Class A peroxides have a shelf life of three months at which point disposal is recommended.
9. Each container received from the manufacturer should be entered as a separate inventory item.
   a. For example, if you receive two 5-gallon drums of Ethanol (Drum A and Drum B) each should receive its own line item and associated inventory number.
2. Quantities indicated in ChemTracker should include the total container size, not the amount remaining in the container. This way a more conservative maximum on hand will be reported.
   a. For example, if you have a 2-liter bottle of acetone listed in the ChemTracker inventory, your inventory will reflect 2 liters of acetone on-hand regardless of the quantity in the bottle. Once the container is empty, the 2 liters should be removed from ChemTracker inventory.
3. If a chemical is removed from an inventoried container and placed in a different container for use as working stock or part of a working solution, the container holding the working material does not need to be inventoried if the material is used within 48 hours.

REGULATORY OBLIGATION

Maintaining an accurate chemical inventory is both a regulatory requirement for using, handling, and storing hazardous materials as well as a cornerstone for effective communication and management of chemical hazards present in the laboratory.
APPLICABLE REGULATIONS

✓ 29 CFR 1910.1450
✓ 29 CFR 1910.1200
✓ NFPA 45
✓ NFPA 475
✓ Boston Fire Prevention Code

HOW THE CHEMICAL INVENTORY IS USED

An accurate chemical inventory provides several utilities, such as those listed below.

1. Efficient Ordering. An accurate inventory will help lab managers track the materials that are present in the laboratory and know whether additional supplies need to be ordered before duplicate/excess orders are placed.
2. Locating reagents. Defining and logging locations where reagents are located make it easier and quicker for researchers to locate the reagents stored in the lab before orders are placed for materials already available in the lab.

3. Deliberate disposal. An accurate inventory helps to identify materials that are no longer in use as well as tracking materials that have a limited shelf-life, including those that may become dangerous over time.

4. Effective response. Chemical inventories provide valuable information to help fire and hazmat responders mount a safe and effective response to emergencies on campus.

5. Compliance with hazardous material limits. Fire and building codes limit the amount of hazardous material that may be stored within a location based on several factors associated with the construction. The Department of Homeland Security has identified chemicals of interest which when stored above defined thresholds may require additional site security measures to be taken to protect against intentional release, theft, or sabotage. Accurate reporting of chemical inventories (both qualitatively and quantitatively) allows the life safety risk of hazardous material overages to be identified and remedied.

6. Effective hazard communication. An accurate chemical inventory allows hazards associated with materials to be identified and communicated to potential users. The inventory also serves as a reference point to ensure comprehensive access to Safety Data Sheets.

7. Safer storage practices. An accurate inventory can help to alleviate some of the work that can be associated with identifying areas where incompatible materials are being stored together and facilitate planning for how to utilize more effective and safe chemical storage and segregation practices.

For more information, please contact your College Safety Officer, your Departmental Safety Officer, or the Office of Academic and Research Safety.
## Record of Amendments

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<tr>
<td>7/13/10</td>
<td>Appendix D</td>
<td>Laboratory Safety Reference Material updated.</td>
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<td>7/13/10</td>
<td>Appendix F</td>
<td>Last sentence updated.</td>
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<td>5/2/11</td>
<td>1.5.1</td>
<td>Frequency for Chemical Hygiene training outlined.</td>
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<td>5/2/11</td>
<td>1.7</td>
<td>Emergency procedures outlined in parenthesis updated.</td>
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<td>7/11/11</td>
<td>1.2 &amp; 1.5.3.3</td>
<td>Replaced Department Chemical Hygiene Officer with Department Safety Officer.</td>
<td>EAG</td>
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<tr>
<td>7/12/11</td>
<td>Appendix B.</td>
<td>Updated list of carcinogens to reflect Report on Carcinogens, Twelfth Edition 2011</td>
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<td>Added reference 76</td>
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<td>9/25/12</td>
<td>2.1.1 &amp; 2.1.2</td>
<td>Do not work alone in laboratory sentence expanded per Chemical Hygiene Committee.</td>
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<td>1.2 &amp; 3.4.1</td>
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<td>11/28/16</td>
<td>CHP</td>
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<td>1.5.3.3.</td>
<td>Safety Data Sheets (SDS).</td>
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<td>Updated list of carcinogens to reflect Report on Carcinogens, 14th Edition 2016</td>
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<td>7/6/17</td>
<td>Add Appendix G.</td>
<td>Add Appendix G. Laboratory Safety Management Plan</td>
<td>EAG</td>
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</table>
Reordered Appendices to counteract removing appendix E.  
Added Standard operating procedure for acutely toxic chemicals now in updated appendix E: ACUTELY TOXIC CHEMICAL STANDARD OPERATING PROCEDURES | EDS    |
| 1/06/20 | Add One-Glove Policy. | Added One-Glove Policy. Updated formatting.                                                 | CAK    |
| 8/2/21  | Add emergency contact information for satellite locations | Added emergency contact information for satellite locations                                  | MAY    |
| 5/31/2022 | Links and words throughout. | Document rebranded to reflect name change to “Office of Academic and Research Safety.” Links updated to reflect new website. Links go to website landing pages that host updated documents. SDSs are now searched electronically through BioRaFT homepage. | JAT    |
| 6/1/2022 | Add guidance document | Guidance document on requirements and expectations for the management of Hazardous Materials/Chemical Inventories. | JAT/MS |