

Chemical Hygiene Plan

Per 29 CFR 1910.1450

Revised October 2020

IN CASE OF AN EMERGENCY, CALL 777 FROM ANY CAMPUS PHONE.

Additional Security telephone numbers by campus:

Campus	Location	Phone
New York City	B-Level, East Wing (Schimmel Entrance)	(212) 346 - 1800
Pleasantville	Goldstein Fitness Center Lobby	(914) 773 - 3400
Briarcliff	Dow Hall Lobby	(914) 923 - 2700
Graduate Center-White Plains	Lobby	(914) 422 - 4166
School of Law-White Plains	Preston Hall Lobby	(914) 422 - 4300

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Chemical Hygiene Plan Part A

1. INTRODUCTION

The Chemical Hygiene Plan (CHP or Plan) is a document required by the U.S. Occupational Safety and Health Act (OSHA) of 1970 and regulations of the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard" or the "Lab Standard"). In addition to other requirements, the OSHA Lab Standard specifies the CHP to include "criteria the employer will use to determine and implement control measures to reduce laboratory employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous."

Pace University is committed to providing safe workplace conditions for all employees and maintaining regulatory compliance. The goals of implementing the CHP include:

- Minimizing risk of chemical exposure
- Minimizing risk of work-related injury and illness
- Minimizing risk to the environment
- Compliance with applicable regulations and standards
- Ensuring that laboratory personnel are knowledgeable of safe and proper incident response procedures

Within the Plan, areas where regulatory or Pace University requirements exist will be clearly identified using words such as "must", "required", "shall", and "it is the responsibility", etc. All other information provided within this document are recommendations that Environmental Health and Safety (EH&S) encourages laboratories to follow as best management practices.

2. THE OSHA LABORATORY STANDARD

The basis for this Standard (29 CFR 1910.1450) is a determination by the Occupational Safety and Health Administration (OSHA), after careful review of the complete rule-making record, that laboratories typically differ from industrial operations in their use and handling of hazardous chemicals and that a different approach than that found in OSHA's substance specific health standards is warranted to protect workers. The final standard applies to all laboratories that use hazardous chemicals in accordance with the definitions of laboratory use and laboratory scale provided in the standard. Generally, where this standard applies it supersedes the provisions of all other standards in 29 CFR, part 1910, subpart Z, except in specific instances identified by this standard. For laboratories covered by this standard, the obligation to maintain employee exposures at or below the permissible exposure limits (PELs) specified in 29 CFR, part 1910, subpart Z is retained. However, the manner in which this obligation is achieved will be determined by each employer through the formulation and implementation of a CHP. The CHP must include the necessary work practices, procedures and policies to ensure that employees are protected from all potentially hazardous chemicals used or stored in their work area. Hazardous chemicals as defined by the final standard include not only chemicals regulated in 29 CFR part 1910, subpart Z, but also any chemical meeting the definition of hazardous chemical with respect to health hazards as defined in OSHA's Hazard Communication Standard, 29 CFR 1910.1200(c).

Among other requirements, the final Standard provides requirements for employee training and information, medical consultation and examination, hazard identification, respirator use and record keeping. To the extent possible, the Standard allows a large measure of flexibility in compliance methods.

Effective Date: May 1, 1990. Compliance Date: Employers shall have completed an appropriate Chemical Hygiene Plan and commenced carrying out its provisions by January 31, 1991.

2.1 EMPLOYEE RIGHTS AND RESPONSIBILITIES

Employees have the right to be informed about the known physical and health hazards of the chemical substances in their work areas and to be properly trained to work safely with these substances.

Employees have the right to file a complaint with OSHA if they feel they are being exposed to unsafe or unhealthy work conditions. Employees cannot be discharged, suspended, or otherwise discriminated against by their employer because of filing a complaint, or exercising their rights under the law.

Employees have the responsibility to attend training seminars on the Laboratory Standard and Chemical Hygiene Plan and to stay informed about the chemicals used in their work areas. They have the responsibility to use safe work practices and protective equipment required for safe performance of their job. Finally they have the responsibility to inform their supervisors of accidents and conditions or work practices they believe to be a hazard to their health or to the health of others.

3. FUNCTIONS & MAINTENCE OF PACE UNIVERSITY CHENICAL HYGIENE PLAN

3.1 APPLICABILITY

The CHP applies to all Pace University laboratory personnel, who handle and may be exposed to hazardous chemicals in research laboratories at Pace University. This includes labs that use small quantities of off-the-shelf hazardous chemicals in their research or laboratory scale materials. OSHA considers graduate students who get paid for working in a lab as employees who are subject to the requirements of the Laboratory Standard. The CHP is not inclusive of chemical materials used outside of the laboratory setting. Biological and radioactive materials are not included in the scope of this plan.

3.2 ACCESSIBILITY

The OSHA Laboratory Standard requires the CHP to be readily available to employees, employee representatives and, upon request, to the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee. This means laboratory employees working with hazardous chemicals in a laboratory must know the location of the CHP, be familiar with the contents, and be able to produce the CHP for any state or federal regulatory inspectors upon request. While EH&S recommends a hard copy be kept in the laboratory, electronic access is acceptable and encouraged. The Chemical Hygiene Plan Part B can be found in Appendix A of this manual.

******It is the responsibility of Principal Investigators and Laboratory Supervisors to ensure that personnel working in laboratories under their control are familiar with the contents and location of the Chemical Hygiene Plan, including any lab specific standard operating procedures and any department or college level laboratory safety manuals, policies, and procedures. Part B of the Chemical Hygiene Plan must be Completed and Updated Annually and can be found in Appendix B.***

3.3 LABORATORY SAFETY ROLES AND RESPONSIBILITES UNDER THE CHP

The ultimate responsibility for health and safety within laboratories lies with each individual who works in the laboratory; however, the responsibility for laboratory safety at Pace University is shared across the institution.

An essential component of any chemical hygiene program is clear communication of the different roles and responsibilities of all stakeholders who work in or visit areas where chemicals are present. Clarifying roles and responsibilities for implementing the CHP will establish accountability, streamline processes, enhance safety, and avoid confusion in meeting the Plan's objectives.

3.3.1 THE DEAN OF DYSON COLLEGE OF ARTS AND SCIENCE

The Dean of Dyson College of Arts and Science shall:

A. Ensure the CHP is written and updated.
B. Provide or obtain administrative and financial support, as needed, for implementing and maintaining the CHP and the requirements of the Plan.

3.3.3 THE ENVIRONMENT, HEALTH and SAFETY (EH&S) OFFICE

The ENVIRONMENT, HEALTH, and SAFETY (EH&S) OFFICE shall:

A. Oversee process for annual update of the CHP, reminding CHOs when annual CHP updates are due and reviewing updated plans.
B. Provide a standard CHP template for use in developing and updating Part Bs.
C. Provide "General Chemical Hygiene" training by classroom, web, or upon request.
D. Provide "Managing Hazardous Waste" training by classroom, web, or upon request.
E. Provide materials and guidance to assist with Lab-Specific Chemical Hygiene Training.
F. Establish and maintain a system for maintaining training records.
G. Conduct an annual meeting for CHOs and EH&S to update them regarding changes in the Template, the EH&S Program, and to review significant chemical safety concerns from the year.
H. Conduct special investigations and exposure monitoring, as requested or as required by regulations, making recommendations for control when needed.
I. Participate in inspections of laboratory operations at least once a year.
J. Provide guidance regarding selection and use of personal protective equipment. When respirators are required, provide services to ensure personnel are provided the proper equipment, to ensure the equipment fits properly, and to ensure users receive the required training.
K. Provide guidance and review standard operating procedures (SOPs) for new experiments or operations, as requested.
L. Provide, as requested, chemical safety information and guidance for appropriate controls of hazards such as proper personal protective equipment and local exhaust ventilation.
M. Assist with investigations of serious accidents or chemical exposure incidents.

3.3.2 THE CHEMICAL HYGIENE OFFICER

The Chemical Hygiene Officer role at Pace will be a hybrid model with the Director of Environmental Health & Safety acting as the University CHO and the Laboratory Directors acting as the Lab Specific CHO. The University CHO shall:

A. Know and understand the requirements of the OSHA Laboratory Standard regulation (29 CFR 1910.1450) and the Chemical Hygiene Plan.
B. Oversee the implementation of the CHP in the Department and assist Principal Investigators or Supervisors (PI/Supervisors) with implementing the Chemical Hygiene Plan within their laboratory.
C. Ensure the Plan is distributed or made available to all employees who are impacted by the Plan.
D. Advise Principal Investigators or Supervisors concerning adequate facilities, controls, and procedures for work with unusually hazardous chemicals.

E. Seek ways to improve the Chemical Hygiene Plan.
F. Review and update the CHP annually, when directed by the EH&S Office.
G. Participate in investigation of serious accidents involving hazardous chemicals, acting as a liaison to the regulatory offices.
H. Assist PI/Supervisors, as needed, with obtaining services or supplies and equipment for correcting chemical hygiene problems or addressing chemical hygiene needs.
I. Ensure periodic exposure monitoring requirements are met and maintain monitoring records.
J. If requested, review proposed experiments for significant environment, health, and safety issues, or concerns.

3.3.4 THE PRINCIPAL INVESTIGATOR or LABORATORY DIRECTOR

The PRINCIPAL INVESTIGATOR or LABORATORY SUPERVISOR (PI/Supervisor) shall:

A. Be familiar with this CHP and ensure that all work is conducted in accordance with requirements of this Plan. They should contact the EH&S/CHO for advice and assistance regarding this Plan and implementing the provisions of this Plan when needed. Complete and annually update Individual Lab Specific Chemical Hygiene Plans (Part B).
B. Assess all chemicals in the research laboratories under their purview, and ensure measures are established for safe use, storage, and disposal of the hazardous chemicals within the laboratory. Such measures include:
    a. Preparing additional, Standard Operating Procedures (SOPs) for research activities involving hazardous chemicals, when needed. See Appendix D for sample SOPs.
    b. Providing personal protective equipment needed for safe handling of the chemicals.
    c. Providing proper containers, containment, and cabinetry for safe storage of materials.
    d. Defining the location and processes where particularly hazardous substances will be used, ensuring these areas are labeled, and ensuring that a list of these substances is maintained.
C. Ensure new processes or experiments involving hazardous materials are planned carefully and appropriate hazard information, safety equipment, and SOPs are available prior to commencing work. Always seek to minimize the amount of hazardous chemicals purchased and used for experiments or processes.
D. Plan for accidents and ensure that appropriate supplies are in place and procedures are established for responding to an accident, including cleaning up chemical spills.
E. Ensure all employees working in the laboratory receive required training for work with potentially hazardous chemical, including lab-specific training on the hazardous materials that they use. Follow procedures for documenting the lab-specific training.
F. Monitor the safety performance of the staff to ensure that the required safety equipment, practices and techniques are understood and being employed, and ensure that action is taken to correct work practices that may lead to chemical exposures or releases.

G. When needed, contact the Environment Health & Safety (EH&S) Office to arrange for workplace air samples, swipes, or other tests to determine the amount and nature of airborne and/or surface contamination, inform employees and students of the results, and use data to aid in the evaluation and maintenance of appropriate laboratory conditions.
H. Ensure employees who suspect they may have received an excessive exposure to a hazardous chemical report to the PACE University Health Care Unit (UCHU) for assessment. Such exposures may occur through accidental inoculation, ingestion, or inhalation of the chemical.
I. Report all accidents involving an employee's chemical exposure or involving a chemical spill that may constitute a danger of environmental contamination to the EH&S Office or EH&S Director.
J. Investigate all chemical accidents and near misses to determine the cause and take appropriate corrective action to prevent similar accidents. Contact the CHO or EH&S Office, when needed, for assistance with investigations, assessment, and recommendations for corrective action.
K. Ensure unwanted or excess hazardous chemicals and materials are properly disposed according to all Pace, state, and federal procedures.
L. Assist the EH&S Office as requested.

3.3.5 EMPLOYEES, STAFF, STUDENTS

Employees, staff, students, and visitors working with or around hazardous chemicals in a laboratory shall:

A. Read and understand the OSHA Chemical *Laboratory Standard* and this Chemical Hygiene Plan.
B. Understand the hazards of chemicals they handle and the signs and symptoms of excessive exposure.
C. Understand and follow all standard operating procedures.
D. Understand and apply all training received.
E. Understand the function and proper use of all personal protective equipment and wear personal protective equipment when mandated or necessary.
F. Report to the Principal Investigator or Laboratory Supervisor any significant problems arising from the implementation of the standard operating procedures.
G. Report to the PI/Supervisor all facts pertaining to every accident that results in exposure to toxic chemicals.
H. Report to the PI/Supervisor or EH&S actions or conditions that may exist that could result in an accident.
I. Contact the PI/Supervisor, the Chemical Hygiene Officer, EH&S Office if any of the above procedures are not clearly understood.
J. If an emergency occurs related to an experiment, provide emergency response personnel with information about the conditions that caused the emergency and the existing situation in the laboratory.

3.4 EMPLOYEE INFORMATION AND TRAINING

Departments must provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area and the steps they should take to protect themselves from these hazards. Such information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignment involving new exposure situations. Employees should receive periodic lab specific refresher information and training from their PI or supervisor.

3.4.1 TRAINING

Federal and state laws and Pace University policy require all laboratory workers to receive Laboratory Safety and Chemical Waste Disposal training and be informed of the potential health and safety risks that may be present in their workplace. Documentation must be maintained to demonstrate that such training was provided and received. In order to assist laboratory personnel comply with this requirement, laboratory safety training must be obtained either through EH&S (classroom or web-based sessions) or documented as having been received from an alternative source. Laboratory personnel who attend EH&S training classes will have documentation entered and maintained for them within the Pace Learning Management System. Laboratory personnel who have not attended the EH&S Laboratory Safety Training program must submit documentation of training received from alternative sources for verification by EH&S.

The OSHA Laboratory Standard requires employers to provide employees with information and training to ensure they are apprised of the hazards of chemicals present in their work area. The Laboratory Standard goes on to state that such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations.

As per the OSHA Laboratory Standard, information that must be provided to employees includes:

- The contents of the Laboratory Standard and its appendices (Appendix A and Appendix B) shall be made available to employees.
- The location and availability of the employer's Chemical Hygiene Plan.
- The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard.
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
- The location and availability of identified reference materials listing the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, SDSs received from the chemical supplier.
- The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and PPE to be used.

It is the responsibility of Principal Investigators and laboratory supervisors to ensure personnel working in laboratories under their supervision have been provided with the proper training, have received information about the hazards in the laboratory they may encounter, and have been informed about ways they can protect themselves.

3.4.2 INFORMATION FOR EMPLOYEES PROVIDED BY DEPARTMENTS

1. The contents of the OSHA standard 29 CFR 1910.1450 and its appendices which shall be available to employees (available from EH&S);
2. The location and availability of the Pace University Chemical Hygiene Plan (available from EH&S);
3. The permissible exposure limits for OSHA regulated substances or published exposure limits for other hazardous chemicals where there is no applicable OSHA standard (available from EH&S);
4. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory (available on container labels and Material Safety Data Sheets);
5. The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory) including, but not limited to, Material Safety Data Sheets received from the supplier.

3.5 STANDARD OPERATING PROCEDURES

Departments and supervisors will develop written standard operating procedures for work area specific operations. Standard operating procedures must be provided to affected employees.

For work involving extremely toxic chemicals, select carcinogens, and reproductive toxins, standard operating procedures must include the following provisions where appropriate:

1. Establishment of a designated area;
2. Use of containment devices such as fume hoods or glove boxes;
3. Procedures for safe removal of contaminated waste; and
4. Decontamination procedures.

3.6 ANNUAL REVIEW

EH&S is responsible for preparing a written annual review of the Chemical Hygiene Plan. The review process will utilize such resources as results of internal and external audits, accident reports, notices of violation, customer satisfaction surveys, and other information and tracking reports which may become available. The focus of the annual review is to evaluate program effectiveness and to identify strengths and weaknesses which may be updated to improve the program. The date of the annual review and approval will be noted in Appendix P.

4. CHEMICAL HAZARDS

The Laboratory Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical or health hazard.

According to OSHA A chemical is a physical hazard if there is scientifically valid evidence that it is a flammable, a combustible liquid, a compressed gas, an explosive, an organic peroxide, an oxidizer, pyrophoric, unstable material (reactive), or water-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. Included are:

- Carcinogens
- Teratogens and reproductive toxins
- Irritants
- Corrosives
- Sensitizers
- Hepatotoxins (liver)
- Agents that act on the hematopoietic system (blood)
- Agents that damage the lungs, skin, eyes, or mucous membranes
- Nephrotoxins (kidney)
- Biohazards
- Radioactive material

In most cases, the label will indicate if the chemical is hazardous. Look for key words like **caution, hazardous, toxic, dangerous, corrosive, irritant, carcinogen**, etc. Old containers of hazardous chemicals (before 1985) may not contain hazard warnings.

If you are not sure a chemical you are using is hazardous, review the **Material Safety Data Sheet (SDS)** or contact your supervisor, instructor, or the Department of Environmental Health & Safety (EH&S).

Designated areas must be established and posted for work with certain chemicals and mixtures, which include select carcinogens, reproductive toxins, and/or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

4.1 PHYSICAL HAZARDS

"Physical hazard" refers to a chemical for which there is evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive. Materials which present a physical hazard can be safely used if the specific hazard(s) are understood, and measures are taken to address the hazards. If appropriate precautions are not taken, a fire, an explosion, unwanted corrosion, personal injury, or property damage could occur.

Certain chemicals cannot be safely mixed or stored with other chemicals because a severe reaction can take place or an extremely toxic reaction product can result. See Appendix B for a table of incompatible chemicals. Special precautions to incorporate in developing lab specific SOPs can be found in Appendix Q.

An eyewash and safety shower must be readily accessible to areas where injurious materials are used and stored. In the event of skin or eye contact with an injurious material, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Get medical help. Additional information concerning eyewash and safety shower requirements is available from EH&S.

4.2 HEALTH HAZARDS

"Health hazard" refers to chemicals for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. This term includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

For many toxic materials, hygienic standards have been established and action must be taken to prevent personnel from receiving exposures in excess of these standards. These standards may be referred to as threshold limit values (TLVs) or permissible exposure limits (PELs).

The SDS will list the hygienic standard for the hazardous chemical or each component of a mixture. In addition, EH&S has a complete listing of published TLVs and PELs and other works concerning the subject of industrial toxicology. If you would like to conduct a more thorough review of a particular compound, or if you would like an evaluation of the exposure to a specific material used in your work area, contact EH&S.

Protection from health hazards is provided by ensuring that exposure to such hazards is minimized or eliminated. To minimize the exposure, it is necessary to determine the route by which the exposure may occur, i.e. inhalation, skin contact, puncture, ingestion, or a combination of exposure routes.

4.2.1 INHALATION

Inhalation of chemicals occurs by absorption of chemicals via the respiratory tract (lungs). Once chemicals have entered into the respiratory tract, the chemicals can then be absorbed into the bloodstream for distribution throughout the body. Chemicals can be inhaled in the form of vapors, fumes, mists, aerosols and fine dust.

Symptoms of exposure to chemicals through inhalation include eye, nose, and throat irritation, coughing, difficulty in breathing, headache, dizziness, confusion, and collapse. If any of these symptoms are noted, leave the area immediately and get fresh air. Seek medical attention if symptoms persist and complete and Injury/Illness Report.

Laboratory workers can protect themselves from chemical exposure via inhalation through proper use of a functioning fume hood, use of dust masks and respirators when a fume hood is not available, avoiding bench top use of hazardous chemicals, ensuring chemical containers are kept tightly capped, and ensuring all chemical spills are promptly cleaned up.

4.2.2 INGESTION

Chemical exposure through ingestion occurs by absorption of chemicals through the digestive tract. Ingestion of chemicals can occur directly and indirectly. Direct ingestion can occur by accidently eating or drinking a chemical; with proper housekeeping and labeling, this is less likely to occur. A higher probability of receiving a chemical exposure can occur by way of indirect ingestion. This can occur when food or drink is brought into a chemical laboratory. The food or drink can then absorb chemical contaminants (vapors or dusts) in the air and result in a chemical exposure when the food or drink is consumed. This can also occur when food or drink is stored with chemicals, such as in a refrigerator. Ingestion can occur when a laboratory worker who handles chemicals does not wear gloves or practice good personal hygiene, such as frequent hand washing, and then leaves the laboratory to eat, drink, or smoke. In all cases, a chemical exposure can result, although the effects of chronic exposure may not manifest itself until years later.

Symptoms of chemical exposure through ingestion include metallic or other strange tastes in the mouth, stomach discomfort, vomiting, problems swallowing, and a general ill feeling. **If you think you may have accidentally ingested a chemical, seek medical attention immediately and/or call the Poison Control Center at 1-(800) 222-1222 or Pace Security at 777 from a campus phone or 911 from a cell phone or off campus phone.** After seeking medical attention, complete an Injury/Illness Report.

The best protection against ingestion of chemicals is to properly label all chemical containers, never consume food or drink or chew gum in laboratories, always wear PPE (such as gloves), and practice good personal hygiene, such as frequent hand washing.

4.2.3 ABSORPTION

Some chemicals can be absorbed by the eyes and skin, resulting in a chemical exposure. Most situations of this type of exposure result from a chemical spill or splash to unprotected eyes or skin. Once absorbed by these organs, the chemical can quickly find its way into the bloodstream and cause further damage, in addition to the immediate effects that can occur to the eyes and the skin.

Symptoms of eye exposure can include itchy or burning sensations, blurred vision, discomfort, and blindness. The best way to protect you from chemical splashes to the eyes is to always wear safety glasses in the laboratory whenever eye hazards exist (chemicals, glassware, lasers, etc.). If you are pouring chemicals, then splash goggles are more appropriate than safety glasses. Whenever a severe splash hazard may exist, the use of a face shield, in combination with splash goggles is the best choice for protection. Please note, a face shield by itself does not provide adequate eye protection.

If you do get chemicals in your eyes, immediately go to an eyewash station and flush your eyes for at least 15 minutes. The importance of flushing for at least 15 minutes cannot be overstated! Once the eyewash has been activated, use your fingers to hold your eyelids open and roll your eyeballs in the stream of water so the entire eye can be flushed. After flushing for at least 15 minutes, seek medical attention immediately and complete an Injury/Illness Report.

Symptoms of skin exposure to chemicals include dry, whitened skin, redness, swelling, rashes, blisters, itching, chemical burns, cuts, and defatting. Please note that some chemicals can be readily absorbed by the skin.

Laboratory workers can protect their skin from chemical exposure by selecting and wearing the proper gloves, wearing a lab coat and other personal protective equipment for special hazards (such as protective sleeves, face shields, and aprons), and not wearing shorts and sandals in areas where chemicals are being used - even if you are not using chemicals, but someone else in the lab is using chemicals nearby.

For small chemical splashes to the skin, remove any contaminated gloves, lab coats, etc., and wash the affected area with soap and water for at least 15 minutes. Seek medical attention afterward, especially if symptoms persist.

For large chemical splashes to the body, it is important to get to an emergency shower and start flushing for at least 15 minutes. Once under the shower, and after the shower has been activated, it is equally important to remove any contaminated clothing. Failure to remove contaminated clothing can result in the chemical being held against the skin and causing further chemical exposure and damage. After flushing for a minimum of 15 minutes, seek medical attention immediately and complete an Injury/Illness Report.

Please note that some chemicals, such as hydrofluoric acid require use of a special antidote (such as Calcium gluconate gel) and special emergency procedures. Be sure to read SDSs for any chemical you work with to determine if a special antidote is needed when chemical exposure occurs.

4.3.4 INJECTION

Chemical exposure via injection can occur when handling chemically contaminated items such as broken glass, plastic, pipettes, needles, razor blades, or other items capable of causing punctures, cuts, or abrasions to the skin. When this occurs, chemicals can be injected directly into the bloodstream and cause damage to tissue and organs. Due to direct injection into the bloodstream, symptoms from chemical exposure may occur immediately.

Laboratory workers can protect themselves from an injection hazard by wearing proper PPE such as safety glasses/goggles, face shields, and gloves. Inspect all glassware for chips and cracks before use, and immediately discard any glassware or plastic ware that is damaged. To help protect coworkers in the lab and building care staff, all broken glass should be disposed of in a puncture resistant container labeled as "Broken Glass". This can be a commercially purchased "broken glass" container or simply a cardboard box or other puncture resistant container labeled as "Broken Glass".

Whenever cleaning up broken glass or other sharp items, always use mechanical means like a broom, scoop or dustpan, or devices such as pliers, before using your hands to pick up broken pieces. If you have to use your hands, it is best to wear leather gloves when handling broken glass. For other items that can cause cuts or puncture wounds, such as needles and razor blades, never leave these items out in the open where someone could come into contact with them. EH&S recommends using a device such as a piece of Styrofoam or similar item to secure them for later use. For disposal, use an appropriate "sharps" container.

If you do receive a cut or injection from a chemically contaminated item, if possible, gently try to remove the object and immediately rinse under water while trying to flush the wound and remove any chemical contamination, administer first aid and seek medical attention if necessary, and then complete an Injury/Illness Report.

4.4 TOXICITY

There are a number of factors that influence the toxic effects of chemicals on the body. These include, but are not limited to:

- The quantity and concentration of the chemical.
- The length of time and the frequency of the exposure.
- The route of the exposure.
- If mixtures of chemicals are involved.
- The sex, age, and lifestyle of the person being exposed to the chemical.

4.4.1TOXIC EFFECTS

Toxic effects are generally classified as acute toxicity or chronic toxicity.

Acute toxicity is generally thought of as a single, short-term exposure where effects appear immediately and are often reversible. An example of acute toxicity relates to the over consumption of alcohol and "hangovers".

Chronic toxicity is generally thought of as frequent exposures where effects may be delayed (even for years) and are generally irreversible. Chronic toxicity can also result in acute exposures, with long term chronic effects. An example of chronic toxicity relates to cigarette smoking and lung cancer.

4.4.2 EVALUATING TOXICITY DATA

SDSs and other chemical resources generally refer to the toxicity of a chemical numerically using the term *Lethal Dose 50* (LD50). The LD50 describes the amount of chemical ingested or absorbed by the skin in test animals that causes death in 50% of test animals used during a toxicity test study. Another common term is *Lethal Concentration 50* (LC50), which describes the amount of chemical inhaled by test animals that causes death in 50% of test animals used during a toxicity test study. The LD50 and LC50 values are then used to infer what dose is required to show a toxic effect on humans.

As a general rule of thumb, the lower the LD50 or LC50 number, the more toxic the chemical. Note there are other factors (concentration of the chemical, frequency of exposure, etc.) that contribute to the toxicity of a chemical, including other hazards the chemical may possess.

While exact toxic effects of a chemical on test animals cannot necessarily be directly correlated with toxic effects on humans, the LD50 and LC50 can give a good indication of the toxicity of a chemical, particularly in comparison to another chemical. For example, when making a decision on what chemical to use in an experiment based on safety for the lab worker, a chemical with a high LD50 or LC50 would be safer to work with, assuming the chemical did not possess multiple hazards and everything else being equal.

In general terms, the resource *Prudent Practices in the Laboratory* lists the following table for evaluating the relevant toxicity of a chemical:

Toxicity Class	Animal LD50	Probable Lethal Dose for 150 lb. Person	Example
Super Toxic	Less than 5 mg/kg	A taste (7 drops or less)	Botulinum toxin
Extremely Toxic	5 - 50 mg/kg	< 1 teaspoonful	Arsenic trioxide, Strychnine
Very Toxic	50 - 500 mg/kg	< 1 ounce	Phenol, Caffeine
Moderately Toxic	0.5 - 5 g/kg	< 1 pint	Aspirin, Sodium chloride
Slightly Toxic	5 - 15 g/kg	< 1 quart	Ethyl alcohol, Acetone

In addition to having a toxic effect on the body, some chemicals can be carcinogenic, mutagenic, teratogenic, and acutely toxic. These specific chemical hazards are covered in more detail under the Particularly Hazardous Substances section in this manual.

4.5 BIOLOGICAL HAZARDS

Policies and procedures pertaining to biological safety are contained in the "Pace University Biological Safety Manual." Contact EH&S for a copy of this manual.

5. CHEMICAL EXPOSURE LIMITS & MONITORING

5.1 CHEMICAL EXPOSURE LIMITS

The OSHA Laboratory Standard requires that laboratory employee exposure of OSHA Regulated Substances do not exceed the Permissible Exposure Limits as specified in 29 CFR Part 1010, subpart Z.

The Permissible Exposure Limits (PEL) are based on the average concentration of a chemical to which workers can be exposed to over an 8-hour workday, 5 days per week, for a lifetime without receiving damaging effects. In some cases, chemicals can also have a Ceiling (C) limit, which is the maximum concentration that cannot be exceeded. OSHA has established PELs for over 500 chemicals. Permissible Exposure Limits are legally enforceable.

Another measure of exposure limits are Threshold Limit Values (TLV) which are recommended occupational exposure limits published by the American Conference of Governmental Industrial Hygienists (ACGIH). Similar to PELs, TLVs are the average concentration of a chemical that a worker can be exposed to over an 8-hour workday, 5 days per week, over a lifetime without observing ill effects. TLVs also have Ceiling (C) limits, which are the maximum concentration a worker can be exposed to at any given time. The ACGIH has established TLVs for over 800 chemicals. A main point of difference between PELs and TLVs is that TLVs are advisory guidelines only and are not legally enforceable. Both PELs and TLVs can be found in SDSs. Another good resource for information is the National Institute for Occupational Health and Safety (NIOSH).

Please note, if laboratory personnel follow the guidelines described within this Laboratory Safety Manual – use fume hoods and other engineering controls, use proper PPE, practice good housekeeping and personal hygiene, keep food and drink out of laboratories, and follow good lab practices – the potential for exceeding exposure limits is significantly reduced.

5.2 CHEMICAL EXPOSURE MONTORING

As a laboratory worker, you may use a variety of potentially hazardous materials on a daily basis. Safe use of these materials depends heavily on following proper laboratory work practices and the utilization of engineering controls. In certain circumstances, it is necessary to verify that work practices and engineering controls are effective in limiting exposures to hazardous materials. EH&S Industrial Hygienists can help evaluate the effectiveness of your controls by monitoring exposures to a variety of laboratory materials. Exposure monitoring is the determination of the airborne concentration of a hazardous material in the work environment. Exposure monitoring data is compared to existing OSHA and ACGIH exposure guidelines and is often used to make recommendations concerning engineering controls, work practices, and PPE.

If you think you are receiving a chemical exposure in excess of OSHA exposure limits, such as feeling symptoms commonly associated with exposure to hazardous materials, or work with any of the chemicals listed below, contact EH&S at 2-2818 and our Industrial Hygienists can use a variety of sampling methods to monitor for any potential exposures.

In some cases, OSHA substance specific standards actually require that the employer conduct initial exposure monitoring. Examples of chemicals that fall into this category include:

- Formaldehyde
- Vinyl chloride
- Methylene chloride
- Benzene
- Ethylene oxide

Other substances that have exposure monitoring requirements include:

- Lead
- Cadmium
- Silica

5.3 MEDICAL CONSULTATIONS AND EXAMINATIONS

Note: Acute medical care will normally be provided by the Pace University Health Care Unit in accordance with existing University policies and procedures.

Departments must provide all 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, under the following circumstances:

1. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee must be provided an opportunity to receive an appropriate examination.
2. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
3. Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultations shall be for the purpose of determining the need for a medical examination.

All medical examinations and consultations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place.

6. HAZARD IDENTIFICATION & RECOGNITION

As part of the employers Chemical Hygiene Plan, the OSHA Laboratory Standard requires that "the employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area…Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations."

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students under their supervision are provided with adequate training and information specific to the hazards found within their laboratories.

In addition to required health and safety training as per the OSHA Lab Standard and University Policy, other sources of information on chemical and physical hazards include:

- This CHP
- Known reference materials
- Other department's safety manuals
- Material Safety Data Sheets (SDSs)
- Websites
- EH&S Training Programs
- Container labels
- Laboratory Standard Operating Procedures
- Laboratory Signage and Postings
- Publications such as the American Chemical Society – Safety in Academic Chemistry Laboratories

6.1 SAFETY DATA SHEETS (SDSs)

A Safety Data Sheet (SDS) is a document containing chemical hazard and safe handling information prepared in accordance with the OSHA Hazard Communication Standard. A guide to understanding SDSs can be found in Appendix F.

Chemical manufacturers and distributors must provide a SDS the first time a hazardous chemical/product is shipped to a facility. Only SDSs received must be retained and made available to laboratory workers. However, you can request an SDS for any laboratory chemical from the manufacturer or distributor. Laboratory Supervisors maintain binders with copies of SDSs of all hazardous materials in their areas.

Any chemical shipment received should be accompanied by an SDS (unless one has been shipped with a previous order). If you do not receive an SDS with your shipment, check the chemical manufacturers website first (or call the manufacturer directly), or check the EH&S SDS website for links to SDSs, or contact EH&S at 2-2818 to request assistance in obtaining the SDS.

If you have questions on how to read SDSs, or questions about the terminology or data used in SDSs, you can contact EH&S at 2-2818 for more information. Additional information, including how to read an SDS, can be found in the SDS FAQ and a glossary of terms used on SDSs can be found in the "Hyper-glossary". Information on the National Fire Protection Association - NFPA diamond and the Hazardous Materials Information Guide and Hazardous Materials Information System – HMIG and HMIS - is also available.

It is the responsibility of Principal Investigators and laboratory supervisors to ensure that staff and students working in laboratories under their supervision have obtained required health and safety training and have access to SDSs (and other sources of information) for all hazardous chemicals used in laboratories under their supervision.

SDSs must be accessible at all times. Access to SDSs can mean access to paper copies or electronic access via the internet. EH&S maintains links to a number of SDS websites and other sites with chemical health and safety information.

EH&S strongly encourages paper copies of SDSs be kept in the laboratory, however, having SDS websites bookmarked is acceptable as long as all employees in the workplace know where to find the SDSs and are trained on the use of computers to access SDSs. If a laboratory chooses to use electronic access, then EH&S recommends the SDS website link be posted on the computer or in another conspicuous location. Some departments maintain three ring binders - "Big Yellow Books" - with SDSs. Check with your DSR for the location of the departmental SDS collection.

Please note: any accidents involving a chemical will require an SDS being provided to emergency response personnel and to the attending physician so proper treatment can be administered.

The EH&S "rule of thumb" is that a person working in a laboratory should be able to produce an SDS for any hazardous chemical found in the lab within five minutes.

Material Safety Data Sheets (SDSs) are an important part of any laboratory safety program in communicating information to chemical users. SDSs provide useful information such as:

- The identity of the chemical substance (Other common names)
- Physical and chemical characteristics.
- Physical and health hazards.
- Primary routes of entry.
- OSHA Permissible Exposure Limits (PELs).
- Carcinogenic and reproductive health status.
- Precautions for safe handling and use (including PPE).
- Spill response procedures.
- Emergency and first aid questions.
- Date the SDS was created.

6.2 NFPA DIAMOND LABELING SYSTEM

The National Fire Protection Association (NFPA) developed a label for containers or areas containing hazardous materials. The label is divided into sections that are specifically color coded and positioned in a pattern. Each section contains a number from 0-4. These labels can often be found on SDSs or directly on the chemical container.

The diamond shaped label features sections for health (blue quadrant), flammability (red quadrant), reactivity (yellow quadrant), and special hazards (white quadrant). The numbers appearing in the quadrant represent the severity of the hazard with ratings from 0 (relatively non-hazardous) to 4 (very hazardous). In the special hazards section (white quadrant), hazards shall be identified by the following codes:



W - violent reaction with water	**COR** - corrosive
OXY - strong oxidizing agent	**ALK** - alkali
RED - reducing agent	**ACID** - strong acid

HEALTH	
4	Deadly: even the slightest exposure to this substance would be life threatening. Only specialized protective clothing, for these materials, should be worn.
3	Extreme Danger: serious injury would result from exposure to this substance. Do not expose anybody surface to these materials. Full protective measures should be taken.
2	Dangerous: exposure to this substance would be hazardous to health. Protective measures are indicated.
1	Slight Hazard: irritation or minor injury would result from exposure to this substance. Protective measures are indicated.
0	No Hazard: exposure to this substance offers no significant risk to health.
FLAMMABILITY	
4	Flash Point Below 73ºF and Boiling Point Below 100ºF: this substance is very flammable, volatile or explosive depending on its state. Extreme caution should be used in handling or storing of these materials.

3	Flash Point Below 100ºF: flammable, volatile or explosive under almost all normal temperature conditions. Exercise great caution in storage or handling of these materials.
2	Flash Point Below 200ºF: moderately heated conditions may ignite this substance. Caution procedures should be employed in handling.
1	Flash Point Above 200ºF: this substance must be preheated to ignite. Most combustible solids would be in this category.
0	Will Not Burn: substances that will not burn.
INSTABILITY	
4	May Detonate: substances that are readily capable of detonation or explosion at normal temperatures and pressures. Evacuate area if exposed to heat or fire.
3	Explosive: substances that are readily capable of detonation or explosion by a strong initiating source, such as heat, shock or water. Monitor from behind explosion-resistant barriers.
2	Unstable: violent chemical changes are possible at normal or elevated temperatures and pressures. Potentially violent or explosive reaction may occur when mixed with water. Monitor from a safe distance.
1	Normally stable: substances that may become unstable at elevated temperatures and pressures or when mixed with water. Approach with caution.
0	Stable: substances that will remain stable when exposed to heat, pressure or water.

7. HAZARDOUS MATERIALS SAFE HANDLING

7.1 PRE-WORK CONSIDERATIONS

Know the physical and health hazards associated with the chemical(s) you are using BEFORE YOU STAR WORK. Consider the physical state (gas, liquid, or solid) of the material(s). Consider the process in which you are using the chemical(s), the facilities you have for storage of the materials, and the facilities and equipment you may need to handle an emergency. Know the procedures necessary for safe disposal of the chemicals.

Questions to consider:

1. Is the material flammable, explosive, corrosive, or reactive?
2. Is the material toxic, and if so, how can I be exposed to the material (inhalation, skin or eye contact, accidental ingestion, accidental puncture)?
3. What kind of ventilation do I need to protect myself? What kind of personal protective equipment (i.e. gloves, respirator, goggles) do I need to protect myself?
4. Will the process generate other toxic compounds, or could it result in a fire, explosion, etc.?
5. Are my storage facilities appropriate for the type of materials I will be using? Can I properly segregate incompatible materials?
6. What possible accidents can occur and what steps can I take to minimize the likelihood and impact of an accident?
7. What are the proper procedures for disposal of the chemical(s)?

Once you evaluate the potential hazards associated with the chemical(s) and the process, you can design your process and work procedures to minimize or eliminate the hazards.

The following sections provide work procedures and engineering controls which can be used to minimize or eliminate hazards in the laboratory. Additional information on chemical hazards and health hazard control measures can be found in the reference list in Appendix P & Q. If you have any questions about any information in these sections, please contact EH&S at 2-2818.

7.2 GENERAL SAFETY GUIDELINES

- Know the hazards associated with the materials you are using. Carefully read the label before using a chemical. Review the Material Safety Data Sheet (SDS) for any special handling information. In some cases it may be necessary to do additional research. Contact EH&S (2-2818) for assistance with the evaluation of hazards associated with a specific material.

- Be prepared for hazardous material emergencies and know what action to take in the event of an emergency. Be certain that necessary supplies and equipment are available for handling small spills of hazardous materials.
- Know the location of safety equipment: emergency shower, eye wash, fire extinguisher, fire alarm pull station.
- Do not work alone in the laboratory if you are working with hazardous materials.
- *Limit access to areas where chemicals are used or stored by posting signs and/or locking doors when areas are unattended. Do not permit children in the laboratory.*
- Purchase the minimum amount of hazardous materials necessary to accomplish your work and dispense only the minimum amount necessary for immediate use.
- Use hazardous chemicals only as directed and for their intended purpose.
- Never smell or taste a hazardous chemical.
- Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices.
- Inspect gloves and all other personal protective equipment before use. On equipment such as hoods and biosafety cabinets, be familiar with the certification date or "to be tested again" date given on the test sticker.
- Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres.
- Do not store cryogens or dry ice in non-ventilated rooms such as cold rooms.
- Inspect equipment or apparatus for damage before adding a hazardous chemical or beginning a hazardous procedure. Do not use damaged equipment.
- Glass vacuum lines, pressure lines and Dewar flasks should be taped or caged.
- Ensure that ventilation is adequate for the materials used. Refer to the SDS for information on ventilation requirements, or contact EH&S. See the "Engineering Controls" section of this booklet.
- Avoid direct contact with any chemical. Keep chemicals off hands, face and clothing, including shoes.
- Avoid practical jokes or other behavior which might confuse, startle or distract another worker.
- Confine long hair and loose clothing. Wear shoes at all times in the laboratory, but do not wear sandals or perforated shoes.
- Keep the work area clean and uncluttered with chemicals and equipment. Clean up the work area on completion of an operation or at the end of each work day.

- Use required personal protective equipment. See the "Personal Protective Equipment" section of this booklet. Remove laboratory coats immediately on significant contamination.
- Label all secondary containers with appropriate hazard information. Make sure that labels on primary and secondary containers do not become damaged. Replace them when necessary.
- Use good hygiene. Keep your hands and face clean. Wash thoroughly with soap and water after handling any chemical.
- Smoking, drinking, eating, and the application of cosmetics are forbidden in areas where hazardous chemicals are in use.
- Do not store food or drink for human consumption, or utensils or equipment for preparing food or drink, in the same cabinet, drawer, refrigerator or freezer with chemicals or equipment used with chemicals.
- *Never use mouth suction to fill a pipette.*
- Electrically ground and bond containers using approved methods before transferring or dispensing a flammable liquid from a large container.
- Promptly clean up spills, using appropriate protective apparel, equipment and procedures. See the "Emergency Preparedness" section of the booklet.
- Ensure that adequate storage facilities and containers are provided for hazardous materials. See the "Chemical Storage" section of this booklet.
- Ensure that hazardous materials are properly segregated into compatible categories. See the "Chemical Storage" section of this booklet.
- For unattended operations, leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of a utility service failure (e.g., loss of cooling water). Plans to conduct unattended operations should be reviewed with the supervisor, or principal investigator.
- For specific information regarding chemical handling, contact your supervisor, instructor, or EH&S.

8. HAZARDOUS MATERIALS/ CHEMICAL STORAGE & MANAGEMENT

Chemical storage areas in the academic laboratory setting include central stockrooms, storerooms, laboratory work areas, storage cabinets, refrigerators, and freezers. There are established legal requirements as well as recommended practices for proper storage of chemicals. Proper storage of chemicals promotes safer and healthier working conditions, extends the usefulness of chemicals, and can help prevent contamination. Safe chemical use includes minimizing exposure to chemicals, proper training, understanding chemical hazards, proper labeling, proper storage and segregation, and proper transport.

8.1 GENERAL GUIDELINES

- Carefully read the label before storing a hazardous chemical. The SDS will provide any special storage information and incompatibilities.
- Ensure all containers are in good condition and **properly labeled**.
- Do not store unsegregated chemicals in alphabetical order.
- Do not store incompatible chemicals in close proximity to each other.
- Whenever possible, separate chemicals into the following general hazard classes:
    - Flammable/combustible liquids
    - Flammable solids
    - Mineral acids
    - Organic acids (liquid)
    - Caustics
    - Oxidizers
    - Perchloric acid
    - Water-reactive
    - Air-reactive
    - Heat-reactive (require refrigeration)
    - Unstable (shock-sensitive, explosive)
    - Others
    - Gases:
        - toxic
        - flammable
        - oxidizers and inert
- Once separated into hazard classes, chemicals may be stored alphabetically.
- Determine what equipment and space is needed for safe storage of chemicals.
- Except when material is being transferred, keep chemical containers tightly closed.
- Use approved storage cabinets, containers, and safety cans for flammable liquids.
- Refrigerators and freezers used for the storage of chemicals or other laboratory supplies must be posted “No flammables or combustibles” if they have internal sources of ignition.

- Do not store chemicals on refrigerator door shelves. Containers could fall when the door is opened or closed.
- Refrigerators for storage of food (for staff lunches, etc.) must be marked "FOOD ONLY, NO CHEMICALS OR LAB SUPPLIES."
- Do not store food, beverages, or food/beverage preparation supplies or equipment in an area (e.g. cabinet, shelf, refrigerator, drawer) that is used for storage of chemicals or equipment used in chemical work.
- Flammable liquids stored in glass containers shall not exceed 1 quart (liter). Exception: For conditions where chemical purity must be protected, flammable liquids stored in glass containers shall not exceed 1 gallon (4 liters).
- Corrosion resistant cabinets are recommended for storage of corrosives.
- Use spill trays under containers of reagents which can cause spill problems.
- Dispose of old chemicals promptly.
- Recycle excess chemicals no longer being used in your area. Contact EH&S for recycling information.
- Do not store liquids above eye level.
- For more information on chemical storage, contact your supervisor, instructor, or EH&S.

8.2 CHEMICAL LABELING

The simple rule for chemical labeling is - if a container looks like it contains a chemical (even a clear liquid even deionized water), then it must be labeled with the contents. Proper labeling of chemicals is one way of informing people who work in laboratories of potential hazards that exist, preventing the generation of unknowns, and facilitating emergency responses such as cleaning up spills and obtaining the proper medical treatment.

Original Containers

New chemical containers have the proper labeling information on the chemical label. The OSHA Laboratory Standard requires that labels on all incoming containers must be maintained and not defaced. As part of laboratory good housekeeping and self-inspections, if any chemical labels appear to be falling off, then laboratory personnel should tape the label back on the container or re-label with a permanent label. Laboratory personnel are strongly encouraged to make use of EH&S Right-To-Know chemical labels.

Non-Original Containers

Non-original containers (secondary use containers) such as wash bottles, squirt bottles, temporary storage containers, beakers, flasks, bottles, vials, etc. or any container that a chemical from an original container is transferred into, must be properly labeled. In general, EH&S recommends writing out the full chemical name and any hazards associated with that chemical. Laboratory personnel are strongly encouraged to use

commercially available pre-labeled containers (such as squirt bottles) for chemicals that get used frequently. However, labs can also choose to label chemical containers in other ways such as:

- All chemical containers (both hazardous and non-hazardous) MUST be labeled. Chemical names must be written out in English. If a label is starting to fall off a chemical container or is becoming degraded, then the container needs to be relabeled (using tape, permanent marker, EH&S Right-To-Know labels, etc.) or the chemical needs to be transferred to another properly labeled container.
- If abbreviations such as formulas, structures, or acronyms are used, then a "key" to the abbreviations must be hung up in a conspicuous location.
- All personnel working in the laboratory must be fully trained on how to label chemicals using the system and how to understand the labeling system. Training must occur when a new person begins working in the laboratory, when new chemicals are introduced, and should occur on a regular basis or annually.

9.0 PARTICULARLY HAZARDOUS SUBSTANCES

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

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

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

EH&S can assist researchers by providing information on working with particularly hazardous substances. General guidelines and recommendations for the safe handling, use, and control of hazardous chemicals and particularly hazardous substances can be found in SDSs and other references such as Prudent Practices in the Laboratory.

9.1 ESTABLISHMENT OF DESIGNATED AREAS

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

In certain cases of establishing designated areas, Principal Investigators and laboratory supervisors may want to restrict use of a particularly hazardous substance to a fume hood, glove box or other containment device. This information should be included as part of the laboratory's SOPs and covered during in-lab training.

Establishing a designated area not only provides better employee protection, but can help minimize the area where potential contamination of particularly hazardous substances could occur. If a designated area is established, a sign should be hung up (on a fume hood for example) indicating the area is designated for use with particularly hazardous substances. Most designated areas will have special PPE requirements and/or special waste and spill cleanup procedures as well. These and other special precautions should be included within the lab's SOPs.

9.2 SAFE REMOVAL OF CONTAMINATED MATERSILS AND WASTE

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

9.3 DECONTAMINATION PROCEEDUES

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

9.4 GUIDELINES FOR WORKING WITH PARTICULARLY HAZARDOUS SUBSTANCES

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

- Substitute less hazardous chemicals if possible to avoid working with particularly hazardous substances and keep exposures to a minimum.
- Always obtain prior approval from the Principal Investigator before ordering any particularly hazardous substances.
- Plan your experiment out in advance, including layout of apparatus and chemical and waste containers that are necessary.
- Before working with any particularly hazardous substance, review chemical resources for any special decontamination/deactivation procedures and ensure you have the appropriate spill cleanup materials and absorbent on hand.
- Ensure that you have the appropriate PPE, particularly gloves (check glove selection charts or call EH&S at 2-2818).
- Always use the minimum quantities of chemicals necessary for the experiment. If possible, try adding buffer directly to the original container and making dilutions directly.
- If possible, purchase premade solutions to avoid handling powders. If you have to use powders, it is best to weigh them in a fume hood. If it is necessary to weigh outside of a fume hood (because some particles may be too light and would pose more of a hazard due to turbulent airflow) then wear a dust mask when weighing the chemical. It is advisable to surround the weighing area with wetted paper towels to facilitate cleanup.

- As a measure of coworker protection when weighing out dusty materials or powders, consider waiting until other coworkers have left the room to prevent possible exposure and thoroughly clean up and decontaminate working surfaces.
- Whenever possible, use secondary containment, such as trays, to conduct your experiment in and for storage of particularly hazardous substances.
- Particularly hazardous substances should be stored by themselves in clearly marked trays or containers indicating what the hazard is i.e. “Carcinogens,” Reproductive Toxins”, etc.
- Always practice good personal hygiene, especially frequent hand washing, even if wearing gloves.
- If it is necessary to use a vacuum for cleaning particularly hazardous substances, only High Efficiency Particulate Air (HEPA) filters are recommended for best capture and protection. Be aware that after cleaning up chemical powders, the vacuum bag and its contents may have to be disposed of as hazardous waste.
- Ensure information related to the experiment is included within any SOPs.

9.5 PRIOR APPROVAL

The OSHA Laboratory Standard requires Chemical Hygiene Plans to include information on “the circumstances under which a particular laboratory operation, procedure or activity shall require prior approval”, including “provisions for additional employee protection for work with particularly hazardous substances” such as "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity.

Prior approval ensures that laboratory workers have received the proper training on the hazards of particularly hazardous substances or with new equipment, and that safety considerations have been taken into account BEFORE a new experiment begins.

While EH&S can provide assistance in identifying circumstances when there should be prior approval before implementation of a particular laboratory operation, the ultimate responsibility of establishing prior approval procedures lies with the Principal Investigator or laboratory supervisor.

Principal Investigators or laboratory supervisors must identify operations or experiments that involve particularly hazardous substances (such as "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity) and highly hazardous operations or equipment that require prior approval. They must establish the guidelines, procedures, and approval process that would be required. This information should be documented in the laboratory's or department's SOPs. Additionally, Principal Investigators and laboratory supervisors are strongly encouraged to have written documentation, such as “Prior Approval” forms that are

completed and signed by the laboratory worker, and signed off by the Principal Investigator or laboratory supervisor and kept on file.

Examples where Principal Investigators or laboratory supervisors should consider requiring their laboratory workers to obtain prior approval include:

- Experiments that require the use of particularly hazardous substances such as "select carcinogens," reproductive toxins, and substances that have a high degree of acute toxicity, highly toxic gases, cryogenic materials and other highly hazardous chemicals or experiments involving radioactive materials, high powered lasers, etc.
- Where a significant change is planned for the amount of chemicals to be used for a routine experiment such as an increase of 10% or greater in the quantity of chemicals normally used.
- When a new piece of equipment is brought into the lab that requires special training in addition to the normal training provided to laboratory workers.
- When a laboratory worker is planning on working alone on an experiment that involves highly hazardous chemicals or operations.

9.6 CAMPUS PRIOR APPROVAL

There are some circumstances where prior approval from a campus research related committee is required before beginning an operation or activity. These include:

- Research using live vertebrate animals – contact the Institutional Animal Care and Use Committee.
- Recombinant DNA use – contact the Institutional Biosafety Committee.
- Use of Radioactive Materials – contact the Radiation Safety Committee
- Use of Human Subjects - contact the Institutional Review Board

9.7 SELECT CARCINIGENS

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

The OSHA Lab Standard defines a “select carcinogen” as any substance which meets one of the following criteria:

- It is regulated by OSHA as a carcinogen; or
- It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

- It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
    - After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);
    - After repeated skin application of less than 300 (mg/kg of body weight) per week; or
    - After oral dosages of less than 50 mg/kg of body weight per day.

With regard to mixtures, OSHA requires that a mixture "shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of **0.1% or greater**, which is considered to be carcinogenic." When working with carcinogens, laboratory staff should adhere to Guidelines for Working with Particularly Hazardous Substances.

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

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

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

9.8 REPORDUCTIVE TOXINS

The OSHA Lab Standard defines a reproductive toxin as a chemical "which affects the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis)".

A number of reproductive toxins are chronic toxins that cause damage after repeated or long duration exposures and can have long latency periods. Women of childbearing potential should be especially careful when handling reproductive toxins. Pregnant women and women intending to become pregnant, or men seeking to have children, should seek the advice of their physician or the Pace University Health Care Unit before working with known or suspected reproductive toxins.

It is important to be aware of the threats to reproductive health and prevent potential reproductive hazard exposures for male and female employees and students who work with known and suspected reproductive toxins including chemical, biological, radiological, and physical agents. EH&S is available to respond to concerns or questions on reproductive hazards, conduct workplace hazard assessments, and provide recommendations to address or eliminate specific reproductive risks. As with any particularly hazardous substance, work involving the use of reproductive toxins should adhere to the Guidelines for Working with Particularly Hazardous Substances.

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

9.9 ACUTE TOXINS

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

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

Information on determining whether or not a chemical meets one of these definitions can be found in SDSs and other chemical references.

As with any particularly hazardous substance, work involving the use of acute toxins should adhere to the Guidelines for Working with Particularly Hazardous Substances. In addition to following the Guidelines for Working with Particularly Hazardous Substances, additional guidelines for working with acute toxins include:

- Consider storing highly toxic materials in a locked storage cabinet.
- Be aware of any special antidotes that may be required in case of accidental exposure (Hydrofluoric acid and inorganic cyanides for example).

- Give particular attention to the selection of gloves and other personal protective equipment.
- Do not work with highly toxic chemicals outside of a fume hood, glove box or ventilated enclosure.

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

10. PROTECTION & CONTROLS

Laboratory work must be performed in ways that will reduce the probability and severity of an accident or toxic exposure to a negligible level. Minimizing risks depends on employing proper engineering controls, safe laboratory practices, and proper selection and use of personal protective equipment. Standard Operating Procedures (SOPs) must be established when particularly hazardous substances are used. Principal Investigators and laboratory managers should develop SOPs in consultation with EH&S.

10.1 ENGINEERING CONTROLS

Exposure to hazardous materials should be controlled to the greatest extent feasible by use of engineering controls. For assistance in determining engineering controls necessary for your work situation, contact EH&S. Engineering controls to reduce or eliminate exposures to hazardous chemicals include:

- substitution of less hazardous equipment or process (e.g., safety cans for glass bottles)
- isolation of the operator or the process (e.g., use of barriers when handling explosives, or completely enclosing process in glove box or other enclosure)
- local and general exhaust ventilation (e.g., use of fume hoods)

Ventilation Controls. To determine ventilation requirements, check the SDS. Expressions on an SDS such may indicate a need for ventilation; examples include use with adequate ventilation, use in a fume hood, use local exhaust, avoidance vapor inhalation, etc.

Ventilation recommendations must be adapted to the worksite and the specific process. For assistance in determining specific ventilation requirements for your work situation, contact EH&S.

Proper Use of Ventilation Systems

As a rule of thumb, use a hood or other local ventilation device when working with any volatile substance.

Once a ventilation system is installed in a work area, it must be used properly to be effective. The objective of a local exhaust ventilation system is to draw hazardous materials in the air away from the breathing zone of the employee. The system must be checked prior to each use to determine that it is operating. If the system is not working, it should be posted out of order and the Building Deputy should be contacted to have the system repaired. **Do not work with hazardous materials if the required ventilation system is not working.**

Ventilation systems must be properly configured. Be sure you know how to properly use the system in your area for the work you are doing. For use of laboratory fume hoods, the following guidelines should be followed:

1. Fume hoods should be marked to indicate proper sash position for optimum hood performance. The hood sash should be set at this point for procedures which could generate toxic aerosols, gases or vapors. If it is not possible to do work with the sash height set at the point marked, or if there is no marking on the hood, contact EH&S. In general, the sash height should be set at a level where the operator is shielded to some degree from any explosions or violent reactions which could occur and where optimum air flow dynamics are achieved. Most fume hoods are not intended to be used with the sash fully open.

2. Fume hoods should be equipped with a manometer or other continuous reading monitoring device to indicate adequacy of flow. Learn how to read and interpret this gauge, and check it daily. If the gauge indicates a reduced flow in the hood, post an out of order sign and contact Building & Grounds to have the hood repaired.

3. Only apparatus and chemicals essential to the specific procedure or process should be placed in the hood. Extraneous materials from previous experiments or procedures should be removed and stored in a safe location outside the hood. Hoods used for experimental work should not be used for chemical or material storage. Hoods used for chemical storage should be dedicated to chemical storage. No experimental work should be conducted in these hoods.

If there are any questions concerning the adequacy of a fume hood or the procedures for safe use of a fume hood, contact EH&S.

10.2 ADMINISTRATIVE CONTROLS

Administrative controls are procedural measures which can be taken to reduce or eliminate hazards associated with the use of hazardous materials. Administrative controls include the following:

- Careful planning of experiments and procedures with safety in mind. Planning includes the development of written work procedures for safe performance of the work. Follow your procedures.
- Restricting access to areas in which hazardous materials are used.
- Using signs or placards to identify hazardous areas (designated areas).
- Use of labels on hazardous materials.
- Substitution of less toxic materials for toxic materials.
- Good housekeeping.
- Good hygiene (e.g., washing hands and other areas of possible chemical contact).
- Prohibiting the storage and preparation of food in areas where chemicals are used or stored.
- Prohibiting eating, drinking, and smoking where chemicals are used or stored, and providing break areas for this purpose.

- No mouth pipetting.
- Adding acid (or caustic) to water, never water to acid (or caustic).
- Ensuring that employees are provided adequate training for safe work with hazardous materials.

Restricted access areas- Facilities placarded with any of the following or similar warning signs are to be regarded as restricted access areas:

- CAUTION - BIOHAZARD
- CAUTION - CARCINOGENS, REPRODUCTIVE TOXINS, OR OTHER EXTREEMLY TOXIC CHEMICALS
- CAUTION - RADIOACTIVE MATERIAL
- CAUTION - RADIATION AREA
- CAUTION - X-RAY
- CAUTION - LASER

Such areas and are not to be entered except by authorized users of the facility and those having permission from authorized users. Children are never permitted in restricted access areas. (See below for considerations relating to Building Services and other support staff.)

All areas which fit the definition of "laboratory use of hazardous chemicals", regardless of whether they are or contain restricted access areas, must be posted, on the outside of the primary egress door(s), with:

(1) The name of the faculty or administrative staff member having responsibility for the area,
(2) Laboratory: Potentially Hazardous Substances. A sign with the above words in red on a white background must be posted on the door outside of each laboratory at the midpoint of the height of the door. It must be made of metal or other durable material and posted at eye level. The height of the letters in the word "Laboratory" must be at least 1 and 1/2 inches high; the words "potentially hazardous substances" must be at least 7/16 inches high.
(3) No Smoking.
(4) Emergency contact name(s) and telephone number(s) of responsible persons.

Custodians are permitted to enter restricted areas to perform routine tasks; however, custodians should not touch containers of chemicals (including waste) or other research equipment or materials. Other support personnel, such as Buildings & Grounds staff and Security personnel are permitted to enter restricted areas provided the work to be performed does not involve disturbing a use area within the facility, equipment, or materials. Examples include fume hoods, sinks, benches, and biological safety cabinets.

Support personnel should contact an authorized user of the facility or EH&S before performing work which may involve any of the above items.
Immediately notify the University Security (see cover page) of any emergency or unusual conditions such as spills, fire, leaks, injuries or contamination. For additional information concerning restricted access areas, contact your supervisor, instructor or EH&S.

10.3 PERSONAL PROTECTIVE EQUIPMENT

General Considerations

Personal protective devices may be needed to supplement available engineering controls, but are never used as a substitute for engineering controls except as a temporary measure while such controls are being instituted or for short term jobs where the implementation of engineering controls is not feasible.

The SDS will provide some information on the personal protective equipment recommended for use with the chemical. The SDS addresses "worst case" conditions; therefore, all the equipment described may not be necessary for a specific job. In addition, the SDS may not provide sufficient information concerning a specific respirator or type of glove appropriate for the chemical.

A Hazard Assessments must be completed by the supervisor to determine which personal protective devices are required for each task performed by employees. There is no harm in being over protected, but the minimal requirements are to be spelled out by the hazard assessments.

Departments must provide required personal protective equipment to employees, and supervisors must ensure that employees are trained in all necessary aspects of its proper use and care. This training must be documented. **Failure to prescribe, provide, and properly use required personal protective equipment can result in personal injury and disciplinary action.**

Protection Against Inhalation Hazards

When ventilation is not adequate to provide protection against an inhalation hazard, respiratory protective equipment may be necessary. There is a variety of respiratory protective equipment available for use, but no one device will provide protection against all possible hazards. Respirator selection is based on the chemical and process hazard, and the protection factors required.

Respirators are not to be used except in conjunction with a comprehensive respiratory protection program. Such a program includes a review of the process to ensure that proper equipment is selected for the job; training of all respiratory protective equipment users concerning the methods for proper use and care of such equipment; fitting of respirator users when required; and medical surveillance of respirator users when required.

Types of respiratory protective equipment include:

- particle-removing air-purifying respirators
- gas and vapor-removing air-purifying respirators
- atmosphere-supplying respirators

If your work requires the use of a respirator or you suspect your work requires the use of a respirator, you should contact your supervisor. He/she will contact EH&S for an evaluation of the exposure and will schedule a medical physical examination to determine that you are physically fit to wear respiratory protection, and respirator fit-testing and training.

Do not use respiratory protective equipment until you have received proper training. Contact EH&S immediately if you are currently using a respirator and have not been fit tested and received training on respirator use and care.

For more information on the Pace University Respiratory Protection Program, contact EH&S.

Protection of Skin and Body
Skin and body protection involves the use of protective clothing to protect various parts of the body.

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

- safety glasses with side shields for dust and flying object hazards
- splash-proof goggles for chemical splash, spray and mist hazards
- full-face and neck shields for head and neck protection from various hazards (must be used with safety glasses or goggles)

Splash-proof goggles provide superior protection against dust, flying objects, and splash, spray and mist hazards. They should be the first choice for primary eye protection.

Cover all unprotected skin surfaces. Do not wear open-toe shoes, sandals, shorts, etc. in a chemical laboratory.

Even when there is minimal danger of skin contact with a hazardous substance, lab coats, coveralls, aprons, or protective suits should be used. General categories of contaminants include lab chemicals, toxic dusts, biological materials, and radioactive materials.

Garments contaminated with hazardous materials should not be taken home by staff for laundering. They should be laundered on-site or by a commercial laundry which has been appraised of potential hazards.

For heavily contaminated work, special attention must be given to sealing all openings in the clothing. Tape can be utilized for this purpose. Caps should be worn to protect hair from contamination.

Exposures to strong acids and acid gases, organic chemicals and strong oxidizing agents, carcinogens, and mutagens require the use of protective equipment that prevents skin contamination. Impervious protective equipment must be utilized. Examples include rubber gloves, rubberized suits, and rubber boots.

CONTAMINATED CLOTHING AND PROTECTIVE EQUIPMENT

Where splash or spill of hazardous chemicals on clothing or protective equipment occurs, the clothing/equipment should be removed and placed in a closed container which prevents dispersion of the hazardous chemical. The clothing/equipment should be disposed of, cleaned, or laundered as appropriate. Employees should not take contaminated clothing/equipment home for cleaning or laundering. Persons or companies cleaning or laundering contaminated clothing or equipment must be informed of the potentially harmful effects of exposure to the chemical contaminant and must be advised of the measures necessary to protect themselves.

11. TRANSPORTATION OF HAZARDOUS MATERIALS

11.1 TRANSPORTATION OVER THE ROAD

Any container of hazardous material transported on a road accessible to or used by the public is subject to the regulation by the U.S. Department of Transportation (DOT). DOT regulations require, in part, that no person may offer or accept a hazardous material for transportation unless the material is properly classified, described, packaged, marked, labeled, manifested, and in condition for shipment. This includes hazardous materials transported between the various University buildings and campuses. DOT regulations require the driver of a vehicle transporting hazardous materials in quantities requiring a placard to possess a Commercial Driver's License. For materials classified as "dangerous by inhalation", there is no exempt quantity. DOT regulations also specify training requirements for any individual who engages in the following activities:

- Load, unloads, or handles hazardous materials in transportation;
- Reconditions or tests containers, drums, or packages represented for use in the transportation of hazardous materials;
- Prepares hazardous materials for transportation;
- Completes hazardous waste manifests;
- Is responsible for safety of transported hazardous materials; or
- Operates a vehicle (including personal vehicle) used to transport hazardous materials.

Contact EH&S prior to shipping or transporting a hazardous material.

11.2 TRANSPORTATION INSIDE BUILDINGS AND BY FOOT

The following best management practices should be utilized for the transportation of hazardous materials inside of buildings or while on foot:

- Approved Transport Container means a commercially available bottle carrier made of rubber, metal, or plastic with carrying handle(s) which is large enough to hold the contents of the container if broken in transit. Carrier lids or covers are recommended, but not required. Rubber or plastic should be used for acids/alkalis; and metal, rubber, or plastic for organic solvents.
- Laboratory Carts used to transport chemicals from one area to another shall be stable and in good condition. Transport only a quantity which can be handled easily. Plan the route ahead of time so as to avoid all steps or stairs. Carts must have a lip or brim.
- Freight Elevators, Not Passenger Elevators, should be used to transport hazardous chemicals whenever possible. The individual transporting the hazardous chemicals should operate the elevator alone if possible. Avoid getting on an elevator when a person is transporting hazardous chemicals.

12. EMERGENCY PREPAREDNESS

IN CASE OF AN EMERGENCY:
CALL 777 from any campus phone to reach Pace University Security or dial 911 or the below numbers from any cell phone, or off campus phone.

Campus	Location	Phone
New York City	B-Level, East Wing (Schimmel Entrance)	(212) 346 - 1800
Pleasantville	Goldstein Fitness Center Lobby	(914) 773 - 3400
Briarcliff	Dow Hall Lobby	(914) 923 - 2700
Graduate Center-White Plains	Lobby	(914) 422 - 4166
School of Law-White Plains	Preston Hall Lobby	(914) 422 - 4300

Consult the Emergency Response Guide for more information.

Emergencies can occur at any time, without warning. Careful planning, with an emphasis on safety, can help members of the Pace community handle crises and emergencies with appropriate responses, and could save lives. Every member of the Pace community shares responsibility for emergency preparedness.

12.1 EMERGENCY EVAUATION PROCEEDURES

A building evacuation is mandatory whenever a fire alarm sounds. Building occupants should exit immediately, putting their lab evacuation plan into effect. After the building has been evacuated, occupants must wait for a safety inspection before re-entry.

If a complete campus evacuation and closure is necessary during an emergency, it will be announced and coordinated by the Pace Emergency Management Committee from the University Emergency Operations Center. Campus evacuations will be sequential to maintain safety and avoid traffic gridlock.

Note that it may or may not be necessary to vacate a specific area during an emergency incident. Occupants in the area may simply be directed to remain on-site and shut down systems, or they may be asked to move to other sections of their floor or building. In some events (such as extended power outages), evacuations are not necessary unless the incident has generated a hazardous materials incident or immediate health and safety risk. In limited emergencies, wait for evacuation instructions and engage the University's Emergency Response Team to communicate the information throughout the department.

Evacuation Procedures Overview

Evacuation is required any time the fire alarm sounds, an evacuation announcement is made or a University official orders you to evacuate.

1. Turn equipment off, if possible
2. Quickly, safely shutdown any hazardous operations or processes and render them safe. Critical emergency coordination staff must follow the unit emergency plan. All emergency plans for critical operations must be reviewed and approved by Environmental Health & Safety. Without prior review and approval, staff members may not remain in a building once an evacuation signal or order has been given.
3. Notify others in the area of the alarm if they did not hear it.
4. Take emergency supplies and staff rosters, if possible.
    - Exit the room
    - Take jackets or other clothing needed for protection from the weather.
    - Close windows and close, but do not lock doors as you leave.
    - Leave room lights on.
    - If you are away from the unit's room when the alarm sounds you should exit the building immediately and not return to the unit's room.
5. Exit the building via the nearest safe exit route. Walk, do not run. Do not use elevators to evacuate.
6. Move away from the building, report to the unit's designated evacuation point and meet with other persons from the unit or building. Report any missing or trapped people to the emergency responders.
7. Keep existing groups together.
8. Account for faculty, staff and students and sign in at evacuation point.
9. Wait an evacuation point for directions

Do not reenter the building until emergency staff gives the "all clear" signal. The silencing of the building fire alarm system is normally used as the "all clear" signal. In some cases the fire alarm will be silenced and staff members placed at building entrances to keep people out until the incident has been resolved.

<u>If you are unable to leave the building due to a physical disability</u>:

- Go to the nearest area where there are no hazards.
- Use a telephone to call Pace Security at 777 from any campus phone (or 911 from a cell phone), or use other means to advise them of the current situation.
- Be sure to give them the building and room number so they can send you help.
- If possible, signal out the window to on-site emergency responders.
- One person may remain with you if they wish to assist you.

Evacuation of Persons with Disabilities

Be aware that faculty, staff and students with "hidden" disabilities (arthritis, cardiac conditions, back problems, learning disabilities, etc.) may also need individual assistance. Use a "buddy system" naming who is responsible for whom.

12.2 EMERGECNY PROCEEDURES

Emergencies can include both fire and non-fire emergencies. Fires are an "expected" emergency in all lab situations and almost all lab staff is trained on emergency steps in the event of a fire. "Non-fire" emergencies can include:

- Loss of electricity, heat, AC, water or other essential utilities.
- Failure of mechanical equipment such (e.g. HVAC systems or generators).
- Flooding, tornadoes, earthquakes, or other natural disasters.
- Nearby chemical releases of hazardous materials to the environment (from the lab down the hall or a ruptured tank car one-half mile away).
- Terrorist actions or civil unrest.

Each laboratory facility should develop a non-fire emergency plan or incorporate non-fire emergencies into a master emergency response plan. Employees must be trained on the contents of the plan and how to respond in a non-fire emergency. Pace EH&S has devised a set of simple steps for the shutdown of labs in non-fire emergency situations. These and other steps, based on the requirements of the facility, should be included in the emergency response plan of each unit or facility. This list is by no means complete, but it gives laboratory personnel simple steps to ensure a safe lab shutdown.

- Close fume hood sashes.
- Be certain that the caps are on all bottles of chemicals.
- Turn off all non-essential electrical devices. Leave refrigerators and freezers on and make sure the doors are closed. It may be necessary to check to ensure that essential equipment is plugged in to the power receptacles supplied by the emergency generator (usually orange or red).
- Turn off all gas cylinders at the tank valves. Note: If a low flow of an inert gas is being used to "blanket" a reactive compound or mixture, then the lab worker may want to leave the flow of gas on. This should be part of a pre-approved, written, posted standard operating procedure for this material or process.
- Check all cryogenic vacuum traps (Nitrogen, Carbon dioxide, and solvent). The evaporation of trapped materials may cause dangerous conditions. Check all containers of cryogenic liquids to ensure that they are vented to prevent the buildup of internal pressure.
- Check all pressure, temperature, air, or moisture sensitive materials and equipment. This includes vacuum work, distillations, glove boxes used for airless/moisture less reactions, and all reactions in progress. Terminate all reactions that are in progress, based on the known scope of the emergency.

- If experimental animals are in use, special precautions may need to be taken to secure those areas such as emergency power, alternative ventilation, etc.
- All non-essential staff/students must leave the building. Depending on the nature of the emergency, some staff may need to stay behind to facilitate the start-up of essential equipment once the lab is reopened.
- It is important to remember that some equipment does not shut down automatically – such as large cryogenic magnets, sources of radioactivity, and other pieces of equipment. Be sure to check any special operating procedures for your equipment before an emergency occurs.

12.3 MEDICAL EMERGECNY PROCEEDURES

Call 777 (or 911 from a cell phone) in any emergency that requires immediate police, fire or medical response to preserve a life.

- Protect the victim from further injury or harm by removing any persistent threat to the victim or by removing the victim to a safe place if needed, however do not move the victim unnecessarily or enter an environment that put you as a responder in danger (e.g. IDLH gas concentrations, electric charge). Do not delay in obtaining trained medical assistance if it is safe to do so.
- Notify Pace Security of the location, nature and extent of the injury by calling 777 or using a Blue Light or Emergency Telephone. Always call from a safe location.
- Provide first aid until help arrives if you have appropriate training and equipment, and it is safe to do so.
- Send someone outside to escort emergency responders to the appropriate location, if possible.

12.4 FIRST AID KITS

If there is a first aid kit in your work space, then there are some additional requirements to address. There has to be the appropriate items in the kit to mediate an injury that could happen in your work area. There needs to be a responsible person in your work space that is trained - with their contact information posted on the kit. The kit should be maintained and complete at all times. An Injury/Illness report should be completed when a first aid kit is used due to an injury/illness in a Pace University laboratory. Review the inventory regularly to make sure the kit is properly stocked and items have not expired.

The ANSI Standard lists the following minimum fill requirements for a first aid kit:

- 1 - Absorbent compress, 4 x 8 in. minimum
- 5 yard Adhesive Tape
- 10 - Antiseptic applications, 0.14 fl.oz. each
- 1 - Triangular bandage, 40 x 40 x 56 in. minimum
- 16 - Adhesive Bandages, 1 x 3 inch

- 2 - Pair medical exam gloves
- 4 - Sterile pads, 3 x 3 in. minimum
- 6 - Burn treatment applications, 1/32 oz. each

12.5. FIRE OR EXPLOSION EMERGENCY PROCEEDURES

All fires must be reported to Pace Security, including those that have been extinguished. Do not hesitate to activate the fire alarm if you discover smoke or fire.

- Alert people in the immediate area of the fire and evacuate the room.
- Confine the fire by closing doors as you leave the room.
- Activate a fire alarm by pulling on an alarm box.
- Notify Pace Security of the location and size of the fire by calling 777 from a campus phone, or 911 from a cell phone or off campus phone, or using a Blue Light or Emergency Telephone. Always call from a safe location.
- Evacuate the building using the Emergency Evacuation Procedure. Do not use elevators to evacuate unless directed to do so by emergency responders.
- Notify emergency responders of the location, nature and size of the fire once you are outside.

If you have been trained and it is safe to do so, you may attempt to extinguish the fire with a compatible and portable fire extinguisher. Attempt to extinguish only small fires and make sure you have a clear escape path. If you have not been trained to use a fire extinguisher you must evacuate the area.

If clothing is on fire:

- Stop - Drop to the ground or floor and Roll to smother flames.
- Smother flames using a fire blanket.
- Drench with water from a safety shower or other source.
- Seek medical attention for all burns and injuries.

12.5.1 FIRE EXTINGUISHERS

- All fire extinguishers are inspected annually and maintained by B&G.
- Laboratory personnel should perform regular visual checks (***minimum on a monthly basis***) to ensure fire extinguishers present in their labs are fully charged. For those fire extinguishers with a readout dial, labs only need to ensure the indicator arrow on the readout dial is within the green zone. If the indicator arrow is on either side of the green zone, which indicates a problem, then call B&G to have the fire extinguisher replaced.
- Any fire extinguisher that has been used at all, even if it wasn't fully discharged, needs to be reported to B&G so a replacement fire extinguisher can be provided in its place. You can also obtain training in using a fire extinguisher by contacting EH&S at 2-2818.

12.6 POWER OUTAGE PROCEEDURES

- Assess the extent of the outage in the unit's area.
- Report the outage to B&G Pace Customer Service Center.
- Assist other building occupants to move to safe locations. Loss of power to fume hoods may require the evacuation of laboratories and surrounding areas.
- Evaluate the unit's work areas for hazards created by a power outage. Secure hazardous materials. Take actions to preserve human and animal safety and health. Take actions to preserve research.
- Turn off and/or unplug non-essential electrical equipment, computer equipment and appliances. Keep refrigerators and freezers closed throughout the outage to help keep contents cold.
- If needed, open windows (in mild weather) for additional light and ventilation (this is not always advisable in BSL2 labs).

12.7 CHEMICAL SPILL PROCEEDURES

When a chemical spill occurs, it is necessary to take prompt and appropriate action. The type of response to a spill will depend on the quantity of the chemical spilled and the severity of the hazards associated with the chemical. The first action to take is to alert others in your lab or work area that a spill has occurred. Then you must determine if you can safely clean up the spill yourself.

Many chemical spills can be safely cleaned up by laboratory staff without the help of EH&S. Only attempt to clean up incidental spills if you are trained and have proper spill cleanup materials available. Note: The following advice is intended for spills that occur within a University building. A release to the outside environment may require the University file a report with the EPA. Calling Pace Security will initiate this determination in conjunction with EH&S.

12.7.1 INCIDENETAL SPILLS

A spill is considered incidental if the criteria below are met:

Physical:

- The spill is a small quantity of a known chemical.
- No gases or vapors are present that require respiratory protection.

Equipment:

- You have the materials and equipment needed to clean up the spill.
- You have the necessary proper personal protective (PPE) equipment available.

Personal:

- You understand the hazards posed by the spilled chemical.
- You know how to clean up the spill.
- You feel comfortable cleaning up the spill.

12.7.1.1 INCIDENTAL SPILL CLEANUP PROCEDURES

1) Notify other people in the area that a spill has occurred. Prevent others from coming in contact with the spill (i.e. walking through the spilled chemical). The first priority is to always protect yourself and others.
2) Put on the Proper Personal Protective Equipment (PPE) such as goggles, gloves, etc. before beginning cleanup. Do not unnecessarily expose yourself to the chemical.
3) Stop the source of the spill if possible, and if safe to do so.
4) Try to prevent spilled chemicals from entering waterways by building a dike around access points (sink, cup sinks, and floor drains inside and storm drains outside) with absorbent material if you can safely do so.
5) Use the appropriate absorbent material for liquid spills (detailed in the following section).
6) Slowly add absorbent material on and around the spill and allow the chemical to absorb. Apply enough absorbent to completely cover the spilled liquid.
7) Sweep up the absorbed spill from the outside towards the middle.
8) Scoop up and deposit in a leak-proof container.
9) For absorbed hazardous chemicals, label the container appropriately and manage as hazardous waste.
10) If possible, mark the area of the spill on the floor with chalk.
11) Wash the contaminated surface with soapy water. If the spilled chemical is highly toxic, collect the rinse water for proper disposal.
12) Report the spill to your supervisor & EH&S.
13) Restock any spill clean-up supplies that you may have used from any spill kits.

12.7.1.2 SPILL ABSORBENT MATERIALS

Note: *The following materials are EH&S approved/recommended spill absorbent materials, however, they are not appropriate for every possible chemical spill – when in doubt, contact EH&S at 2-2818 for advice.*

For acid spills (except Hydrofluoric acid):

- Sodium carbonate
- Sodium bicarbonate (baking soda)
- Calcium carbonate
- Calcium bicarbonate
- Do not use absorbent clay for acid spills

For Hydrofluoric acid (HF) spills:

- Use Calcium carbonate or Calcium bicarbonate to tightly bind the fluoride ion.

For oil spills:

- Use universal absorbent, vermiculite, or absorbent clay (kitty litter).

For most aqueous solutions:

- Use universal absorbent

For most organic liquid spills:

- Use universal absorbent. If the liquid is flammable, be sure to use an excess of universal absorbent.

For oxidizing liquids:

- Use universal absorbent, absorbent clay, vermiculite, or some other nonreactive absorbent material. Do not use paper towels. Note: Most nitrate solutions are not sufficiently oxidizing for this requirement.

For mercury spills:

- Do not dispose of mercury or mercury contaminated spill debris in the regular trash or down the drain.
- There is no absorbent material available. Physical removal processes are best for removing and collecting mercury.

12.7.2 SPILL KITS

While commercially available spill kits are available from a number of safety supply vendors, laboratory personnel can assemble their own spill kits to properly clean up chemicals specific to their laboratory. Whether commercially purchased or made in-house, EH&S strongly encourages all laboratories to obtain a spill kit for their use. Departments should give serious consideration to distributing basic spill kits to all laboratories within their units.

A useful spill kit can be assembled using a 2.5 or 5 gallon bucket containing the following absorbent materials. Stock only the absorbents appropriate for your space. Each container of absorbent must be labeled as to what it contains and what type of spills it can be used for.

Spill kit absorbent material:

- 1-5 lbs. of Universal Absorbent – for most aqueous and organic liquid spills.
- 1-5 lbs. of absorbent clay (kitty litter) - for oils or oxidizing liquids.
- 1-5 lbs. of Sodium bicarbonate - for liquid acid and base spills.
- 1-5 lbs. of Calcium carbonate or Calcium bicarbonate - for HF spills.

Equipment in the spill kit could include:

- Wisk broom and dust pan (available at home improvement stores)
- Sponge

- pH paper
- 1 gallon and 5 gallon bags - for collection of spill cleanup material
- Small and large Ziploc bags – for collection of spill cleanup material or to enclose leaking bottles/containers.
- Safety goggles
- Thick and thin Nitrile gloves
- Hazardous waste labels

The spill kit should be clearly labeled as "SPILL KIT" or "CHEMICAL SPILL KIT", with a list of the contents posted on or in the kit. This list should include information about restocking the kit after use and where to obtain restocking materials.

Laboratory personnel must also be properly trained on:

- How to determine if they can or should clean up the spill, or if they should call 777 or EH&S at 2-2818.
- Where the spill kit will be kept within the laboratory.
- What items are in the kit and where replacement items can be obtained.
- How to use the items in the kit properly.
- How to clean up the different types of chemical spills.
- How to dispose of spill cleanup material.

Environmental Health and Safety can provide guidance in assembling spill kits for laboratories and offers information on spill clean-up in the Laboratory Safety Training module. More information can be obtained by contacting Environmental Health and Safety at 2-2818.

12.7.3 MAJOR SPILLS

A major spill is any chemical spill for which the researcher determines they need outside assistance to safely clean up a spill. EH&S is activated to assist with spill cleanup whenever Pace Security are notified of a spill by calling 777 from a campus phone or 911 from a cell phone or off campus phone.

12.7.3.1 MAJOR SPILL CLEANUP PROCEEDURES

When a spill occurs that you are not capable of handling:

- Alert people in the immediate area of the spill and evacuate the room.
- If an explosion hazard is present, do not unplug, or turn electrical equipment on or off – doing so can result in a spark and ignition source.
- Confine the hazard by closing doors as you leave the room.
- Use eyewash or safety showers as needed to rinse spilled chemicals off people or yourself.
- Evacuate any nearby rooms that may be affected. If the hazard will affect the entire building, then evacuate the entire building by pulling the fire alarm.

- Notify Pace Security by calling 777 or using a Blue Light or Emergency Telephone. Always call from a safe location.

Be prepared to provide Pace Security with the following information:

- Where the spill occurred (building and room number).
- If there are there any injuries and if medical attention is needed.
- The identity of the spilled material(s) - be prepared to spell out the chemical names.
- The approximate amount of material spilled.
- How the spill occurred (if you know).
- Any immediate actions you took.
- Who first observed the spill and the approximate time it occurred.
- Where you will meet emergency responders, or provide a call back number (if available).

Once outside, notify emergency responders of the location, nature and size of the spill. Isolate contaminated persons and protect yourself and others from chemical exposure.

12.8 EMERGENCY EYEWASH AND SHOWERS

All laboratories using hazardous chemicals, particularly corrosive chemicals, must have access to an eyewash and/or an emergency shower as per the OSHA standard 29 CFR 1910.151 – Medical Services and First Aid. The ANSI Standard Z358.1-2004 - Emergency Eyewash and Shower Equipment provides additional guidance by stating that emergency eyewash and/or emergency showers must be readily accessible, free of obstructions and within 10 seconds from the hazard. The ANSI standard also outlines specific requirements related to flow requirements, use of tempered water, inspection and testing frequencies, and training of laboratory personnel in the proper use of this important piece of emergency equipment.

Due to the flow requirements outlined in the ANSI standard, hand held bottles do not qualify as approved eyewashes.

Plumbed eyewash units and emergency showers should ideally have a tempering valve in place to prevent temperature extremes to the eyes or body. If you have questions about where eyewashes and emergency showers should be located, or which models meet ANSI standards, contact EH&S at 2-2818.

12.8.1 TESTING AND INSPECTION FO EMERGENCY EYEWASH AND SHOWERS

The ANSI Standard provides guidance by stating that plumbed emergency eyewash and safety showers should be activated **weekly** to verify proper operation and inspected annually. Regular activation (weekly flushing) ensures the units are operating properly, helps to keep the units free of clutter, and helps prevent the growth of bacteria within the plumbing lines, which can cause eye infections. It is recommended to allow the

water to run for at least 3 minutes. EH&S strongly encourages laboratories to post an "eyewash test log" near the eyewash to keep track and document that weekly activation is occurring. Check with your Building Coordinator for the location of the emergency shower test kit and instructions.

It is the responsibility of laboratory personnel to activate (flush) units on a regular basis.

Laboratories are responsible for ensuring that access to eyewashes and emergency showers are kept free of clutter and ensuring the eyewash nozzle dust covers are kept in place. If nozzle dust covers are not kept on the eyewash nozzles, dust or other particles can clog the nozzles and result in poor or no water flow. This could result in dust or other particles being forced into the eyes when the eyewash is used.

Always report any malfunctioning eyewashes and emergency showers to B&G immediately. If the emergency shower or eyewash is not working properly, then let other people in the lab know by hanging up a "Do Not Use Sign" on the unit.

B&G performs free annual inspections of emergency showers. B&G will test units for compliance with ANSI Z358.1-2004 including:

- Test the water flow for proper quantity, spray pattern, and good water quality.
- Ensure the unit is the proper height from the floor.
- Ensure the unit is not obstructed.
- Ensure the unit has a tempering valve (if the unit does not have a tempering valve, this will be identified as a recommended repair in the inspection report).
- Ensure valves are working properly.
- Ensure signs are posted.
- Ensure the unit is free of corrosion.

12.8.2 USING EMERGENCY EYEWASH AND SHOWERS

Always preplan your experiments and what you will do in case of an emergency. Always identify the locations of the nearest emergency shower and eyewash before working with hazardous chemicals.

In the event of an emergency (chemical spill or splash) where an eyewash or emergency shower is needed, please adhere to the following procedures:

<u>EYEWASHES</u>

1) If you get a chemical in your eyes, yell for help if someone else is in the lab.
2) Immediately go to the nearest eyewash and push the activation handle all the way on.

3) Put your eyes or other exposed area in the stream of water and begin flushing.
4) Open your eyelids with your fingers and roll your eyeballs around to get maximum irrigation of the eyes.
5) Keep flushing for at least 15 minutes or until help arrives. The importance of flushing the eyes first for at least 15 minutes cannot be overstated!
6) If you are alone, call 777 after you have finished flushing your eyes for at least 15 minutes.
7) Seek medical attention.
8) Complete Injury/Illness report.

If someone else in the lab needs to use an eyewash, assist them to the eyewash, activate the eyewash for them, and help them get started flushing their eyes using the procedures above and then call **777**. After calling 777, go back to assist the person using the eyewash and continue flushing for 15 minutes or until help arrives and have the person seek medical attention.

EMERGENCY SHOWERS

1) If you get chemical contamination on your skin resulting from an accident, yell for help if someone else is in the lab.
2) Immediately go to the nearest emergency shower and pull the activation handle.
3) Once under the stream of water, begin removing your clothing to wash off all chemicals.
4) Keep flushing for at least 15 minutes or until help arrives. The importance of flushing for at least 15 minutes cannot be overstated!
5) If you are alone, call 777 after you have finished flushing for at least 15 minutes.
6) Seek medical attention.
7) Complete an Injury/Illness report.

If someone else in the lab needs to use an emergency shower (and it is safe for you to do so), assist them to the emergency shower, activate the shower for them, and help them get started flushing using the procedures above and then call **777**. After calling 777, go back to assist the person using the shower and continue flushing for 15 minutes or until help arrives and have the person seek medical attention.

NOTE: Although an emergency is no time for modesty, if a person is too modest and reluctant to use the emergency shower, you can assist them by using a lab coat or other piece of clothing or barrier to help ease their mind while they undress under the shower. If you are assisting someone else, you should wear gloves to avoid contaminating yourself. When using an emergency shower, do not be concerned about the damage from flooding. The important thing to remember is to keep flushing for 15

minutes. If there is a large quantity of chemical spilled or washed off, please contact EH&S at 2-2818 to see if the rinsate needs to be collected as hazardous waste.

13. WORK RELATED INJURY, ILLNESS, AND INCIDENT REPORTING

For a life-threatening emergency at Pace, call Security (777) to notify or request assistance in transport and if at the New York City Campus report to the New York Downtown Hospital Emergency Services (170 Williams St, New York NY) or if the Pleasantville Campus wait for transport to Phelps Memorial Hospital Emergency Room (701 Broadway, Sleepy Hollow NY).

Employees suffering from a work-related illness or injury must report this to their supervisor, complete an Accident Report Form, and seek medical attention. Occupational medical care for work-related incidents at Pace University is provided at no cost to employees at the University Health Care Unit (UCHU). An employee may alternatively seek medical care by a personal physician of their choice. Students at Pace suffering from a work-related illness or injury must report to UCHU. The UCHU locations are:

- Goldstein Fitness Center, Room 125
  861 Bedford Road
  Pleasantville, New York 10570
  Telephone: (914)773-3760

Or

- 41 Park Row, Suite 313
  New York, New York 10038
  Telephone: (212)346-1600

A work-related injury or illness should be reported by completing the Pace University Accident Report Form provided by HR. Certain situations or exposure conditions may warrant medical consultation or medical monitoring of employees at the UHCU. This includes medical evaluations for an employee exposed to concentrations of a hazardous substance routinely above the OSHA action level, the PEL or the STEL.

All accidents and injuries, no matter how minor, are <u>required</u> to be reported to University officials. The supervisor of an injured employee, the department head, or a designated individual within the department must complete all sections of the accident reporting forms with Security.

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure all injuries are reported to University officials.

13.1 MEDICAL CONSULTATIONS

When a chemical exposure occurs, medical consultations and medical examinations will be made available to laboratory workers who work with hazardous chemicals as required. All work related medical examinations and consultations will be performed by

or under the direct supervision of a licensed physician and will be provided at no cost to the employee without loss of pay, and at a reasonable time, through the UCHU.

The opportunity to receive medical attention, including any follow up examinations, will be provided to employees who work with hazardous chemicals under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
- Where airborne exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements. Action level means the airborne concentration of a specific chemical, identified by OSHA, and calculated as an 8-hour time weighted average (TWA).
- Whenever an event such as a spill, leak, explosion or other occurrence takes place and results in the likelihood of a hazardous exposure. Upon such an event, the affected employee shall be provided an opportunity for a medical consultation. The consultation shall be for the purpose of determining the need for a medical examination.

More information on action levels and Permissible Exposure Limits can be found on the OSHA Health and Safety topics page – Permissible Exposure Limits.

13.2 INFORMATION PROVIDED TO THE PHYSICIAN

The physician shall be provided with the following information:

- The identity of the hazardous chemical(s) to which the employee may have been exposed. Such information can be found in the Safety Data Sheet (SDS) for the chemical(s).
- A description of the conditions under which the exposure occurred including quantitative exposure data, if available.
- A description of the signs and symptoms of exposure that the employee is experiencing, if any.

13.3 THE PHYSICIAN'S WRITTEN OPINION

The physician's written opinion for the consultation or examination shall include:

- The results of the medical examination and any associated tests.
- Any medical condition that may be revealed in the course of the examination, which may place the employee at increased risk as a result of exposure to a hazardous workplace.

- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
- The written opinion shall not reveal specific findings of diagnoses unrelated to the occupational exposure.

All records of medical consultations, examinations, tests, or written opinions shall be maintained at the UCHU in accordance with 29 CFR 1910.1020 - Access to employee exposure and medical records. The UCHU is located on the Pleasantville Campus at the Goldstein Fitness Center, Room 125 or On the NYC campus at 41 Park Row, Room 313. Exposure monitoring records of contaminate levels in laboratories will be maintained at EH&S office at 116A Dow Hall. For more information, contact EH&S at 2-2818.

14. HAZARDOUS CHEMICAL WASTE MANAGEMENT

Hazardous chemical waste storage and disposal is regulated by the U.S. Environmental Protection Agency (EPA). In New York State, the Department of Environmental Conservation (DEC) regulates chemical waste management activities. All University chemical wastes are subject to inspection and enforcement actions by the EPA or the DEC.

Within your work area, the following practices must be followed for proper management of hazardous waste:

- Determine if your unwanted materials pose a significant risk requiring management as hazardous waste.
- Label containers of hazardous chemical wastes with the identity of the chemical(s) **AND** the words "Hazardous Waste" or label with a Pace University Hazardous Waste label. No shorthand or abbreviations are allowed.
- Keep containers of hazardous chemical wastes closed at all times when they are not in use. Funnels must be removed from containers unless actively filling the containers.
- Store hazardous waste containers within the room in which they are generated in.

Recommended practices that should be followed:

- Always maintain a neat and orderly workplace.
- Use secondary containment bins or trays to store your chemical waste containers in.
- Store your waste containers in a designated place.

It is the responsibility of the PI and Supervisor to ensure that all lab personnel working in laboratories under their supervision are familiar with and follow hazardous chemical waste container requirements and have attended EH&S Chemical Waste Disposal training.

APPENDIX A: CHEMICAL HYGIENE PLAN Part B

Individual Laboratory Safety & Chemical Hygiene Plan

Principal Investigator_____ Date filed_____

Department _____ Building/Floor/Room _____

E-mail address _____@Pace.edu __Phone _____ Facsimile _____

Laboratory Safety Manager_____ Phone _____

Laboratory Name _____Building/Floor/Room _____

Departmental Safety Officer_____ Phone _____

E-mail address _____@Pace.edu _Phone _____ Facsimile _____

****

Please complete and forward the attached pages to Environmental Health & Safety.

Keep a copy in the laboratory and make available to lab workers electronically.

The **Principal Investigator** and/or the **Laboratory Safety Manager** have personally discussed the hazards and the proper procedures for using and storing hazardous substances with all personnel who are or will potentially be exposed to such hazards. The Principle Investigator has reviewed this plan and certifies that it reflects the current condition of his/her laboratory.

Principal Investigator's Signature: _____ Date: _____

Principal Investigator's Signature: _____ Date: _____

Principal Investigator's Signature: _____ Date: _____

Principal Investigator's Signature: _____ Date: _____

Principal Investigator's Signature: _____ Date: _____

Pace University – Chemical Hygiene Plan 2012

Appendix A (con't)

List of Laboratory Personnel

Department:	Campus:	Building:	Room Number:	Ext.:
_____	_____	_____	_____	_____

	Name	Pace Email	Read Plan Sign and Date	Lab Safety Training Date	Degree	FDNY CoF #
P.I.						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

(Each lab worker, including P.I., must provide this information)

Appendix A (con't)

LOCATION OF THE NEAREST SAFETY EQUIPMENT

Department: _____ Building/Floor/Room: _____ Extension: _____

Eye Wash Station: _____

Safety Shower: _____

Fire Blanket (if applicable): _____

Fire Extinguisher: _____

Spill Clean-up Kits:

- **Acids _____**
- **Alkalis _____**
- **Organic Solvents_____**
- **Mercury _____**

Personal Protective Equipment (PPE):

- **Safety eye wear (glasses/goggles) _____**
- **Gloves _____**
- **Aprons/Laboratory Coats_____**
- **Face Shields _____**
- **Mask/Respirator_____**
- **Chemical Hygiene Plan_____**
- **Reference Safety Manual & SOPs_____**

POST a copy of this page and a Map of the Emergency Evacuation Routes in a conspicuous place in the LABORATORY

Appendix A (con't)

Chemical Inventory Form

An inventory of all hazardous substances is required to comply with the New York City Community Right to Know Law (Local Law 26, 1988). A hazardous substance, according to the New York City Community Right to Know Law, is defined as one that presents a physical or health hazard and is listed in the hazardous substance list. Chemicals that exhibit the properties of flammability, corrosivity, reactivity, or toxicity, are examples of hazardous substances that must be listed in your inventory. In addition, include known and suspected carcinogens, mutagens, and teratogens that may not be listed in the hazardous substance list.

An inventory template and instructions on completing the chemical inventory can be found in the Forms section of the Pace EH&S webpage.

Chemical Inventories must include:

- The proper chemical name or active ingredient (if material is a commercial product).
- The Chemical Abstract Service Number (CAS#). If the chemical is a mixture, as opposed to a pure substance, the CAS# for each hazardous substance in the mixture must be included.
- The physical state (solid, liquid, or gas) of the hazardous substance or mixture.
- Average quantity, in pounds, of the hazardous substance used or stored.
- Maximum quantity, in pounds, of the hazardous substance used or stored.
- Container type (glass, plastic, metal) in which your hazardous substance is stored.
- Manufacturer name and catalog number, if available.

The Laboratory Chemical Inventory (page 63) must be complete, updated and a copy submitted to EH&S on an annual basis.

***Material Safety Data Sheets -** Material Safety Data Sheets (SDS's) must be accessible to all laboratory staff and visitors. They are available from the chemical manufacturer or through the EH&S website. EH&S recommends that a copy of the hazardous chemical SDS be kept on file in the laboratory.

PACE UNIVERSITY
Work toward greatness.

Chemical Inventory

(A) Contact Information

Department: _____
Lab/Inventory Supervisor: _____
Phone #: _____
Department Manager/PI: _____

(B) Inventory & Storage Location Information

Building: _____
Room #: _____
Date of Inventory: _____
Person Completing Inventory: _____

(C)	(D)	(E)	(F)	(G)				(H)	(I)	(J)				(K)
				Container				Physical	MSDS	NFPA Rating				Storage
Chemical Name	CAS Number	Quantity	Unit	Actual Ct.	Max Ct.	Size	Type	State	Location	H	F	R	S	Location

The official versions of all EH&S forms and documents are the versions at the EH&S website. Always check there -- being at https://www.pace.edu/university-operations/environmental-health-and-safety -- to make sure that you have the official version of the form.

Appendix A (con't)

Laboratory Equipment

- Compressed Gas Cylinders
- Ultraviolet (UV) Light Sources
- Intense Visible Light Sources (including LASERS)

1. **Compressed Gas Cylinders.** Indicate name of gas, size, and room location. Cylinders must be properly secured and hydrostatically tested every 10 years.

2. **Ultraviolet Light Sources.** The sources listed below emit light with wavelengths in the range from 185-290 nm. The design, use and maintenance of these sources must meet current standards.

Source	Wavelength(s)	Location

3. **Intense Visible Light Sources (including LASERS).** Please list below the sources that emit or contain devices that emit high intensity light. The design and use of these devices must meet current standards. The use of **a** LASER is controlled by the University's LASER Safety Program.

Type of Device	Manufacturer & Model #	Wavelength(s	Location

APPENDIX B: COMPILED LAB SAFETY RESPONSIBILITIES

1) It is the responsibility of Principal Investigators and laboratory supervisors to ensure that personnel working in laboratories under their control are familiar with the contents and location of the Chemical Hygiene Plan, including any lab specific standard operating procedures and any department or college level laboratory safety manuals, policies, and procedures. (Section 3.3)

2) It is the responsibility of the Principal Investigator and individual supervisors (and individuals working under their supervision) to be in compliance with the components of the University Chemical Hygiene Plan and any other department or University specific policies.(Section 3.3)

3) It is the responsibility of laboratory personnel to immediately report malfunctioning protective equipment, such as fume hoods, or mechanical problems to their Building Coordinator as soon as any malfunctions are discovered. (Section 10.1)

4) Principal Investigators, laboratory supervisors, departments and colleges are free to set policies that establish minimum PPE requirements for personnel working in and entering their laboratories. Be sure to check with your DSR to see if there are any department or college specific requirements for PPE. (Section 10.3)

5) It is the responsibility of the Principal Investigator or laboratory supervisor to ensure laboratory staff have received the appropriate training on the selection and use of proper PPE, that proper PPE is available and in good condition, and laboratory personnel use proper PPE when working in laboratories under their supervision. (Section 10.3)

6) EH&S strongly encourages Principal Investigators and laboratory supervisors to make use of eye protection a mandatory requirement for all laboratory personnel, including visitors, working in or entering laboratories under their control. (Section 10.3)

7) EH&S strongly recommends that Principal Investigators and laboratory supervisors discourage the wearing of shorts and skirts in laboratories using hazardous materials (chemical, biological, and radiological) by laboratory personnel, including visitors, working in or entering laboratories under their supervision. (Section 10.3)

8) EH&S strongly encourages Principal Investigators and laboratory supervisors to require the use of closed toed shoes for all laboratory personnel, including visitors, working in or entering laboratories and laboratory support areas under their supervision. (Section 10.3)

9) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that personnel working in laboratories under their supervision are informed and follow laboratory specific, departmental, and campus wide policies and procedures related to laboratory safety – such as the guidelines and requirements covered in this Laboratory Safety Manual. (Section 7.0)

10) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure written SOPs incorporating health and safety considerations are developed for work involving the use of hazardous chemicals in laboratories under their supervision and that PPE and engineering controls are adequate to prevent overexposure. In addition, Principal Investigators and laboratory supervisors must ensure that personnel working in laboratories under their supervision have been trained on those SOPs. (Section 7.2)

11) It is the responsibility of Principal Investigators and laboratory supervisors to ensure laboratories under their supervision are maintained in a clean and orderly manner and personnel working in the lab practice good housekeeping. (Section 7.2)

12) It is the responsibility of Principal Investigators and laboratory supervisors to ensure procedures for working alone are developed and followed by personnel working in laboratories under their supervision. (Section 7.2)

13) It is the responsibility of Principal Investigators and laboratory supervisors to ensure procedures for unattended operations are developed and followed by personnel working in laboratories under their supervision. (Section 7.2)

14) It is the responsibility of the Department Chairperson, Principal Investigators, and laboratory supervisors to restrict access of visitors and children to areas under their supervision when potential health and physical hazards exist. . (Section 7.2)

15) It is the responsibility of the Principal Investigator and individual supervisors to ensure research areas under their supervision have been registered using the Appendix A: Lab Specific Hygiene Plan.

16) It is the responsibility of laboratory personnel to activate (flush) emergency showers and eyewash units on a regular basis. (Section 12.8.1)

17) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure all injuries are reported to University officials through the use of the Pace University injury/illness reporting system. (Section 13)

18) It is the responsibility of Principal Investigators and laboratory supervisors to ensure personnel working in laboratories under their supervision have been provided with the proper training, have received information about the hazards in the laboratory they may encounter, and have been informed about ways they can protect themselves. (Section 3.4)

19) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students under their supervision are provided with adequate training and information specific to the hazards found within their laboratories. (Section 3.4)

20) It is the responsibility of Principal Investigators and laboratory supervisors to ensure that staff and students working in laboratories under their supervision have obtained required health and safety training and have access to SDSs (and other sources of information) for all hazardous chemicals used in laboratories under their supervision. (Section 6.1)

21) While EH&S can provide assistance in identifying circumstances when there should be prior approval before implementation of a particular laboratory operation, the ultimate responsibility of establishing prior approval procedures lies with the Principal Investigator or laboratory supervisor. (Section 9.5)

22) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that personnel working in laboratories under their supervision are familiar with and follow hazardous chemical waste container requirements and have attended EH&S Chemical Waste Disposal training. (Section 14)

23) It is the responsibility of the Principal Investigator or laboratory supervisor to ensure any employee working under their supervision who ships or prepare shipments of hazardous materials have received the proper training. (Section 3.4)

24) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students in laboratories under their supervision are provided with adequate training and information specific to the physical hazards found within their laboratories. (Section 3.4)

APPENDIX C: SAMPLE STANDARD OPERATING PROCEDURE EXAMPLES

The following links are examples of SOPs from other University websites:

**Disclaimer: EH&S has not verified the accuracy of the information contained within these links and SOPs. It is the responsibility of the laboratory personnel to ensure the accuracy of these non-Pace SOPs. These links are being provided only as examples and each lab should write an SOP that is specific to their processes and procedures.*

- A list of SOP examples and resources on the web from the University of Maryland
- The SOP library (with numerous examples) from the University of California - Irvine
- The Michigan State University SOP webpage (with a number of examples)
- A blank form that can generate a custom SOP online – Michigan State University.
- Example of a chemical specific information sheet type SOP (generic – not lab specific) – University of California, Irvine
- A blank template for chemical specific or chemical group SOP - University of California, Irvine
- An example of a chemical list SOP (generic – not lab specific) – University of Pennsylvania

APPENDIX D: GLOVE SELECTION FOR SPECIFIC CHEMICALS

Chemical	Incidental Contact	Extended Contact
Acetic acid	Nitrile	Neoprene, Butyl rubber
Acetic anhydride	Nitrile (8 mil), double glove	Butyl rubber, Neoprene
Acetone	[1]Natural rubber (Latex) (8 mil)	Butyl rubber
Acetonitrile	Nitrile	Butyl rubber, Polyvinyl acetate (PVA)
Acrylamide	Nitrile, or double Nitrile	Butyl rubber
bis-Acrylamide	Nitrile	
Alkali metals	Nitrile	
Ammonium hydroxide	Nitrile	Neoprene, Butyl rubber
Arsenic salts	Nitrile	
Benzotriazole, 1,2,3-	Nitrile	
Bismuth salts	Nitrile	
Butanol	Nitrile	Nitrile, Butyl rubber
Butyric acid	Nitrile	Butyl rubber, Neoprene
Cadmium salts	Nitrile	
Carbon disulfide	Nitrile (8 mil), double glove, or 15 mil or heavier	Viton, Polyvinyl acetate (PVA)
Carbon tetrachloride	Nitrile (8 mil), double glove, or 15 mil or heavier	Viton
Catechol	Nitrile	
Chloroform	Nitrile (8 mil), double glove, or 15 mil or heavier	Viton, Polyvinyl acetate (PVA)
Chlorosulfuron	Nitrile	
Chromium salts	Nitrile	
Cobalt chloride	Nitrile	Nitrile
Cobalt salts	Nitrile	
Copper (Cupric) sulfate	Nitrile	
Cryogenic liquids	Cryogloves	
3,3'-Diaminobenzidine (DAB)	Nitrile	Nitrile, double glove
Diazomethane in Ether	Nitrile (8 mil), double glove, or 15 mil or heavier	Norfoil
Dichloromethane	Nitrile (8 mil), double glove	Polyvinyl acetate (PVA) or Viton
2,4-Dichlorophenoxy acetic acid	Nitrile	
Diethyl pyrocarbonate	Nitrile	Nitrile, double glove
Dimethyl sulfoxide	[1]Natural rubber (15-18mil)	Butyl rubber

1,4-Dioxane	Nitrile (8 mil), double glove, or 15 mil or heavier	Butyl rubber
Dithiothreitol	Nitrile	
Ethanol	Nitrile	
Ethidium bromide (EtBr)	Nitrile	Nitrile, double glove
Ethyl acetate	Nitrile (8 mil), double glove	Butyl rubber, PVA
Ethyl ether	Nitrile (8 mil), double glove, or 15 mil or heavier	Polyvinyl acetate (PVA)
Formaldehyde	Nitrile	
Formamide	Nitrile	Butyl rubber
Formic acid	Nitrile (8 mil), double glove	Butyl rubber, Neoprene (.28-.33mm)
Gallic acid	Nitrile	
Geneticin	Nitrile	
Glutaraldehyde	Nitrile	
Heavy metal salts	Nitrile	Nitrile, double glove
Heptane	Nitrile (8 mil), double glove, or 15 mil or heavier	Nitrile (35 mils or thicker), Viton, PVA
Hexamethylenediamine (1,6-Diaminohexane)	Nitrile (8 mil)	Neoprene
Hexane	Nitrile (8 mil), double glove, or 15 mil or heavier	Nitrile (35 mils or thicker), Viton, PVA
Hydrochloric acid	Nitrile	Neoprene, Butyl rubber
Hydrofluoric acid (HF)	Nitrile (8 mil), double glove, or 15 mil or heavier	Nitrile or Rubber sleeves
Hypophosphorous acid	Nitrile (4mil), double glove or 8 mil or heavier	
Isoamyl alcohol	Nitrile	
Isoctane	Nitrile	Heavy weight Nitrile
Isopropanol	Nitrile	
Kananmycin	Nitrile	
Lactic acid	Nitrile	Nitrile (double glove), or Neoprene or Butyl rubber
Laser dyes	Nitrile	
Lead acetate	Nitrile	Nitrile, double glove
Lead salts	Nitrile	
Mercuric chloride	Nitrile	Nitrile, double glove
Mercury	Nitrile	
Mercury salts	Nitrile	
Methanol (Methyl	Nitrile	

alcohol)		
Methylene chloride	Nitrile (8 mil), double glove	Polyvinyl acetate, Viton
Methylphosphonic acid	Nitrile (4 mil), double glove	8 mil or heavier Nitrile
Methyl sulfonic acid, Ethyl ester (EMS) (Ethyl methanesulfonate)	Nitrile	Nitrile, double glove
Monoethanolamine	Nitrile	
Nickel chloride	Nitrile	Nitrile, double glove
Nickel salts	Nitrile	Nitrile, double glove
Nitric acid	Nitrile (8 mil), double glove	Heavy weight (.28-.33mm) Butyl rubber or Neoprene
N-Methylethanolamine	Nitrile (8 mil), double glove	Viton, Neoprene, Butyl rubber
Octane	Nitrile	Heavy weight Nitrile or Viton
Organophosphorous compounds	Nitrile (8 mil), double glove, or 15 mil or heavier	
Osmium salts	Nitrile	
Osmium tetroxide	Nitrile	Nitrile, double glove
Paraformaldehyde	Nitrile	
Pentane	Nitrile (8mil), double glove	Heavy weight Neoprene, or Viton
Perchloroethylene (tetrachloroethylene)	Nitrile (8 mil), double glove	Nitrile (22mil or heavier)
Pesticides	Heavy weight, unlined Nitrile (8-20 mils), or glove specified by pesticide label.	
Petroleum ether	Nitrile	Heavy weight Nitrile or Viton
Phenol	Nitrile (8 mil), double glove	Neoprene, Butyl rubber
Phenol-Chloroform mixtures	Nitrile (8 mil), double glove, or 15 mil or heavier	Viton
Phenylmethylsulfonyl fluoride (PMSF)	Nitrile	Nitrile, double glove
Phosphonic acid	Nitrile (4 mil), double glove, or 8 mil or heavier single	
Phosphoric acid	Nitrile (4 mil), double glove, or 8 mil or heavier	
Picloram (4-amino-3,5,6-trichloropicolinic acid)	Nitrile	
Polychlorinated Biphenyls (PCB's)	Nitrile (8 mil) glove over a Neoprene glove	Neoprene (20 mil)
Polyoxyethylene-sorbital-n-monolaurate (Tween 20)	Nitrile	

Potassium ferricyanide	Nitrile	
Potassium ferrocyanide	Nitrile	
Potassium permanganate	Nitrile	
Propanol	Nitrile	
Propionic acid	Nitrile	Neoprene or Butyl rubber
Propylene oxide	heavier weight (17 mil or greater) Butyl rubber or Neoprene	Norfoil
Psoralen	Nitrile	Nitrile, double glove
Pump oil	Butyl rubber	
Silane based silanization or derivatization compounds	Nitrile (8 mil), double glove, or 15 mil or heavier single	
Silver nitrate	Nitrile	Nitrile, double glove
Silver salts	Nitrile	
Sodium dodecyl sulfate (SDS)	Nitrile	
Sodium azide	Nitrile, or double glove	
Spermidine	Nitrile	
Sulfuric acid	Nitrile (8 mil)	Neoprene, Butyl rubber (20 mil or greater)
Tetrahydrofuran (THF)	Nitrile (8 mil), double glove, or 15 mil or heavier	Norfoil
3,3',5,5'-Tetramethyl-benzidine (TMB)	Nitrile	Nitrile, double glove
N,N,N',N'-Tetramethyl-ethylenediamine (TEMED)	Nitrile	Nitrile, double glove
Timetin	Nitrile	
Toluene	Nitrile (8 mil), double glove, or 15 mil or heavier	Viton, Polyvinyl acetate (PVA)
Trichloroethylene	Nitrile (8 mil), double glove	Viton, Polyvinyl acetate (PVA)
Trichloromethyl chloroformate (diphosgene)	Nitrile (8 mil) over Butyl rubber glove	This material must be used in a glove box.
Triton-X100	Nitrile	
Uranium salts	Nitrile	
Valeric acid	Nitrile	Nitrile, double gloves, or Neoprene or Butyl rubber
Xylene	Nitrile	Polyvinyl acetate (PVA), Viton

[1]If you are allergic to natural rubber products, you may double glove with 8 mil Nitrile gloves.

APPENDIX E: GLOVE SELECTION WEBSITES

DISCLAIMER: While the glove selection web links below are being provided as additional resources, Pace University has not investigated the accuracy of the information contained within the webpages.

All Safety Products, Inc. – Glove Selection Chart

Ansell Protective Products – See Ansell Chemical Resistance Guide

Best Gloves - Comprehensive Guide to Chemical Resistant Best Gloves

Cole Parmer – Safety Glove Selection Guide

Kimberly Clark Professional – Chemical Resistance Database

Mapa Professional – Chemical Resistance Guide

Microflex – Chemical Resistance Guide

North Safety - Chemical Resistance Guide

Argonne National Laboratory – Glove Selection Guideline

Michigan State University - Glove Guide

Oklahoma State University – Chemical Guide

APPENDIX F: HOW TO UNDERSTAND SDSs

Chemical manufacturers are currently required by law to supply "Material Safety Data Sheets" (OSHA Form 174 or its equivalent) upon request by their customers. The Hazard Communication Standard (HCS) requires chemical manufacturers, distributors, or importers to provide Safety Data Sheets (SDSs) (formerly known as Material Safety Data Sheets or MSDSs) to communicate the hazards of hazardous chemical products. As of June 1, 2015, the HCS will require new SDSs to be in a uniform format, and include the section numbers, the headings, and associated information under the headings below:

Section 1, Identification includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.

Section 2, Hazard(s) identification includes all hazards regarding the chemical; required label elements.

Section 3, Composition/information on ingredients includes information on chemical ingredients; trade secret claims.

Section 4, First-aid measures includes important symptoms/ effects, acute, delayed; required treatment.

Section 5, Fire-fighting measures lists suitable extinguishing techniques, equipment; chemical hazards from fire.

Section 6, Accidental release measures lists emergency procedures; protective equipment; proper methods of containment and cleanup.

Section 7, Handling and storage lists precautions for safe handling and storage, including incompatibilities.

Section 8, Exposure controls/personal protection lists OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE).

Section 9, Physical and chemical properties lists the chemical's characteristics.

Section 10, Stability and reactivity lists chemical stability and possibility of hazardous reactions.

Section 11, Toxicological information includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.

Section 12, Ecological information*

Section 13, Disposal considerations*

Section 14, Transport information*

Section 15, Regulatory information*

Section 16, Other information, includes the date of preparation or last revision.

*Note: Since other Agencies regulate this information, OSHA will not be enforcing Sections 12 through 15(29 CFR 1910.1200(g)(2)).

Employers must ensure that SDSs are readily accessible to employees.

APPENDIX G: HAZARDS OF FUNCTIONAL GROUPS

The following information gives a basic overview of the hazards of functional groups. This information is not meant to replace material safety data sheets for the specific chemical(s) used in your experiments. While these functional groups are listed alphabetically for convenience, chemicals should be segregated and stored by hazard classes.

ALCOHOLS

- The lower aliphatic alcohols are low to moderately toxic and usually have low vapor pressures, therefore inhalation toxicity is low.
- Vapors may be an irritant to the eyes and mucous membranes.
- Ingestion and absorption of the liquids through the skin can be a major health hazard.
- Lower alcohols containing double or triple bonds exhibit a greater degree of toxicity and irritation.
- Fatty alcohols (derived from oils, fats, and waxes) are almost nontoxic.
- Lower alcohols are flammable or combustible liquids.
- Flammability decreases with an increase in the carbon number.
- Solubility of alcohols decrease with increase in carbon chain length.
- Toxicity tends to decrease with an increase in carbon number.

Examples:	Allyl alcohol	Ethanol
	1-Butanol	Methanol
	Cyclohexanol	1-Propanol
	1,2-Ethanediol	2-Propyn 1-ol

ALDEHYDES

- Aldehydes are intermediate products in the conversion of primary alcohols to carboxylic acids or vice versa.
- The low molecular weight aldehydes are more toxic than the higher ones.
- Toxicity decreases with increase in the carbon chain length.
- Aromatic aldehydes are less toxic than low molecular weight aliphatic aldehydes.
- Low molecular weight aldehydes are highly flammable, with flammability decreasing with increasing carbon chain length.
- Low aromatic aldehydes are combustible or nonflammable liquids.

Examples:	Acetaldehyde	Glutaraldehyde
	Acrolein	1-Hexanal
	Benzaldehyde	Isobutyraldehyde
	Formaldehyde	Propenal

ALIPHATIC AMINES

- The toxicity of most aliphatic amines may fall in the low to moderate category.

- The health hazard from amines arises primarily from their caustic nature.
- All lower aliphatic amines are severe irritants to the skin, eyes, and mucous membranes.
- All of these compounds have a strong to mild odor of ammonia and their vapors produce irritation of the nose and throat.
- Aliphatic amines, especially the lower ones, are highly flammable liquids, many which have flashpoints below 0 degrees Celsius.
- The vapors are heavier than air.
- They react vigorously with concentrated mineral acids.
- The flammability decreases with an increase in the carbon number.
- The reactivity of amines in general, is low.

Examples:	Aminocyclohexane	Methylamine
	Ethyleneimine	2-Propylamine

ALIPHATIC and ALICYCLIC HYDROCARBONS

- Organic compounds composed solely of carbon and hydrogen.
- Hydrocarbons may be classified into 3 broad categories:
    - Open-chain aliphatic compounds
    - Cyclic or alicyclic compounds of naphthalene type
    - Aromatic ring compounds
- Open chain aliphatic hydrocarbons constitute alkanes, alkenes, alkynes, and their isomers. Alkenes or olefins are unsaturated compounds, characterized by one or more double bonds between the carbon atoms. Alkynes or acetylenic hydrocarbons contain a triple bond in the molecule and are highly unsaturated. An alicyclic hydrocarbon is a cyclic ring compound of 3 or more carbon atoms. Aromatics are ring compounds too, but are characterized by a 6 carbon atom unsaturated benzenoid rings.
- The toxicities of aliphatic and alicyclic hydrocarbons in humans and animals are very low.
- The gaseous compounds are all nontoxic and are simple asphyxiants.
- Lower hydrocarbons are highly flammable substances; an increase in the carbon number causes a decrease in flammability.
- It is the flammable properties that make hydrocarbons hazardous.
- The reactivity of alkanes and cycloalkanes is very low.
- Alkenes and alkynes containing double and triple bonds are reactive.

Examples:	Butane	Methane
	Cyclohexene	n-Pentane
	Cyclopentane	

ALKALI and OTHER REACTIVE METALS

- Alkali metals constitute Group IA of the periodic table.
- Alkaline-earth metals constitute Group IIA and are less active than the alkali metals.
- These can be water and/or air reactive.
- Several of these metals are flammable, too, but only in finely divided state.
- Reactions with water produce strong bases.

Examples: Aluminum Magnesium
Calcium Potassium
Lithium Sodium

ALKALIES

- Water-soluble bases, mostly the hydroxides of alkali- and alkaline-earth metals.
- Certain carbonates and bicarbonates also exhibit basic properties but are weak bases.
- These compounds react with acids to form salts and water.
- The health hazard from concentrated solutions of alkalies arises from their severe corrosive actions on tissues.
- These compounds are bitter to taste, corrosive to skin and a severe irritant to the eyes.
- The toxicity of alkalies is governed by the metal ions.
- Hydroxides and carbonates of alkali-and alkaline-earth are noncombustible.
- Strong caustic alkalies react exothermically with many substances, including water and concentrated acids, generating heat that can ignite flammable materials.

Examples: Lithium hydroxide Potassium carbonate
Potassium hydroxide Sodium hydroxide

AROMATIC AMINES

- Compounds that contain one or more amino groups attached to an aromatic ring.
- These amines are similar in many respects to aliphatic amines.
- These amines are basic, but the basicity is lower to aliphatic amines.
- The health hazard from aromatic amines may arise in two ways:
    - Moderate to severe poisoning, with symptoms ranging from headache, dizziness, and ataxia to anemia, cyanosis, and reticulocytosis.
    - Carcinogenic, especially cancer of the bladder.
- Many amines are proven or suspected human carcinogens, among aromatic amines, ortho-isomers generally exhibit stronger carcinogenic properties than those of the para- and meta-isomers.

- Unlike aliphatic amines, the aromatic amines do not cause severe skin burn or corneal injury.
- The pure liquids (or solids) may produce mild to moderate irritation on the skin.
- Lower aromatic amines are combustible liquids and form explosive mixtures with air.
- Amines may react violently with strong oxidizing compounds.

Examples: Aniline o-Toluidine
Benzidine

AROMATIC HYDROCARBONS

- Aromatics are a class of hydrocarbons having benzene-ring structures.
- Many polyaromatics are carcinogens.
- The acute toxicity of mononuclear aromatics is low.
- Inhalation of vapors at high concentrations in air may cause narcosis with symptoms of hallucination, excitement, euphoria, distorted perception, and headache.
- Benzene is the only mononuclear aromatic with possible human carcinogenicity and other severe chronic effects.
- With a greater degree of substitutions in the benzene ring and/or increase in the carbon chain length of the alkyl substituents, the flammability decreases.

Examples: Benzene Toluene
Benzolalpyrene Xylene
Pyrene

AZIDES, FULMINATES, ACETYLIDES, and RELATED COMPOUNDS

- These compounds form highly explosive shock- and heat-sensitive salts with many metals.
- Structurally they differ from each other, but have similar detonating characteristics.
- While alkali metal azides are inert to shock, the salts for copper, silver, lead, and mercury are dangerously shock sensitive.
- Fulminates of heavy metals are powerful explosives.
- These compounds are highly sensitive to impact and heat.
- Acetylides of heavy metals are extremely shock sensitive when dry, whereas, the salts of alkali metals are fairly stable.
- Most azides, fulminates, acetylides, nitrides and related compounds are highly unstable and constitute an explosion hazard.
- Salts of Group IB and IIB metals are especially explosive.
- Azides of nonmetals, such as those of halogens or organic azides such as that of cyanogen, are also extremely shock sensitive.

- Some of these compounds may even explode on exposure to light.

Examples:	Cuprous acetylide	Silver fulminate
	Hydrazoic acid	Silver nitride
	Lead azide	Sodium azide
	Mercury fulminate	

CARBOXYLIC ACIDS

- Weak organic acids, their strength is much weaker than mineral acids.
- Toxicity of monocarboxylic acids is moderate to low and decreases with carbon chain length.
- Some of lower dicarboxylic acids are moderate to high toxicity, becoming less toxic with increasing carbon chain length.
- Low molecular weight carboxylic acids are combustible liquids.
- Aromatic acids are of low toxicity.

Examples:	Acetic acid	Oxalic acid
	Butyric acid	Propionic acid
	Formic acid	Succinic acid
	Methacrylic acid	Valeric acid

EPOXY COMPOUNDS

- Epoxides, also called oxiranes and 1,2-epoxides.
- Exposure to epoxides can cause irritation of the skin, eyes, and respiratory tract.
- Low molecular weight epoxides are strong irritants and more toxic than higher ones.
- Inhalation can produce pulmonary edema and affect the lungs, central nervous system and liver.
- Many epoxy compounds have been found to cause cancer in animals.
- Lower epoxides are highly flammable.
- They also polymerize readily in the presence of strong acids and active catalysts, this reaction generates heat and pressure that may rupture closed containers.
- Therefore contact with anhydrous metal halides, strong bases, and readily oxidizable substances should be avoided.

Examples:	Butylene oxide	Glycidaldehyde
	Epichlorohydrin	Glycidol
	Ethylene oxide	Isopropyl glycidyl ether

ESTERS

- Lower aliphatic esters have a pleasant fruity odor.

- The acute toxicity of esters is generally of low order; they are narcotic at high concentrations.
- Vapors are an irritant to the eyes and mucous membranes.
- Toxicity increases with an increase in the alkyl chain length.
- Lower aliphatic esters are flammable liquids; some have low flash points and may cause flashback to an open container.
- The vapors form explosive mixtures with air.
- The flash point increases with increase in the alkyl chain length.
- The reactivity of esters is low.
- Aromatic esters are similar in effects as aliphatic esters.

Examples:	Ethyl acetate	Methyl formate
	Ethyl formate	n-Propyl acetate
	Methyl acrylate	
(Aromatics)	Methyl benzoate	Methyl salicyate

ETHERS

- Widely used as solvents.
- They have a high degree of flammability.
- They tend to form unstable peroxides, which can explode spontaneously or upon heating.
- The flash point decreases with increase in carbon chain.
- Lower aliphatic ethers are some of the most flammable organic compounds and can be ignited by static electricity or lightning.
- The vapor densities are heavier than air.
- They form explosive mixtures with air.
- Aromatic ethers are noncombustible liquids or solids and do not exhibit the flammable characteristics common to aliphatic ethers.
- Ethers react with oxygen to form unstable peroxides; this reaction is catalyzed by sunlight, when evaporated to dryness, the concentrations of such peroxides increase, resulting in violent explosions.
- The toxicity of ethers is low to very low; at high concentrations these compounds exhibit anesthetic effects.

Examples:	Butyl vinyl ether	Methyl propyl ether
	Ethyl ether	Vinyl ether
	Isopropyl ether	

GLYCOL ETHERS

- Also known by the name Cellosolve.
- The toxic effects are mild; however, moderate to severe poisoning can occur from excessive dosage.

- The routes of exposure are inhalation, ingestion, and absorption through the skin.
- Compounds with high molecular weights and low vapor pressures do not manifest an inhalation hazard.
- Low molecular weight alkyl ethers are flammable or combustible liquids forming explosive mixtures with air.
- The reactivity of glycol ethers is low.
- There is no report of any violent explosive reactions.
- The high molecular weight compounds are noncombustible.

Examples: Ethylene glycol monobutyl ether
Ethylene glycol monomethyl ether
2-Isopropoxyethanol

HALOETHERS

- Haloethers are ethers containing hydrogen atoms.
- Halogen substitutions make ether molecules less flammable or nonflammable.
- The explosion hazards of low aliphatic ethers due to peroxide formation are not manifested by the haloethers. The halogens inhibit the ether oxidation to peroxides.
- Inhalation of Fluoroethers can produce anesthesia similar to that of the lower aliphatic ethers. Lower aliphatic chloro-and bromoethers can be injurious to the lungs.
- Many of these are cancer causing to lungs in animals or humans.
- Aromatic chloroethers are toxic by inhalation, ingestion, and skin absorption only at high doses. These effects can be attributed to the chlorine content and to a lesser extent on the aromaticity of the molecule.

Examples: Bis(chloromethyl)ether
2-Chloroethyl vinyl ether
Pentachlorodiphenyloxide

HALOGENATED HYDROCARBONS

- The flammability of these compounds shows a wide variation.
- Bromo compounds are less flammable than their Chloro- counterparts, the difference in flammability is not great though.
- An increase in the halo substitutions in the molecule increases the flash point.
- The flammable hydrocarbons are stable compounds with low reactivity.
- These compounds, however, may react violently with alkali metals and their alloys or with finely divided metals.
- Violent reactions may occur with powerful oxidizers, especially upon heating.

- Volatile halocarbons may rupture glass containers due to simple pressure build up or to exothermic polymerization in a closed vessel.
- Halogenated hydrocarbons in general exhibit low acute toxicity.
- Inhalation toxicity is greater for gaseous or volatile liquid compounds.
- The health hazard from exposure to these compounds may be due to their anesthetic actions; damaging effects on liver and kidney; and in case of certain compounds, carcinogenicity.
- The toxic symptoms are drowsiness, lack of coordination, anesthesia, hepatitis, and necrosis of the liver.
- Vapors may cause irritation of the eyes and respiratory tract.
- Death may result from cardiac arrest due to prolonged exposure to high concentrations.
- Ingestion can produce nausea, vomiting, and liver injury.
- Fluorocarbons are less toxic than the chloro-, bromo-, and iodo- compounds, the toxicity increases with increase in the mass number of the halogen atoms.
- Some of the halogenated hydrocarbons cause cancer in humans.

Examples:	Benzyl chloride	Ethyl bromide
	Carbon tetrachloride	Fluorobenzene
	Chloroform	Methylene chloride
	1,2-Dichlorobenzene	

HYDRIDES

- The single most hazardous property of hydrides is their high reactivity toward water.
- The reaction with water is violent and can be explosive with liberation of hydrogen.
- Many hydrides are flammable solids that may ignite spontaneously on exposure to moist air.
- Many ionic hydrides are strongly basic; their reactions with acids are violent and exothermic, which can cause ignition.
- Hydrides are also powerful reducing agents, they react violently with strong oxidizing substances, causing explosions.
- Covalent volatile hydrides such as arsine, silane, or germane are highly toxic.
- Ionic alkali metal hydrides are corrosive to skin, as they form caustic alkalies readily with moisture.

Examples:	Decarborane	Sodium borohydride
	Lithium aluminum hydride	Sodium hydride
	Potassium hydride	

INDUSTRIAL SOLVENTS

- The toxic effects of most of the solvents are of low order, chronic exposures or large doses can produce moderate to severe poisoning.
- Most organic solvents are flammable or combustible liquids, the vapors of which can form explosive mixtures with air.
- Many of the common solvents can cause flashback of the vapors, and some form peroxide on prolonged storage, especially those compounds containing an ether functional group, some also can form shock-sensitive solvated complexes with metal perchlorates.

Examples:	Acetamide	Chloroform
	Acetone	Methyl acetate
	Benzene	Pyridine
	Carbon tetrachloride	Tetrahydrofuran

INORGANIC CYANIDES

- Inorganic cyanides are the metal salts of Hydrocyanic acid.
- Cyanides of alkali metals are extremely toxic.
- In addition to being extremely toxic by ingestion or skin absorption, most metal cyanides present a serious hazard of forming extremely toxic Hydrogen cyanide when they come into contact with acids.

Examples:	Barium cyanide	Hydrogen cyanate
	Cyanogen chloride	Potassium cyanide
	Cyanamide cyanogen	Sodium cyanide

KETONES

- Similar to aldehydes.
- In general, the toxicity is much lower than that of other functional groups, such as cyanides or amines.
- Unlike aldehydes and alcohols, some of the simplest ketones are less toxic than the higher ones.
- Beyond 7 carbons, the higher ones are almost nontoxic.
- Substitution of other functional groups can alter toxicity significantly.
- The simplest ketones are highly flammable.
- The flammability decreases with increase in the carbon number.

Examples:	Acetophenone	Mesityl oxide
	Acetone	Methyl Ethyl Ketone
	Ketene	

MINERAL ACIDS

- Acid strengths vary widely.

- Sour in taste.
- React with a base to form salt and water.
- Produce hydrogen when reacting with most common metals.
- Produce carbon dioxide when reacting with most carbonates.
- All mineral acids are corrosive.
- Noncombustible substances.
- Some are highly reactive to certain substances, causing fire and/or explosions.

Examples: Hydrochloric acid
Hydrofluoric acid
Hydroiodic acid
Phosphoric acid
Nitric acid
Sulfuric acid

ORGANIC CYANIDES (NITRILES)

- These are organic derivatives of Hydrocyanic acid or the cyano-substituted organic compounds.
- Nitriles are highly reactive, the CN group reacts with a large number of reactants to form a wide variety of products, such as amides, amines, carboxylic acids, aldehydes, ketones, esters, thioamides, and other compounds.
- Nitriles are highly toxic compounds, some of them are as toxic as alkali metal cyanides.
- Lower aliphatic nitriles are flammable and form explosive mixtures with air. The explosive range narrows down with an increase in the carbon chain length.

Examples: Acrylonitrile
Acetonitrile
Butyronitrile
Cyanohydrin

ORGANIC ISOCYANATES

- Organic groups attached to the isocyanate group.
- These compounds are highly reactive due to the high unsaturation in the isocyanate functional group.
- Isocyanates in general are highly reactive toward compounds containing active hydrogen atoms.
- Most isocyanates are hazardous to health.
- They are lachrymators and irritants to the skin and mucous membranes.
- Skin contact can cause itching, eczema, and mild tanning.
- Inhalation if isocyanate vapors can produce asthma-like allergic reaction, with symptoms from difficulty in breathing to acute attacks and sudden loss of consciousness.
- Toxicities of isocyanates vary widely, in addition, health hazards differ significantly on the route of exposure but occur primarily via inhalation exposure.
- Most isocyanates have high flash points, therefore the fire hazard is low.

- However, closed containers can rupture due to the pressure built up from carbon dioxide, which is formed from reaction with moisture.

Examples:	n-Butyl isocyanate	Methyl isocyanate
	Hexamethylene diisocyanate	Phenyl isocyanate

ORGANIC PEROXIDES

- Compounds containing the peroxide group bound to organic groups.
- In general the toxicity is low to moderate.
- Peroxides are a hazardous class of compounds, some of which are extremely dangerous to handle.
- The dangerous ones are highly reactive, powerful oxidizers, highly flammable and often form decomposition products, which are more flammable.
- Many organic peroxides can explode violently due to one or a combination of the follow factors:
    - Mechanical shock, such as impact, jarring, or friction
    - Heat
    - Chemical contact
- Short chain alkyl and acyl peroxides, hydroperoxides, peroxyesters, and peroxydicarbonates with low carbon numbers are of much greater hazard than the long chain peroxy compounds.
- The active oxygen content of peroxides is measured as the amount of active oxygen (from peroxide functional group) per 100 gm. of the substance. The greater the percentage of active oxygen in formulation, the higher is its reactivity. An active oxygen content exceeding 9% is too dangerous for handling and shipping.

Examples:	Benzoyl peroxide	Diisopropyl peroxydicarbonate
	Hydroperoxyenthanol	Diacetyl peroxide

APPENDIX H: PEROXIDE FORMING CHEMICALS

SAFE STORAGE PERIODS FOR PEROXIDE FORMERS	
Unopened chemicals from manufacturer	18 months or (expiration date)
Opened containers:	
Chemicals in Table A	3 months
Chemicals in Tables B and D	12 months
Uninhibited chemicals in Table C	24 hours
Inhibited chemicals in Table C (Do not store under an inert atmosphere)	12 months

A. Chemicals that form explosive levels of peroxides without concentration		
Butadiene[a]	Isopropyl ether	Sodium amide (sodamide)
Chloroprene[a]	Potassium metal	Tetrafluoroethylene[a]
Divinylacetylene	Potassium amide	Vinylidene chloride
B. Chemicals that form explosive levels of peroxides on concentration		
Acetal	Diethyl ether	4-Methyl-2-pentanol
Acetaldehyde	Diethylene glycol dimethyl ether (diglyme)	2-Pentanol
Benzyl alcohol	Dioxanes	4-Penten-1-ol
2-Butanol	Ethylene glycol dimethyl ether (glyme)	1-Phenylethanol
Cumene	4-Heptanol	2-Phenylethanol
2-Cyclohexen-1-ol	2-Hexanol	2-Propanol
Cyclohexene	Methylacetylene	Tetrahydrofuran
Decahydronaphthalene	3-Methyl-1-butanol	Tetrahydronaphthalene
Diacetylene	Methylcyclopentane	Vinyl ethers
Dicyclopentadiene	Methyl isobutyl ketone	Other secondary alcohols
C. Chemicals that may autopolymerize as a result of peroxide accumulation		
Acrylic acid[b]	Methyl methacrylate[b]	Vinyl chloride
Acrylonitrile[b]	Styrene	Vinylpyridine
Butadiene[c]	Tetrafluoroethylene[c]	Vinyladiene chloride
Chloroprene[c]	Vinyl acetate	
Chlorotrifluoroethylene	Vinylacetylene	

D. Chemicals that may form peroxides but cannot clearly be placed in sections A-C		
Acrolein	p-Chlorophenetole	4,5-Hexadien-2-yn-1-ol
Allyl ether[d]	Cyclooctene[d]	*n*-Hexyl ether
Allyl ethyl ether	Cyclopropyl methyl ether	*o,p*-Iodophenetole
Allyl phenyl ether	Diallyl ether[d]	Isoamyl benzyl ether[d]
p-(*n*-Amyloxy)benzoyl chloride	*p*-Di-n-butoxybenzene	Isoamyl ether[d]
n-Amyl ether	1,2-Dibenzyloxyethane[d]	Isobutyl vinyl ether
Benzyl *n*-butyl ether[d]	*p*-Dibenzyloxybenzene[d]	Isophorone[d]
Benzyl ether[d]	1,2-Dichloroethyl ethyl Ether	*B*-Isopropoxypropionitrile[d]
Benzyl ethyl ether[d]	2,4-Dichlorophenetole	Isopropyl 2,4,5-trichloro-phenoxy- acetate
Benzyl methyl ether	Diethoxymethane[d]	Limonene
Benzyl 1-napthyl ether[d]	2,2-Diethoxypropane	1,5-*p*-Methadiene
1,2-Bis(2-chloroethoxy) Ethane	Diethyl ethoxymethylene-Malonate	Methyl *p*-(*n*-amyloxy)-benzoate
Bis(2 ethoxyethyl)ether	Diethyl fumarate[d]	4-Methyl-2-pentanone
Bis(2-(methoxyethoxy)-ethyl) ether	Diethyl acetal[d]	*n*-Methylphenetole
Bis(2-chloroethyl)ether	Diethyketene[f]	2-Methyltetrahydrofuran
Bis(2-ethoxyethyl)adipate	*m,o,p*-diethoxybenzene	3-Methoxy-1-butyl acetate
Bis(2-ethoxyethyl)phthalate	1,2-Diethoxyethane	2-Methoxyethanol
Bis(2-methoxyethyl)-Carbonate	Dimethoxymethane[d]	3-Methoxyethyl acetate
Bis(2-methoxyethyl) ether	1,1-Dimethoxyethane[d]	2-Methoxyethyl vinyl ether
Bis(2-methoxyethyl) Phthalate	Dimethylketene[f]	Methonxy-1,3,5,7-cyclo-octa-tetraene
Bis(2-methoxymethyl) Adipate	3,3-Dimethoxypropene	B-Methoxypropionitrile
Bis(2-n-butoxyethyl) Phthalate	2,4-Dinitrophenetole	m-Nitrophenetole
Bis(2-phenoxyethyl) ether	1,3-Dioxepane[d]	1-Octene
Bis(4-chlorobutyl) ether	Di(1-propynyl)ether[f]	Oxybis(2-ethyl acetate)
Bis(chloromethyl) ether[e]	Di(2-propynyl)ether	Oxybis(2-ethyl benzoate)
2-Bromomethyl ethyl ether	Di-*n*-propoxymethane[d]	*B,B*-oxydipropionitrile
B-Bromophenetole	1,2-Epoxy-3-isopropoxy-propane[d]	1-Pentene
o-Bromophenetole	1,2-Epoxy-3-phenoxy-Propane	Phenoxyacetyl chloride
p-Bromophenetole	*p*-Ethoxyacethophenone	*a*-Phenoxypropionyl chloride
3-Bromopropyl phenyl ether	2-Ethoxyethyl acetate	Phenyl *o*-propyl ether

1,3-Butadiyne	(2-Ethoxyethyl)-o-benzoyl Benzoate	*p*-Phenylphenetone
Buten-3-yne	1-(2-Ethoxyethoxy)ethyl Acetate	*n*-Propyl ether
tert-Butyl ethyl ether	1-Ethoxynaphthalene	*n*-Propyl isopropyl ether
tert-Butyl methyl ether	o,p-Ethoxyphenyl isocyanate	Sodium 8,11,14-eicosa-tetraenoate
n-Butyl phenyl ether	1-Ethoxy-2-propyne	Sodium ethoxyacetylide[f]
n-Butyl vinyl ether	3-Ethoxyopropionitrile	Tetrahydropyran
Chloroacetaldehyde diethylacetal[d]	2-Ethylacrylaldehyde oxime	Triethylene glycol diacetate
2-Chlorobutadiene	2-Ethylbutanol	Triethylene glycol diprop-ionate
1-(2-Chloroethoxy)-2-phen-oxyethane	Ethyl *B*-ethoxypropionate	1,3,3-Trimethoxypropene[d]
Chloroethylene	2-Ethylhexanal	1,1,2,3-Tetrachloro-1,3-butadiene
Chloromethyl methyl ether[e]	Ethyl vinyl ether	4-Vinyl cyclohexene
B-Chlorophenetole	Furan	Vinylene carbonate
o-Chlorophenetole	2,5-Hexadiyn-1-ol	Vinylidene chloride[d]

NOTES:

[a] When stored as a liquid monomer.

[b] Although these chemicals form peroxides, no explosions involving these monomers have been reported.

[c] When stored in liquid form, these chemicals form explosive levels of peroxides without concentration. They may also be stored as a gas in gas cylinders. When stored as a gas, these chemicals may autopolymerize as a result of peroxide accumulation.

[d] These chemicals easily form peroxides and should probably be considered under Part B.

[e] OSHA - regulated carcinogen.

[f] Extremely reactive and unstable compound.

References:

Prudent Practices in the Laboratory, National Research Council, 1995.

APPENDIX I: INCOMPATIBLE CHEMICALS

Substances in the left-hand column should be stored and handled so they cannot contact corresponding substances in the right-hand column. The following list contains some of the chemicals commonly found in laboratories, but it should not be considered exhaustive. Information for the specific chemical you are using can usually be found in the "REACTIVITY" or "INCOMPATIBILITIES" section of the Material Safety Data Sheet.

Material	Incompatible Materials
Alkaline and alkaline earth metals, such as Sodium, Potassium, Cesium, Lithium, Magnesium, Calcium	Carbon dioxide, Carbon tetrachloride and other chlorinated hydrocarbons, any free acid or halogen. Do not use water, foam or dry chemical on fires involving these metals.
Acetic acid	Chromic acid, Nitric acid, hydroxyl compounds, Ethylene glycol, Perchloric acid, peroxides, permanganates.
Acetic anhydride	Chromic acid, Nitric acid, hydroxyl-containing compounds, Ethylene glycol, Perchloric acid, peroxides and permanganates.
Acetone	Concentrated Nitric and Sulfuric acid mixtures.
Acetylene	Copper, Silver, Mercury and halogens, Fluorine, Chlorine, Bromine.
Alkali & alkaline earth metals (such as powdered Aluminum or Magnesium, Calcium, Lithium, Sodium, Potassium)	Water, Carbon tetrachloride or other chlorinated hydrocarbons, Carbon dioxide, and halogens.
Aluminum alkyls	Halogenated hydrocarbons, water.
Ammonia (anhydrous)	Silver, Mercury, Chlorine, Calcium hypochlorite, Iodine, Bromine, Hydrogen fluoride, Chlorine dioxide, Hydrofluoric acid (anhydrous).
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, Sulfur, finely divided organics or combustibles.
Aniline	Nitric acid, Hydrogen peroxide.
Arsenical materials	Any reducing agent.

Material	Incompatible Materials
Azides	Acids.
Benzoyl peroxide	Chloroform, organic materials.
Bromine	Ammonia, Acetylene, Butadiene, Butane and other petroleum gases, Sodium carbide, Turpentine, Benzene and finely divided metals, Methane, Propane, Hydrogen.
Calcium carbide	Water (see also Acetylene).
Calcium hypochlorite	Methyl carbitol, Phenol, Glycerol, Nitromethane, Iron oxide, Ammonia, activated carbon.
Calcium oxide	Water.
Carbon, activated	Calcium hypochlorite, all oxidizing agents.
Carbon tetrachloride	Sodium.
Chlorates	Ammonium salts, acids, metal powders, Sulfur, finely divided organics or combustibles.
Chlorine	Ammonia, Acetylene, Butadiene, Butane, Propane, and other petroleum gases, Hydrogen, Sodium carbide, Turpentine, Benzene and finely divided metals, Methane.
Chlorine dioxide	Ammonia, Methane, Phosphine and Hydrogen sulfide.
Chlorosulfonic acid	Organic materials, water, powdered metals.
Chromic acid & Chromium trioxide	Acetic acid, Naphthalene, Camphor, Glycerin, Turpentine, alcohol and other flammable liquids, paper or cellulose.
Copper	Acetylene, Hydrogen peroxide, Ethylene oxide.
Cumene hydroperoxide	Acids, organic or mineral.
Cyanides	Acids.

Material	Incompatible Materials
Ethylene oxide	Acids, bases, Copper, Magnesium perchlorate.
Flammable liquids	Ammonium nitrate, Chromic acid, Hydrogen peroxide, Nitric acid, Sodium peroxide, halogens.
Fluorine	Almost all oxidizable substances.
Hydrocarbons (such as Bromine, Butane)	Fluorine, Chlorine, Chromic acid, Sodium peroxide.
Hydrocyanic acid	Nitric acid, alkalis.
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous).
Hydrogen peroxide	Copper, Chromium, Iron, most metals or their salts, any flammable liquid, combustible materials, Aniline, Nitromethane, alcohols, Acetone, organic materials, Aniline.
Hydrides	Water, air, Carbon dioxide, chlorinated hydrocarbons.
Hydrofluoric acid, anhydrous (Hydrogen fluoride)	Ammonia (anhydrous or aqueous), organic peroxides.
Hydrogen sulfide	Fuming Nitric acid, oxidizing gases.
Hydrocarbons (Benzene, Butane, Propane, Gasoline, Turpentine, etc.)	Fluorine, Chlorine, Bromine, Chromic acid, Sodium peroxide, fuming Nitric acid.
Hydroxylamine	Barium oxide, Lead dioxide, Phosphorus pentachloride and trichloride, Zinc, Potassium dichromate.
Hypochlorites	Acids, activated Carbon.
Iodine	Acetylene, Ammonia (anhydrous or aqueous), Hydrogen.
Maleic anhydride	Sodium hydroxide, Pyridine and other tertiary amines.
Mercury	Acetylene, Fulminic acid, Ammonia, Oxalic acid.

Material	Incompatible Materials
Nitrates	Acids, metal powders, flammable liquids, chlorates, sulfur, finely divided organics or combustibles, Sulfuric acid.
Nitric acid (concentrated)	Acetic acid, Aniline, Chromic acid, Hydrocyanic acid, Hydrogen sulfide, flammable liquids, flammable gases, nitratable substances, organic peroxides, chlorates, Copper, brass, any heavy metals.
Nitroparaffins	Inorganic bases, amines.
Oxygen	Oil, grease, Hydrogen, flammable liquids, solids, or gases.
Oxalic acid	Silver, mercury, organic peroxides.
Perchlorates	Acids.
Perchloric acid	Acetic anhydride, Bismuth and its alloys, alcohol, paper, wood, grease, oil, organic amines or antioxidants.
Peroxides, organic	Acids (organic or mineral); avoid friction, store cold.
Phosphorus (white)	Air, Oxygen, alkalis, reducing agents.
Phosphorus pentoxide	Propargyl alcohol.
Potassium	Carbon tetrachloride, Carbon dioxide, water.
Potassium chlorate	Acids, Sulfuric acid (see also chlorates).
Potassium perchlorate	Sulfuric & other acids (see also Perchloric acid, & chlorates).
Potassium permanganate	Glycerin, Ethylene glycol, Benzaldehyde, any free acid, Sulfuric acid.
Selenides	Reducing agents.
Silver	Acetylene, Oxalic acid, Tartaric acid, Fulminic acid, ammonium compounds.
Sodium	Carbon tetrachloride, Carbon dioxide, water. See alkaline

Material	Incompatible Materials
	metals (above).
Sodium amide	Air, water.
Sodium nitrate	Ammonium nitrate and other ammonium salts.
Sodium oxide	Water, any free acid.
Sodium peroxide	Any oxidizable substance, such as Ethanol, Methanol, glacial Acetic acid, Acetic anhydride, Benzaldehyde, Carbon disulfide, Glycerine, Ethylene glycol, Ethyl acetate, Methyl acetate and Furfural.
Sulfides	Acids.
Sulfuric acid	Chlorates, perchlorates, permanganates, organic peroxides. Potassium chlorate, Potassium perchlorate, Potassium permanganate (similar compounds of light metals, such as Sodium, Lithium).
Tellurides	Reducing agents.
UDMH (1,1-Dimethylhydrazine)	Oxidizing agents such as Hydrogen peroxide and fuming Nitric acid.
Zirconium	Prohibit water, Carbon tetrachloride, foam and dry chemical on zirconium fires.

APPENDIX J: EH&S CHEMICAL SEGREGATION SCHEME

CLASS OF CHEMICALS	RECOMMENDED STORAGE METHOD	CHEMICAL EXAMPLES	INCOMPATIBLES (SEE SDS IN ALL CASES)
Compressed Gases - Flammable	Store in a cool, dry area, away from oxidizing gases. Securely strap or chain cylinders to a wall or bench top.	Methane, Acetylene, Propane	Oxidizing and toxic compressed gases, oxidizing solids.
Compressed Gases - Oxidizing	Store in a cool, dry area, away from flammable gases and liquids. Securely strap or chain cylinders to a wall or bench top.	Oxygen, Chlorine, Bromine	Flammable gases.
Compressed Gases - Poisonous	Store in a cool, dry area, away from flammable gases and liquids. Securely strap or chain cylinders to a wall or bench top.	Carbon monoxide, Hydrogen sulfide	Flammable and/or oxidizing gases.
Corrosives – Acids INORGANIC	Store in a separate, lined/protected acid storage cabinet. **DO NOT store acids on metal shelves**	**Inorganic (mineral) acids -** Hydrochloric acid, Sulfuric acid, Chromic acid, Nitric acid.	Flammable liquids, flammable solids, bases, and oxidizers**. Organic acids**
Corrosives – Acids ORGANIC	Store in a separate, lined/protected acid storage cabinet. **DO NOT store acids on metal shelves**	**Organic acids -** Acetic acid, Trichloroacetic acid, Lactic acid	Flammable liquids, flammable solids, bases, and oxidizers**. Inorganic acids**
Corrosives - Bases	Store in a separate storage cabinet.	Ammonium hydroxide, Potassium hydroxide, Sodium hydroxide	Flammable liquids, oxidizers, poisons, and acids.
Explosives	Store in a secure location away from all other chemicals. Do not store in an area where they can fall.	Ammonium Nitrate, Nitro Urea, Sodium azide, Trinitroaniline, Trinitrobenzene, Trinitrophenol/Picric acid, Trinitrotoluene (TNT).	All other chemicals.

CLASS OF CHEMICALS	RECOMMENDED STORAGE METHOD	CHEMICAL EXAMPLES	INCOMPATIBLES SEE SDS IN ALL CASES
Flammable Liquids	Store in a flammable storage cabinet. **Peroxide forming chemicals must be dated upon opening e.g. Ether, Tetrohydrofuran **	Acetone, Benzene, Diethyl ether, Methanol, Ethanol, Hexanes, Toluene	Acids, bases, oxidizers, and poisons.
Flammable Solids	Store in a separate dry cool area away from oxidizers, corrosives.	Phosphorus, Carbon, Charcoal	Acids, bases, oxidizers, and poisons.
Water Reactive Chemicals	Store in a dry, cool location. Protect from water and the fire sprinkler system, if applicable. Label location - WATER REACTIVE CHEMICALS-	Sodium metal, Potassium metal, Lithium metal, Lithium Aluminium hydride	Separate from all aqueous solutions, and oxidizers.
Oxidizers	Store in a spill tray inside a non-combustible cabinet, separate from flammable and combustible materials.	Sodium hypochlorite, Benzoyl peroxide, Potassium permanganate, Potassium chlorate, Potassium dichromate. The following are generally considered oxidizing substances: Peroxides, Perchlorates, Chlorates, Nitrates, Bromates	Separate from reducing agents, flammables, and combustibles and organic materials.
Poisons/Toxic	Store separately in a vented, cool, dry, area in chemically resistant secondary containers.	Cyanides, heavy metal compounds, i.e. Cadmium, Mercury, Osmium	Flammable liquids, acids, bases, and oxidizers.
General Chemicals -Non-Reactive	Store on general laboratory benches or shelving.	Agar, Sodium chloride, Sodium bicarbonate, and most non-reactive salts	See SDS

APPENDIX K: SAMPLE PRIOR APPROVAL FORM

Prior Approval for Highly Hazardous Operations

PI or supervisor:_____ Location:_____

Name of chemical(s) or operation: _____

Each person on this list should have permission from the lab supervisor or Principal Investigator to use the chemicals or conduct the operation above in this lab and have completed the following:

- Are aware of the hazards the chemical(s) or operation(s) pose?
- Has read the Standard Operating Procedures for this process?
- Knows the first aid procedure in case of an exposure?
- Knows what to do in the event of a spill or other emergency?
- Has received any specific training needed above the standard Lab Safety and Chemical Waste Disposal training?

Name	Initials	Date

APPENDIX L: SAMPLE LABORATORY DOOS SIGN

24 Hour Laboratory Emergency Contact

Primary Lab Emergency # _____

Secondary Lab Emergency # _____

POSSIBLE LABORATORY HAZARDS:

APPENDIX M: SAMPLE PRIOR APPROVAL FORM

Name: _____ Date: _____

Email: _____ Phone: _____

PI/Researcher: _____ Building & Room Number: _____

Material information: _____

Material Name: _____

CAS#:_____

Amount of material: Choose an item. Form: Choose an item.

URL to SDS: _____

Hazards:

☐Explosive ☐Flammable ☐Corrosive (strong acid/base) ☐Carcinogen ☐Oxidizer ☐Toxic

☐Biohazard level 2 or higher ☐Water reactive ☐Pyrophoric ☐Flammable gas ☐Other: Click here to enter text.

Proposed Use of new Material: (Brief Summary of the SOP including where the materials will be used and with what lab equipment)Click here to enter text.

Storage: (Where will the material be stored? Are additional controls needed?)Click here to enter text.

Waste: What will be the waste disposal procedures for this material?Click here to enter text.

Additional information: (Please provide any additional information EH&S should be aware of regarding this chemical or its use. Click here to enter text.

Check each box once completed:

☐I have obtained and read the SDS

☐I have ordered the PPE required to use this material safety

☐I have an appropriate spill kit to handle the release of this material

Submit to EH&S

APPENDIX N: SPECIAL PHYSICAL HAZARDS PRECAUTIONS TO INCLUDE IN SITE-SPECIFIC SOPS

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Flammables and Combustibles

Flammable/combustible materials are materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source. Flammable materials can generate sufficient vapors at temperatures below 100^{O}F (38^{O}C); combustibles, at temperatures at or above 100^{O}F (38^{O}C) and below 140^{O}F (60^{O}C). The vapors of these materials are invisible, and a vapor trail to an ignition source away from the immediate area can result in a flashback. Flammables are more hazardous at elevated temperatures due to more rapid vaporization. In addition, flammable and combustible materials react with oxidizers which can result in a fire. Observe the following special precautions.

1. Eliminate ignition sources such as open flames, smoking materials, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity. Post conspicuous "No Smoking" signs in areas where flammable materials are used or stored.
2. Minimize the quantity kept in the work area.
3. Store in approved flammable liquid containers (safety cans) and storage cabinets, or in a special storage room designed for that purpose. Store away from oxidizers.
4. Flammable liquids stored in glass containers shall not exceed 1 quart. Exception: For conditions where chemical purity must be protected, flammable liquids stored in glass containers shall not exceed 1 gallon.
5. Refrigerators and freezers used for the storage of flammable or combustible liquids must have no internal sources of ignition (lab-safe).
6. Ensure that there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Bonding and grounding must be checked regularly.
7. Ensure that appropriate fire control systems or extinguishers are available.

Special Precautions for Working with Corrosives

Corrosives are materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface. Acids and bases are corrosives. Observe the following special precautions.

1. Containers and equipment used for storage and processing of corrosive materials should be corrosion resistant.
2. Eye protection and rubber gloves should always be used when handling corrosive materials. A face shield, rubber apron, and rubber boots may also be appropriate, depending on the work performed.
3. When mixing concentrated acids (caustics) with water, add the acid (caustic) slowly to water. **Never add water to acid (caustic)**.
4. Acids and bases should be stored separately from each other. Organic acids should be stored with flammable materials, separate from oxidizers and oxidizing acids.

Special Precautions for Working with Oxidizers

Oxidizers are materials which readily yield oxygen or another oxidizing gas, or that readily react to promote or initiate combustion of flammable/combustible materials. Oxidation reactions are a frequent cause of chemical accidents. Observe these precautions to reduce risk when storing or handling oxidizers.

1. Know the reactivity of the materials involved in experiment or process. Make sure that there are no extraneous materials in the area which could become involved in a reaction.
2. If the reaction can be violent or explosive, use shields or other methods for isolating the materials or the process.
3. Use the minimum amounts necessary for the procedure. Do not keep excessive amounts of the material in the vicinity of the process.
4. Store properly, away from organic materials, flammable materials and other reducing agents.
5. Perchloric acid should be used only in specially-designed perchloric acid fume hoods equipped with wash-down systems to prevent deposition of shock-sensitive perchlorates in the ductwork and machinery. Before purchasing perchloric acid, the laboratory supervisor should arrange for use of an approved perchloric acid hood.

Special Precautions for Working with Water-Reactive Materials

Materials which react with water to produce a flammable or toxic gas, or other hazardous condition are said to be water-reactive. Fire and explosion are serious concerns when working with these materials. Special precautions for safe handling of water-reactive materials will depend on the specific material, and the conditions of use and storage. Contact EH&S for information on the safe use of a specific material. Examples of water-reactive materials include

alkali and alkaline earth metals (e.g. Li, Na, K, Ca, Mg), metal hydrides, some metal and nonmetal chlorides (e.g. $SiCl_4$, PCl_3, $AlCl_3$), calcium carbide, acid halides and acid anhydrides.

Special Precautions for Working with Peroxidizables

Peroxidizables are substances or mixtures which react with oxygen to form peroxides. Some peroxides can explode with impact, heat, or friction such as that caused by removing a lid. Peroxides form inside the containers of some materials even if they have not been opened. Examples include ethyl ether, tetrahydrofuran, liquid paraffins (alkanes), and olefins (alkenes). See Appendix C for additional materials which may form peroxides. Precautions are given below.

1. Date all peroxidizables upon receipt and upon opening. Unless an inhibitor has been added by the manufacturer, materials should be properly disposed of after 18 months from date of receipt or 3 months from date of opening.
2. Do not open any container having obvious crystal formation around the lid.
3. Other special precautions are similar to those used for flammables.

Special Precautions for Working with Light-Sensitive Materials

Light-sensitive materials are unstable with respect to light energy. They tend to degrade in the presence of light, forming new compounds which can be hazardous, or resulting in conditions such as pressure build-up inside a container which may be hazardous. Observe the following precautions.

1. Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers which reduce or eliminate penetration of light.
2. Date containers on receipt and upon opening, and dispose of surplus material after one year if unopened or 6 months if opened.

Special Precautions for Working with Shock Sensitive or Explosive Materials

Shock-sensitive/explosive materials are substances or mixtures which can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some materials become increasingly shock-sensitive with age and/or loss of moisture. The inadvertent formation of shock-sensitive/explosive materials such as peroxides, perchlorates, picrates and azides is of great concern in the laboratory. A list of some shock-sensitive materials appears in Appendix D.

1. Contact EH&S at 2-2818 when work with shock-sensitive or explosive materials is planned or when it is suspected that the inadvertent formation of shock-sensitive materials in ductwork, piping, or chemicals being stored has occurred.

2. Date all containers of explosive or shock-sensitive materials upon receipt and when opened. Unless an inhibitor has been added, unopened shock-sensitive materials should be discarded within 12 months after receipt. Open containers of shock-sensitive materials should be discarded within 6 months of the date opened.

3. Use the minimum amount of materials necessary for a procedure. Keep a minimum amount of material on hand.
4. If there is a chance of explosion, use barriers or other methods for isolating the materials or the process.

Special Precautions for Working with Compressed Gases

Special systems are needed for handling materials under pressure. Toxic and corrosive gases present special problems in designing engineering controls. The physical and health hazards of any material are typically compounded by the pressure hazard. Carefully observe special precautions.

1. Always use the smallest size cylinder required to perform the work.
2. Cylinders of compressed gases must be handled as high energy sources.
3. Cylinders on wheeled carts must be capped and secured by an approved cylinder support strap or chain. The cart must be an approved cylinder cart. Do not attempt to take a loaded cylinder cart up or down a stairway.
4. All uncapped cylinders must be secured independently (not ganged behind a single chain) to a solid element of the lab structure. Carts are not acceptable for supporting uncapped or in-use cylinders.
5. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
6. 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.
7. Always wear goggles or safety glasses with side shields when handling compressed gases.
8. Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled. Regulators must be compatible with gas cylinders (do not use adapters).
9. When work with toxic, corrosive or reactive gases is planned, EH&S should be contacted for information concerning specific handling requirements for the gas involved. Generally, these gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.

Special Precautions for Working with Cryogens

Some of the hazards associated with cryogens (fluids used to maintain extremely low temperatures) are fire, pressure, embrittlement of materials, and skin or eye burns upon contact with the liquid. Cryogens can condense nearly pure liquid oxygen from the air, creating a severe fire risk. A pressure hazard exists because of the large expansion ratio from liquid to gas, causing pressure build up in containers. Many materials become brittle at extreme low

temperatures. Brief contact with materials at extreme low temperatures can cause burns similar to thermal burns. Carefully observe all special precautions.

1. Equipment should be kept clean, especially when working with liquid or gaseous oxygen.
2. Mixtures of gases or fluids should be strictly controlled to prevent formation of flammable or explosive mixtures.
3. For flammable cryogens the precautions provided in the "Flammable/Combustible Materials" section of this booklet should be used.
4. Always wear goggles when handling cryogens. If there is a splash or spray hazard, a face shield over the goggles, an impervious apron or coat, cuffless trousers, and fully-covering, non-lacing shoes should be worn. Watches, rings, and other jewelry should not be worn. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen be spilled. Cryo-gloves or pot holders should also be used. Respirators may be required if the cryogen is toxic and sufficient local exhaust ventilation is not available. Contact EH&S for exposure monitoring.
5. Containers and systems containing cryogens should have pressure relief mechanisms.
6. Containers and systems should be capable of withstanding extreme cold without becoming brittle. Glass containers should be taped solidly around the outside or encased in plastic mesh.
7. Funnels should not be used for pouring liquid nitrogen or any other cryogen.
8. Large mobile Dewars or LN2 refrigerators (or the trolleys carrying these) used for transporting cryogens within a building or between buildings should be equipped with a braking mechanism.
9. Large mobile Dewars at risk for tipping should be transported on appropriate carts. Wheeled trolleys may not be used if the vessel must pass over elevator thresholds or other slots/crevasses wider than 25% of the wheel width.
10. Dispensing stations designed to allow research staff to fill smaller vessels from a larger self-pressurizing Dewar must be located in non-public areas, and should be posted with standard operating procedures.
11. Smaller vessels of liquid nitrogen or other cryogens transported by hand within or between buildings must have a handle or bail, and must be covered.

APPENDIX O: SPECIAL HEALTH HAZARDS PRECAUTION FOR TO INCLUDE IN SITE-SPECIFIC SOPS

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Allergens

The term *allergens* describes a wide variety of substances that can produce skin and lung hypersensitivity. Examples include diazomethane, chromium, nickel bichromates, formaldehyde, isocyanates, and certain phenols. Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity. Conduct aerosol producing procedures in a fume hood.

Special Precautions for Working with Embryotoxins and Reproductive Toxins

Substances that act during pregnancy to cause adverse effects on the fetus are referred to as embryotoxins. These effects include embryolethality (death of the fertilized egg, the embryo, or the fetus), malformation (teratologic effects), retard growth, and postnatal functional deficits. Examples include organo-mercurials, lead compounds, and formamide. Because the period of greatest susceptibility to embryotoxins is the first 8-12 weeks of pregnancy, which includes a period when a woman may not know she is pregnant, women of child-bearing potential should take care to avoid skin contact with all chemicals. The term "reproductive toxins" is used to describe substances which cause harmful effects on the male or female reproductive system or the developing embryo and fetus. These effects include but are not limited to menstrual irregularity, lowered fertility, testicular atrophy, and birth defects.

1. Review each use of embryotoxins with the research supervisor and EH&S. Review continuing uses annually or whenever a procedural change is made.
2. Label embryotoxins as follows: EMBRYOTOXIN: READ SPECIFIC PROCEDURES FOR USE.
3. Store embryotoxins and reproductive toxins in unbreakable containers or unbreakable secondary containers in a well-ventilated area.
4. Guard against spills and splashes. Appropriate safety apparel, especially gloves, should be worn. All hoods, glove boxes, or other essential engineering controls should be known to be operating properly before work is started.
5. Notify your supervisor and EH&S of all incidents of exposure or spills. EH&S will arrange for a medical consultation.

Special Precautions for Working with Chemicals of Moderate Chronic or High Acute Toxicity

See Appendix E of this manual for definition and discussion of the meanings of chronic and acute toxicity. Examples of chemicals of moderate chronic toxicity or high acute toxicity include hydrofluoric acid and hydrogen cyanide.

1. Consult one of the standard compilations that list toxic properties of known substances and learn what is known about the substance that will be used. Follow the specific precautions and procedures for the chemical.
2. Use and store these substances only in designated (restricted access) areas placarded with appropriate warning signs.
3. Use a hood or other containment device for procedures which may result in the generation of aerosols or vapors; trap released vapors to prevent their discharge with fume hood exhaust.
4. Avoid skin contact by use of gloves and long sleeves and other protective apparel as appropriate.
5. Maintain records of the amounts of materials on hand, amounts used, and the names of the workers involved.
6. Be prepared for accidents and spills. At least two people should be present at all times if compounds in use are highly toxic or of unknown toxicity.
7. Store breakable containers in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.
8. If a major spill occurs outside the hood, evacuate the area and call for assistance (See cover page).
9. Thoroughly decontaminate or dispose of contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion to a less toxic product.
10. Store contaminated waste in closed, suitably labeled, impervious containers.

Special Precautions for Working with Chemicals of High Chronic Toxicity

See Appendix E of this manual for definition and discussion of the meanings of chronic and acute toxicity. Examples of chemicals exhibiting high chronic toxicity include dimethylmercury, nickel carbonyl, benzo-a-pyrene, N-nitrosodiethylamine, and other human carcinogens or substances with high carcinogenic potency in animals.

1. Conduct all transfers and work in designated (restricted access) areas: a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all persons with access are aware of the substances being used and necessary precautions.
2. Protect vacuum pumps against contamination with scrubbers or HEPA filters and vent effluent into the hood..

3. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed there.
4. On leaving the area, remove protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.
5. Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces. DO NOT DRY SWEEP SPILLED POWDERS.
6. If using toxicologically significant quantities of a substance on a regular basis (in quantities above a few milligrams to a few grams, depending on the substance, 3 or more times per week), contact EH&S. EH&S will arrange for a medical consultation, if appropriate.
7. Keep accurate records of the amounts of these substances stored and used, the dates of use, and names of users.
8. The designated area must be conspicuously marked with warning and restricted access signs and all containers should be appropriately labeled with identity and warning labels (e.g., CANCER-SUSPECT AGENT).
9. Ensure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available.
10. For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and at a pressure of at least 0.5 inches of water gauge. For a positive pressure glove box, thoroughly test for leaks before each use. In either case, trap the exit gases or filter them through a HEPA filter and then release them into a fume hood.
11. Use chemical decontamination whenever possible; ensure that containers of contaminated wasted are transferred from the designated area under the supervision of authorized personnel.

APPENDIX P: ACCIDENT INVESTIGATION GUIDELINES AND SUPERVOSOR REPORT

Every employee accident must be investigated as soon as possible after the accident by the injured employee's supervisor. Injured employees, co–workers and others should participate as pertinent and necessary to the gaining of a real understanding of the cause(s) of the accident.

Everyone involved in accident investigations must understand the aim of the investigation is not to place blame but rather to identify causes of accidents so that employees will be more protected from the same or a similar accident happening again.

Each accident investigation should result in a written report that

1) identifies all contributing factors causing the accident,
2) recommends measures to correct the contributing factors, and
3) presents all facts necessary for proper management of the claim.

FACTORS TO CONSIDER AND QUESTIONS TO ASK IN ACCIDENT INVESTIGATIONS

Causes of accidents include unsafe acts as well as unsafe conditions. Frequently both are involved. Rarely does an unsafe condition alone cause an accident. Often some unsafe act underlies or allows the unsafe condition to exist. Keep in mind that procedures, or the lack of them, can be unsafe acts.

- How did the accident occur? Obtain the injured employee's statement of the facts. Obtain the statement of the facts of any witnesses.

- What time of day did the accident occur? Was this during the injured employee's normal work hours?

- Where did the accident occur? Was this the injured employee's normal work site?

- Was the employee alone when the accident occurred? Were there witnesses to the accident?

- Was the employee performing his/her routine job or a job for which the employee had received special training?

- ☐ Did the job being performed by the injured employee at the time of the accident require more than one employee to perform the job?

- ☐ Was weather a factor in the accident? If so, how?

- ☐ Was the employee observing normal safe operating procedures when the accident occurred?

- ☐ Safety Equipment
  - What safety equipment called for to complete the job?
  - Was the employee using the normal and prescribed safety equipment when the injury occurred?
  - Was the employee trained in the proper use of the safety equipment?
  - Was the employee using the safety equipment properly?
  - Was the safety equipment in good repair?
  - Could the use of safety equipment have prevented the accident or the resulting injury?

- ☐ Was a tool or other equipment involved in the accident?
  - Was it the proper tool to be used for the job attempted?
  - Was the tool defective, damaged or in need of maintenance or replacement?
  - Were any guards missing from the tool when the accident occurred?
  - Was the employee properly trained in the use and safety of the tool?
  - Was the item the tool was being used on defective, damaged or worn, causing the application of an otherwise safe tool to be an unsafe act?

- ☐ Did the accident involve lifting?
  - Was the thing being lifted too heavy, large or awkward to be lifted by one person?
  - Did the injured person request and receive assistance with the lift?
  - Was the injured employee trained in safe lifting techniques?
  - Were mechanical lifting devices available or recommended for use with the lift causing the injury?

- ☐ Did the accident involve office or laboratory equipment?
  - Was the equipment being used for its intended purpose? (e.g. was a desk chair being used as a step stool?)
  - Was the equipment damaged, worn, defective or missing parts?

- ☐ Did the injury result from a trip or fall?
  - Was something wrong with the surface that caused the employee to trip or fall, such as loose or crumbling stair, pothole, rough surface, ice, etc.?
  - Did the accident result from clutter or debris? What type and from where did it come?
  - Was the area where the fall occurred a normal walkway or aisle?
  - Did the employee fall from a height or ground level?
  - Were guards, rails, chains or other supports or barriers present?

- ☐ Did any environmental factors (e.g. light, heat, cold, noise, etc.) contribute to the accident?

- ☐ Was the employee properly attired? Did loose or restrictive clothing or long hair or fingernails contribute to the accident or injury?

- ☐ Did the injured employee report the accident immediately to his/her supervisor?

- ☐ Was the employee directed to or taken for medical assistance? Where and by whom?

- ☐ Did the employee receive medical treatment? Where and by whom?

- ☐ Were the proper accident reports filed? By whom and when?

- ☐ Did the cause of the accident or the accident itself present any danger to other employees or other persons?

- ☐ Were any steps taken after the accident to remove, repair or secure the cause of the accident? What, by whom and when?

- ☐ How could this accident have been prevented?

SUPERVISORS' ACCIDENT INVESTIGATION REPORT

WHEN	Date and Time of Accident: Date and Time Reported to Supervisor or Public Safety (if delayed explain):
WHO	Injured Person: Department: Age: Occupation: Length of Employment:
INJURY/LOSS	Nature/Extent of Injuries or Property Damage:
WHERE	Exact Location Where Accident Happened:
WHAT/HOW	Description of Accident (Detail what employee was doing, how he/she was doing it, and what physical objects, tools, materials, chemicals, machines, structures or equipment were involved) Was employee doing something other than required duties at time of accident? If so, what and why.
WHY	Why did this accident happen? Describe everything that contributed to the accident.
PREVENTION	What should be done to prevent recurrence of this type of accident? By whom?
INVESTIGATION COMPLETED BY	Supervisor's Signature Date
DEPT. HEAD'S COMMENTS	Department Head's Signature Date Comments:

Use additional sheets of paper as necessary if any portion of this form does not provide sufficient space to allow for an complete explanation of the facts or your analysis of the accident. Be sure to consider all factors described in the accompanying instructions for completing your accident investigation. Return this completed form to Pace Risk Manamgement or EH&S.

APPENDIX Q: EH&S REVIEW OF CHEMICAL HYGIENE PLAN LOG

Name	Initials	Date
Brian Anderson	BA	04-Apr-2012