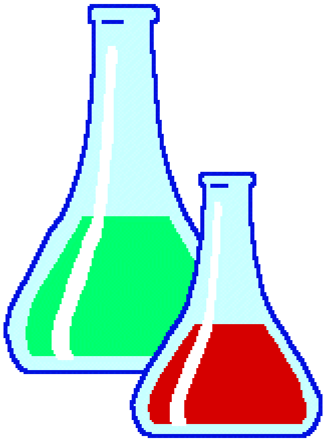
Ithaca College

Chemical Hygiene Plan



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Revised: December, 2022

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1.0 Introduction

The *Ithaca College Policy Manual Volume II - Policies for the Entire Campus Community,* Section 2.8 “Health and Safety Policies” outlines safety responsibilities and training requirements to ensure individual and institutional compliance with relevant environmental health and safety laws, regulations, policies, and guidelines.

The Occupational Safety and Health Administration (OSHA) requires a safe work environment for all types of employment. OSHA has adopted a health and safety standard to protect laboratory workers from chemical hazards in the workplace. 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories,* mandates safety and health practices and procedures for laboratories that use hazardous chemicals. (A complete text of this standard is located in **Appendix A**.)

The purpose of the OSHA Laboratory Standard is to protect employees from harm caused by chemicals while they are working in a laboratory. Laboratories at Ithaca College using chemicals are subject to the requirements of the Laboratory Standard. In addition to employees who ordinarily spend most of their time working within a laboratory, other workers covered by the Standard may include office professionals, custodians, maintenance and repair personnel, and others, who as part of their duties regularly spend a significant amount of time within a laboratory environment.

The OSHA Laboratory Standard is a performance standard, meaning there are few specific procedural requirements; instead, the standard specifies results that are to be achieved, without specifying exactly how to achieve those results. The OSHA Laboratory Standard requires employers to develop a Chemical Hygiene Plan (CHP), designate a Chemical Hygiene Officer, and ensure laboratory employees are provided with the proper information and training, including knowing the location of the Chemical Hygiene Plan, and how to work safely in their labs. In addition to other requirements, the OSHA Lab Standard specifies the Chemical Hygiene Plan to include “criteria the employer will use to determine and implement control measures to reduce 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.”

1.1 Chemical Hygiene Plan 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.

***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.*

1.2 Laboratory Safety Responsibilities

The ultimate responsibility for health and safety within laboratories lies with each individual who works in the laboratory; however, it is the responsibility of the principal investigator, faculty, and laboratory supervisor to ensure that employees (including visiting scientists, fellows, volunteers, temporary employees, and student employees) have received all appropriate training, and have been provided with all the necessary information to work safely in laboratories under their control. Principal investigators, faculty, and lab supervisors have numerous resources at their disposal for helping to ensure a safe and healthy laboratory that is compliant with state and federal regulations.

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 College's Chemical Hygiene Plan, the college's Health and Safety Policy, and any other department or college specific policies.

1.2.1 Environmental Health and Safety

Environmental Health and Safety (EH&S) will provide technical information and program support to assist in compliance with the OSHA Laboratory Standard. This includes developing policies, recommendations, guidelines, providing training programs designed to meet regulatory requirements, and serving as consultants in providing health and safety information to laboratory personnel. EH&S will maintain the campus Chemical Hygiene Plan and the institutional Chemical Hygiene Officer responsibilities.

1.2.2 Chemical Hygiene Officer

The role of the Chemical Hygiene Officer (CHO) is to facilitate the implementation of the campus Chemical Hygiene Plan in laboratories across campus and outlying facilities, and to serve as a technical resource to the campus laboratory community.

The major duties of the Chemical Hygiene Officer are as follows:

- Work with campus stakeholders to evaluate, implement, review annually, and make updates as needed to the Chemical Hygiene Plan
- Ensure that guidelines are in place and communicated for particularly hazardous substances **(Apendix D)** regarding proper labeling, handling,

use, storage, selection of proper personal protective equipment, and facilitating the development of standard operating procedures for laboratories using these substances.

- Serve as a resource to review academic research protocols and standard operating procedures developed by principal investigators and department personnel for the use, disposal, spill cleanup, decontamination of hazardous chemicals, and the proper selection and use of personal protective equipment.
- Coordinate the testing and maintenance of fume hoods, emergency safety showers and eyewashes in all laboratories where hazardous chemicals are used.
- Conduct laboratory safety training sessions for laboratory personnel and upon request, assist laboratory supervisors in developing and conducting hands-on training sessions with employees.
- Review reports for laboratory incidents, accidents, chemical spills, and near-misses and recommend follow up actions where appropriate.
- Stay informed of plans for renovations or new laboratory construction projects and serve as a resource in providing code citations and internal standards to assist with the design and construction process.

1.2.3 Deans, Directors, and Department Chairpersons

The Deans, Directors, and Department Chairpersons are responsible for laboratory safety within their department and understand the guidelines and requirements of the Chemical Hygiene Plan. In addition to the responsibilities outlined within the College Health & Safety Policy Section 2.8 the following requirements:

- Communicate and implement the College Health and Safety Policy and its requirements to faculty, staff (including temporary employees), visiting scholars, volunteers, and students working in laboratories within their units.
- Assist the Chemical Hygiene Officer with implementation of the Chemical Hygiene Plan.
- Ensure laboratory personnel develop and adhere to proper health and safety protocols.
- Direct individuals under their supervision, including but not limited to - Principal Investigators, supervisors, regular and temporary employees, visiting professors, and student employees - to obtain any required safety and health training before working with hazardous chemicals, biohazardous agents, radiation, and/or other physical/mechanical hazards found within their working or learning environments.
- Determine and ensure that safety needs and equipment for units/departments are met (e.g., engineering controls, training, protective equipment) and ensure corrective measures for noncompliance items identified in safety audits are corrected promptly.

- Encourage the formation of a college and/or department safety committee(s).
- Keep the Chemical Hygiene Officer informed of plans for renovations or new laboratory construction projects.
- Ensure college and departmental procedures are established and communicated to identify and respond to potential accidents and emergency situations.
- Notify the Chemical Hygiene Officer before a faculty member retires or leaves the University so proper laboratory decommissioning occurs.
- Establish college and departmental priorities, objectives, and targets for laboratory safety and health performance. Obtain assistance and guidance from EH&S when necessary.

1.2.4 Principal Investigators, Faculty, and Laboratory Supervisors

Principal Investigators, faculty, and laboratory supervisors are responsible for laboratory safety in their research or teaching laboratories. In addition to the responsibilities outlined within the College Health & Safety Policy 2.8, the laboratory safety duties of Principal Investigators, faculty, and laboratory supervisors (which can also be delegated to other authorized personnel within the laboratory) are:

- Implement and communicate the College Health & Safety Policy 2.8 and all other College safety practices and programs, including the guidelines and procedures found within the Chemical Hygiene Plan, in laboratories under your supervision or control.
- Establish laboratory priorities, objectives and targets for laboratory safety, health and environmental performance.
- Communicate roles and responsibilities of individuals within the laboratory relative to environmental, health, and safety according to this Chemical Hygiene Plan
- Conduct hazard evaluations for procedures conducted in the laboratory and maintain a file of standard operating procedures **(Appendix C)** documenting those hazards.
- Ensure that specific operating procedures for handling and disposing of hazardous substances used in their laboratories are written, communicated, and followed and ensure laboratory personnel have been trained in these operating procedures and use proper control measures.
- Attend required health and safety training.
- Require all staff members and students under their direction to obtain and maintain required health and safety training.
- Ensure that all items identified during annual EH&S research area inspections are corrected in a timely manner.
- Ensure that all appropriate engineering controls including chemical fume hoods and safety equipment are available and in good working order in

their laboratories. This includes notifying EH&S when significant changes in chemical use may require a re-evaluation of the laboratory ventilation.
- Ensure procedures are established and communicated to identify the potential for, and the appropriate response to accidents and emergency situations.
- Ensure that all incidents and near misses occurring in their laboratories are reported to their director or department chairperson that a written Injury/Illness Report is filed with Human Resources (HR) for each injured person.
- Ensure laboratory personnel under your supervision know and follow the guidelines and requirements contained within the Chemical Hygiene Plan
- Keep the department chairperson, and the Chemical Hygiene Officer informed of plans for renovations or new laboratory construction projects.

1.2.5 Laboratory Employees

Laboratory employees are those personnel who conduct their work in a laboratory and are at risk of possible exposure to hazardous chemicals on a regular or periodic basis. These personnel include laboratory technicians, instructors, researchers, visiting researchers, administrative assistants, graduate assistants, student aides, student employees, and part-time and temporary employees. The laboratory safety duties of laboratory employees are

- Comply with the College Health & Safety Policy 2.8 and all other health and safety practices and programs by maintaining class, work, and laboratory areas safe and free from hazards.
- Know the location of the Chemical Hygiene Plan and how to access material safety data sheets.
- Attend required health and safety training as designated by your supervisor.
- Inform your supervisor or instructor of any safety hazards in the workplace, classroom, or laboratory, including reporting any unsafe working conditions, faulty fume hoods, or other emergency safety equipment to the laboratory supervisor.
- Conduct hazard evaluations with your supervisor for procedures conducted in the laboratory and maintain a file of standard operating procedures documenting those hazards.
- Be familiar with what to do in the event of an emergency situation.
- Follow the standard operating procedures for your laboratory and incorporate the guidelines and requirements outlined in this Chemical Hygiene Plan into everyday practice.
- Participate in laboratory self inspections and annual EH&S Research Area Inspections.
- Follow the standard operating procedures for your laboratory and incorporate the guidelines and requirements outlined in this Chemical Hygiene Plan.

2.0 Chemical Hygiene Plan Requirements

As required, the Ithaca College Chemical Hygiene Plan (ICCHP) has been prepared to cover aspects of laboratory safety. The ICCHP addresses the following:

- Protecting employees from health hazards associated with hazardous chemicals in that laboratory and keeping exposures below the OSHA limits.
- The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.
- The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:
    - Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals.
    - To determine and implement control measures to reduce 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.
    - A requirement that fume hood and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment
    - Provision for employee information and training.
- The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation.
- Provisions for medical consultation and medical examinations
- Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee.
- Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included 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.

- The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

Questions about the ICCHP should be directed to Environmental Health & Safety at 274-3353.

3.0 General Control Measures

The exposure to hazardous chemicals in the laboratory shall be controlled through the use of engineering controls, personal protective equipment, good general laboratory practices, and standard operating procedures specific to an individual laboratory or department.

- Engineering controls: There are a variety of engineering controls that can be used in the laboratory to control exposures to hazardous chemicals. Some of the engineering controls that will be used in laboratories at Ithaca College may include dilution ventilation, local exhaust ventilation (fume hoods), and proper storage facilities.
- General laboratory practices: EH&S provides laboratories with information about general laboratory work practices and rules that are recognized as effective control measures to minimize exposure to hazardous chemicals in the laboratory. The information is referenced from *Prudent Practices in the Laboratory, Safety in Academic Chemistry Laboratories,* and other references.
- Specific laboratory practices: Individual departments or laboratories must develop additional written safety procedures whenever necessary to protect laboratory workers from specific chemical hazards that are unique to their particular area of research. Particular attention should be given to control measures for operations that involve the use of particularly hazardous substances such as select carcinogens, reproductive toxins, or acutely toxic chemicals. EH&S can assist researchers in developing safety procedures for specific hazards.
- Personal protective equipment: Personal protective equipment (PPE) will be available to laboratory workers for use to reduce exposures to hazardous chemicals in the laboratory. Common PPE such as goggles, gloves, face shields, and aprons are recommended for use with hazardous chemicals. Other PPE such as respirators will be available and recommended for use if necessary. EH&S will assist in the proper selection, use, and care of PPE. PPE will be readily available, and most equipment is provided at no cost to the employee.
- Other: Other control methods that will be used to determine and reduce employee exposures to hazardous chemicals in the laboratory may include exposure monitoring, testing eyewash and emergency shower facilities, developing emergency procedures, proper container selection, and substitution of less toxic chemicals whenever possible.

4.0 Engineering Controls

Engineering controls are considered the first line of defense in the laboratory for the reduction or elimination of the potential exposure to hazardous chemicals. Examples of engineering controls used in laboratories at Ithaca College may include dilution ventilation, local exhaust ventilation, chemical fume hoods, glove boxes, safety shields, and proper storage facilities.

The OSHA Laboratory Standard requires that "fume hoods and other protective equipment function properly and that specific measures are taken to ensure proper and adequate performance of such equipment." General laboratory room ventilation is not adequate to provide proper protection against bench top use of hazardous chemicals. Laboratory personnel need to consider available engineering controls to protect themselves against chemical exposures before beginning any new experiment(s) involving the use of hazardous chemicals.

The proper functioning and maintenance of fume hoods and other protective equipment used in the laboratory is the responsibility of a variety of service groups. Maintenance, Facilities Engineering, HVAC, EH&S, and other groups service equipment such as fire extinguishers, emergency eyewash and showers, and mechanical ventilation. Periodic inspections and maintenance by these groups ensure proper functioning and adequate performance of these important pieces of protective equipment.

However, it is the responsibility of laboratory personnel to immediately report malfunctioning protective equipment, such as fume hoods, or mechanical problems to the FacilitiesDepartmen as soon as any malfunctions are discovered.

4.1 Chemical Fume Hoods

Fume hoods and other capture devices must be used for operations that might result in the release of toxic chemical vapors, fumes, or dusts. Bench top use of chemicals that present an inhalation hazard **is not permitted**. Fume hoods must be used when conducting new experiments with unknown consequences from reactions or when the potential for a fire exists.

To obtain optimum performance and achieve the greatest protection when using a fume hood, please adhere to the following:

- Before using a fume hood, ensure the fume hood is working by checking the air monitoring device if the hood is equipped with one. DO NOT use an improperly working fume hood. If EH&S or Maintenance has posted the hood as being out of service, do not use the fume hood for any reason.
- Keep the fume hood sash lowered at all times to the height recommended by EH&S (as indicated by the green arrow stickers). Keeping the hood sash lowered improves the performance of the fume hood, acts as a safety shield during experimental procedures and helps to conserve energy.
- Keep the fume hood sash closed all of the way whenever the fume hood is not being used to help conserve energy.

- Keep all materials stored in hoods to a minimum to reduce clutter. Excess and unnecessary storage and clutter results in decreased hood performance and increases the chances of an accident or spill occurring. Do not use hoods as storage cabinets, especially for long term storage of chemicals and hazardous waste.
- For optimum performance of the fume hood, keep all materials and equipment back at least six (6) inches from the face of the hood and do not block the vents or baffle openings in the back of the hood.
- Keep any lab equipment elevated at least one inch off the work surface of the hood to allow for proper airflow. Use bench stands or items such as blocks of wood, metal test tube racks, or other items that will not react with the chemical(s) in use.
- When working in a fume hood, keep windows and doors closed within the lab and minimize traffic in front of the hood. Minimize rapid movements while working in the hood, including opening and closing the sash. All of these precautions will help to prevent air currents from forming, which can result in hazardous vapors being pulled out of the hood and into the laboratory personnel’s breathing zone.
- Always work with the fume hood sash as low as possible and always keep your fume hood sash closed when you are not working in it this offers better protection against splashes and explosions and saves a significant amount of energy and electricity.
- Do not use fume hoods to evaporate hazardous waste. **Evaporating hazardous waste is illegal.**
- For work involving particularly hazardous substances or chemicals that can form toxic vapors, fumes, or dusts, the hood or equipment within the hood may need to be fitted with condensers, traps, or scrubbers in order to prevent the vapors, fumes, and dusts from being released into the environment.
- When pouring flammable liquids, always make sure both containers are electrically interconnected to each other by bonding and grounding in order to prevent the generation of static electricity - which can cause the flammable liquid to ignite.
- As with any work involving chemicals, always practice good housekeeping and clean up all chemical spills immediately. Be sure to wash both the working surface and hood sash frequently and always maintain a clean and dry work surface that is free of clutter.
- Always report any malfunctioning fume hoods to your Lab Coordinator immediately to request the unit to be repaired. If the fume hood is not working properly, let other people in the lab know by hanging up a Do Not Use sign on the hood. In addition to annual fume hood inspection andface velocity testing, EH&S can offer a training program on the safe use of fume hoods.

4.1.2 Fume Hood Inspection

The fume hood inspection program at Ithaca College consists of an initial comprehensive inspection upon installation, followed by annual standardized inspections for all campus fume hoods. Follow-up inspection for proper use as well as face velocity measurements are done twice each year and also upon requests. After each inspection, hoods are labeled with inspection stickers and testing date. All inspection information is recorded on a standard form and kept on file at EH&S.

The fume hood inspections consist of:

- Recording of information identifying building, room number, and fan number.
- Measurements of hood average face velocity.
- Determination of the acceptability of hood.
- Verify that alarm lights and alarms are functioning properly.

Hoods are classified as acceptable or unacceptable based on the face velocity measurement. In most cases, an average face velocity between 80 and 120 feet per minute (fpm) (with hood sash fully open) is considered acceptable. The hood is considered unacceptable if it cannot achieve an 80 fpm average with the sash at two feet (2.0') opening or greater. If a hood is found to be unacceptable, a warning sign indicating that the hood has been inspected and found not to provide adequate protection is attached to the center of the sash window or another conspicuous location. Physical Plant is notified to repair the hood. Upon completion of the maintenance services, EH&S must be contacted to re-inspect the hood. A sticker indicating face velocity and the date of testing is attached to each fume hood upon acceptable inspection.

4.2 Glove Boxes

Glove boxes are sealed enclosures designed to protect the user, the process or both. They are usually equipped with at least one pair of gloves attached to the enclosure. The user manipulates the materials inside using the gloves. Typically, a glove box has an antechamber that is used to take materials in and out of the box.

The topic of glove boxes can be confusing because their configuration depends on the application. Glove boxes can be under negative or positive pressure. Glove boxes under negative pressure are designed to protect the operator and ambient environment from the materials or processes; glove boxes under positive pressure are intended to protect the materials or processes from the operator and/or the ambient environment. The atmosphere in the glove box may be inert (e.g. nitrogen, argon, helium), sterile, dry, or otherwise controlled. Some glove boxes are equipped with filters (e.g. HEPA) while others vent to a fume hood duct or a dedicated duct. Glove boxes can have various controls, sensors and equipment such as pressure gauges, oxygen sensors, temperature controllers and purifiers.

Regular maintenance and inspection is essential to ensure that a glove box is adequately protecting the user, the environment and/or the product/process. Routine maintenance procedures and the frequency of inspection (or certification) should follow the manufacturers and regulatory recommendations. Glove boxes used for work with hazardous chemicals or processes currently do not have a required frequency of inspection but annual certification by the manufacturer or an industrial hygienist is strongly encouraged. If the manufacturer does not offer an inspection program, contact EH&S for information on qualified industrial hygienists in the area.

The integrity of the glove box is key to successful containment. The gloves of a glove box are particularly vulnerable. Gloves should be regularly inspected for cuts, tears, cracking and pinhole leaks. If defects are found, the gloves should be replaced. Note that there are many different types of glove box gloves that vary in thickness, material, size, etc … Chose the correct one for the glove box and application.

There are various tests that can be performed on glove boxes, the suitability of which depends on the glove box and the application. Tests may include pressure decay (for positive pressure), rate of rise (for negative pressure), oxygen analysis, containment integrity, ventilation flow characterization, and cleanliness. The source of a leak can be identified using a Mass Spectrometer Leak Detector, ultrasound, the soap bubble method or use of an oxygen analyzer. For an in-depth discussion of glove boxes and testing, see: AGS (American Glove Box Society) 2007 Guide for glove boxes – Third Edition. AGSG001-2007.

4.3 Water Protection in Labs

Laboratory personnel must ensure that any piece of equipment or laboratory apparatus connected to the water supply utilizes backflow protection or is connected to a faucet with a vacuum breaker. The purpose of backflow prevention and vacuum breakers is to prevent water used in an experimental process or with a piece of equipment, from back flowing and contaminating the laboratory’s and building’s water supply system. Examples of situations that can result from improper backflow protection include chemical contamination and/or temperature extremes (i.e. hot water coming from a drinking water fountain).

The two most common water protection problems found in labs are:

1) A tube attached to a faucet without a vacuum breaker.
2) Drainage tubing hanging down into the sink.

These tubes can be immersed in wash water when the sink is stopped up and backflow into the faucet, and then contaminate the building water supply. The most common example of backflow prevention found in laboratories are sink faucets equipped with a vacuum breaker. These faucets are easily identifiable from standard (rounded) faucets by the vacuum breaker head at the top of the faucet. If you have questions about whether your laboratory faucets have a vacuum breaker or backflow protection, contact your Building Coordinator or EH&S. If your sink faucet does not have a vacuum breaker present, make sure any hoses that you connect to the faucet are short enough to prevent the possibility of water in the sink from back flowing up the faucet.

5.0 General Lab Practices

5.1 General Safety Principles for Work with Laboratory Chemicals

The following are general principles that can be applied to almost all uses of hazardous chemicals in laboratories:

- Minimize chemical exposure. Because few laboratory chemicals are without hazards, general precautions for handling of all laboratory chemicals shall be adopted in addition to specific guidelines for particular chemicals and/or mixtures as determined by the applicable researcher. Inhalation of and skin contact with chemicals should be avoided as a cardinal rule.

- Avoid underestimation of risk. Even for substances with no known significant hazards, exposure shall be minimized. For work with substances that present special hazards, specific precautions shall be taken. One should generally assume that any mixture may be more toxic than its most toxic component and that all substances of unknown toxicity are potentially toxic.

- Provide adequate ventilation. The best way to prevent exposure to airborne substances is to prevent their escape into the work atmosphere by the use of hoods and other ventilation devices.

- Observe exposure limits. The OSHA PELs and the current Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists shall not be exceeded. The PELs and TLVs are provided in **Appendix G**.

5.2 Chemical labeling

The Ithaca College's CHP will conform to the college's Hazard Communication program. The Occupational Safety and Health Administration's (OSHA) *Hazard Communication Standard* 29 CFR 1910.1200 requires employers to supply employees with information concerning the hazards of chemicals in the workplace and the protective measures that must be taken to reduce exposure to associated hazards.

5.2.2 Requirements

Ithaca College employees who encounter hazardous chemicals on a routine basis in his or her job are covered in the institutions "Hazard Communication Program." The program addresses 5 main requirements of the OSHA Standard. These are: 1) Hazard Determination, 2) Written Program, 3) Container Labeling, 4) Safety Data Sheets (SDS), and 5) Training. A current copy of the standard shall be maintained and available for employee review during regular business hours at the EH&S office. A copy of the standard is also accessible on the Internet at www.osha.gov.

1) **Hazard Determination.** Chemical manufacturers must evaluate their products to determine associated hazards. The information about the chemicals' hazards must be given to each purchaser of that chemical. Hazard warnings and other information are commonly provided on the container label and in SDS.

2) **Written Program.** Employers must develop, implement, and maintain a written Hazard Communication Program that describes how chemical safety information will be provided to employees (e.g., labeling, MSDS, training, etc.). Ithaca College will make a paper copy of its written program available upon request to employees, their designated representative, and OSHA as required by law. The complete written program can also be viewed on-line at http://www.ithaca.edu/sacl/safety/docs/ehsworkplace/.

3) **Container Labeling.** As required by federal OSHA regulations, *ALL* containers (e.g., spray bottles, 1-gallon jugs, 5-gallon pails, drums, etc.) of hazardous chemicals must be clearly labeled with the following information:

   - Chemical or Product Name
     - Chemical formulas and acronyms are **not** acceptable forms of labeling when used alone.
   - Manufacturer Name and Address
   - Applicable Hazard Information (e.g. "Flammable," "Corrosive," etc.)
   - Appropriate Health Hazard Warnings (e.g., "Inhalation Hazard," "Eye Irritant," etc.)

4) **SDS:** As required by OSHA regulations, all employees must have unobstructed access to an SDS for each chemical product they may use or potentially be exposed to during their work. Ithaca College uses Velocity EHS online SDS inventory system. The link to the SDS data base is available from the EHS Website or mobile devices can scan the QR Code on the SDS posters in each lab. If the internet is down EHS has a backup copy.

5) **Training.** To effectively educate employees, Ithaca College's training program includes three parts: 1) initial informational training through this summary sheet at the New Employee Orientation; 2) job-specific information from the supervisor and, 3) annual classroom instruction.

All new employees will receive comprehensive classroom training at the next scheduled annual refresher training for his/her department. EH&S annually trains all employees who work with hazardous chemicals about the *Ithaca College Hazard Communication Program*. The annual classroom training primarily consists of lectures and discussions, and may be supplemented with instructional videos as appropriate.

Prior to working with hazardous chemicals, the responsible supervisor must provide information more specific to the employee's work activities. Additional training must be provided whenever the potential for chemical exposure is altered (e.g., new chemical is introduced, new work area is assigned, etc.) or when a new hazard is introduced.

Ensure that labels on incoming chemical containers list the identity of the contents as well as appropriate hazard warnings. The labels are not to be defaced or removed. When chemicals are transferred from their original container to a portable container, the portable container must be labeled with the identity and hazards of that chemical. (Refer to **Appendix B** for hazard rating system.)

5.3 Chemical Storage

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. Chemicals that are stored improperly can result in:

- Degraded containers that can release hazardous vapors that are detrimental to the health of laboratory personnel.
- Degraded containers that allow chemicals to become contaminated, which can have an adverse effect on experiments.
- Degraded containers that can release vapors, which in turn can affect the integrity of nearby containers.
- Degraded labels that can result in the generation of unknowns.
- Chemicals becoming unstable and/or potentially explosive.
- Citation and/or fines from state and federal regulatory agencies.

5.3.1 General Storage Guidelines

Laboratories should adhere to the following storage guidelines for the proper and safe storage of chemicals. By implementing these guidelines, laboratories can ensure safer storage of chemicals and enhance the general housekeeping and organization of the lab. Proper storage of chemicals also helps utilize limited laboratory space in a more efficient manner.

- Keep all containers of chemicals closed when not in use.
- Keep an updated chemical inventory to ensure stock rotation and eliminate unnecessary orders of chemicals.
- Every chemical should have an identifiable storage place and should be returned to that location after use.

- The storage of chemicals on bench tops should be kept to a minimum to help prevent clutter and spills, and to allow for adequate working space.
- Chemical storage in fume hoods should be kept to a minimum - limited to the experiment being conducted. Excess storage of chemical containers in hoods can interfere with airflow, reduce working space, and increase the risk of a spill, fire, or explosion.
- For chemical storage cabinets, larger chemical bottles should be stored toward the back and smaller bottles should be stored up front where they are visible. Chemical bottles should be turned with the labels facing out so they can be easily read.
- Chemicals should not be stored on the floor due to the potential for bottles to be knocked over and result in a spill. If it is necessary to store bottles on the floor, then the bottles should be placed in secondary containment, such as trays, and the bottles should be placed away from aisle spaces.
- For multiples of the same chemical, older containers should be stored in front of newer chemicals and containers with the least amount of chemical should be stored in front of full containers. This allows for older chemicals to be used first and helps to minimize the number of chemical containers in the storage area.
- Do not store chemicals in direct sunlight or next to heat sources.
- Laboratories should strive to keep only the minimum quantity of chemicals necessary. When ordering new chemicals, laboratories should only order enough stock needed for the experiment or the quantity that will be used within 1 or 2 years at most.
- Liquid chemical containers should be stored in secondary containment, such as trays, to minimize the potential for bottle breakage and minimize the potential for spills.
- Always segregate and store chemicals according to compatibility and hazard classes.
- Chemical containers should be dated when they arrive and should be checked regularly and disposed of when they are past their expiration date. **Please Note**: Due to the potential explosion hazard, peroxide forming chemicals are required to be tested and dated.
- Flammable liquids in excess of quantities for specific flammability classes must be stored in approved flammable liquid storage cabinets.
- Do not store acids in flammable liquid storage cabinets. This can result in serious degradation of the storage cabinet and the containers inside. Corrosive chemicals should be stored in corrosion resistant cabinets. The exceptions to this rule are organic acids, such as Acetic acid, Lactic acid, and Formic acid, which are considered flammable/combustible and corrosive and can be stored in flammable or corrosive storage cabinets.
- Do not store corrosive or other chemicals that can be injurious to the eyes above eye level. In general and where practical, no chemicals should be stored above eye level.

- Do not store flammable liquids in standard (non-explosion proof) refrigerators or freezers. Due to the potential explosion hazard, only store flammables in refrigerators or freezers approved by the manufacturer for storage of flammables.
- Highly toxic chemicals such as inorganic cyanides should be stored in locked storage cabinets. Always keep the quantities of highly toxic chemicals to an absolute minimum. See Particularly Hazardous Substances Section 9.0.
- Be aware of any special antidotes or medical treatments that may be required for some chemicals (such as cyanides and Hydrofluoric acid).
- Always keep spill kits and other spill control equipment on hand in areas where chemicals are used. Ensure all personnel working in the lab have been properly trained on the location and use of the spill kit.
- For reagent shelves, it is recommended to use shelves with anti-roll lips, to prevent bottles from falling off. This can also be accomplished using heavy gauge twine or wire to create a lip on the shelf.

There are a number of segregation schemes recommended in the literature by government agencies, the college chemical inventory system can supply segregation for each chemical in its system. For more information on the Chemtracker System contact the EH&S Department at 274-3353.

5.3.2 Transporting Chemicals

When transporting chemicals between laboratories or other buildings on campus, the following guidelines should be implemented for protection of people and the environment, and to minimize the potential for spills to occur:

- Whenever transporting chemicals by hand, always use a secondary container such as a rubber acid carrying bucket, plastic bucket, or a 5gallon pail. If necessary, a small amount of packing material (shipping peanuts, vermiculite, or cardboard inserts), that is compatible with the chemical(s), should be used to prevent bottles from tipping over or breaking during transport. You should have proper PPE accessible in the event of a spill.
- Wheeled carts with lipped surfaces (such as Rubbermaid carts) should be used whenever feasible.
- Whenever possible, do not use passenger elevators when transporting chemicals, only freight elevators should be used. If it is necessary to use a passenger elevator, use should be restricted to low-use times such as early in the morning or late in the afternoon. If this is not possible, be sure to warn passengers, or prohibit passengers from riding with you.
- When transporting compressed gas cylinders, always use a proper gas cylinder hand truck with the cylinder strapped to the cart and keep the cap in place. **NEVER** roll or drag a compressed gas cylinder.
- Avoid riding in elevators with cryogenic liquids or compressed gas cylinders. If this is necessary, consider using a buddy system to have one person send

  the properly secured dewars or cylinders on the elevator, while the other person waits at the floor by the elevator doors where the dewars or cylinders will arrive.
- Do not transport chemicals in your personal vehicle.

Please note: If you plan on shipping any hazardous chemicals off the main campus, be aware there are specific procedures, training and other legal requirements that must be followed.

5.4 Housekeeping

Housekeeping refers to the general condition and appearance of a laboratory and includes:

- Keeping all areas of the lab free of clutter, trash, extraneous equipment, and unused chemical containers. Areas within the lab that should be addressed include benches, hoods, refrigerators, cabinets, chemical storage cabinets, sinks, trash cans, etc.
- Keep all containers of chemicals closed when not in use.
- Cleaning up all chemicals spills immediately, regardless if the chemical is hazardous or not. When cleaning up a chemical spill, look for any splashes that may have resulted on nearby equipment, cabinets, doors, and counter tops. For more information on cleaning up spills, see the Chemical Spill Procedures Section 12.8.
- Keeping areas around emergency equipment and devices clean and free of clutter. This includes items such as eyewash/emergency showers, electric power panels, fire extinguishers, and spill cleanup supplies.
- Keeping a minimum of three feet of clearance (as required by fire codes) between benches and equipment. Exits must be clear of obstacles and tripping hazards such as bottles, boxes, equipment, electric cords, etc. Combustible materials may not be stored in exits (including corridors and stairways), exit enclosures, boiler rooms, mechanical rooms, or electrical equipment rooms.
- When storing items overhead, keep heavier and bulkier items closer to the floor. New York State (NYS) Building Code prohibits the storage of combustible material (such as paper, boxes, plastics, etc.) within two feet of the ceiling in unsprinklered rooms. In sprinklered rooms, All storage, including both combustible and non-combustible materials, must be kept at least 18” below the level of the sprinkler head deflectors to ensure that fire sprinkler coverage is not impeded.
- Always use a stepladder when reaching for overhead items, do not stand on chairs or countertops. If you do not have a stepladder available, then contact your Lab Coordinator.

In summary, good housekeeping has obvious health and safety benefits and can have a positive mental effect on laboratory personnel who work in a clean environment, which can lead to increased productivity. Also keep in mind that during an inspection by a state or federal regulatory agency, the general condition of the laboratory observed in the first few minutes of the inspection (the housekeeping of the lab) can have a significant impact (positive or negative) on the rest of the inspection process.

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.

5.5 Personal Hygiene

Good chemical hygiene practices include the use of personal protective equipment (PPE) and good personal hygiene habits. Although PPE can offer a barrier of protection against chemicals and biological materials, good personal hygiene habits are essential to prevent chemical exposure, even when using PPE.

Some general guidelines that should always be followed include:

- Do not eat, drink, chew gum, or apply cosmetics in a lab or other area where chemicals are used.
- Do not store food or drink in refrigerators that are used to store chemicals.
- Do not ever try starting a siphon or pipette by mouth, doing so can result in ingestion of chemicals or inhalation of chemical vapors. Always use a pipette aid or suction bulb to start a siphon.
- Always confine long hair, loose clothing, and jewelry.
- Wear a lab coat when working with hazardous materials.
- Shorts and sandals should not be worn in a lab when anyone is using corrosives or other chemicals that present a skin contact hazard or where the potential for physical hazards such as dropping pieces of equipment or broken glass are present.
- Remove laboratory coats, gloves, and other PPE immediately when chemical contamination occurs. Failure to do so could result in chemical exposure.
- After removing contaminated PPE, be sure to wash any affected skin areas with soap and water for at least 15 minutes.
- Always remove lab coats, gloves, and other PPE before leaving the lab. Do not wear lab coats, or other PPE (especially gloves) in areas outside the lab, particularly not in areas where food and drink are served, or other public areas.
- Always wash hands with soap and water after removing gloves and before leaving the lab or using items such as the phone, turning doorknobs, or using an elevator.
- Always wash lab coats separately from personal clothing. Be sure to identify contaminated lab coats to commercial laundry facilities to help protect their workers by placing the contaminated lab coat in a separate plastic bag and clearly identifying the bag with a note or label indicating the lab coat is contaminated.
- **Smoking is prohibited** in all lab areas at Ithaca College.

5.6 Working Alone

Whenever possible, laboratory personnel should avoid working alone when conducting research, especially when experiments involve hazardous substances and procedures. Laboratories should establish specific guidelines and standard operating procedures specifying when working alone is not allowed and develop notification procedures when working alone occurs. All work to be performed by someone working alone, and the monitoring system that is established, must be approved in advance by the Principal Investigator or laboratory supervisor.

If a laboratory person determines it is necessary to work alone, consideration should be given to notifying someone else in the area – in an adjacent room, another lab on the same floor, or a lab on a different floor. It is recommended that a "buddy system" be established for regular, routine checks on personnel working alone, such as every 15 – 30 minutes, to ensure no accidents have occurred. This could be accomplished by physically walking to the room where the lab worker is or through the use of a phone. If the person working alone is doing highly hazardous work, then the person checking on the lab worker should not enter same room. A system of visual checks should be established to indicate there are no problems or to determine if help is needed.

In the event of an emergency that requires the buddy to leave prior to the completion of an experiment involving highly hazardous chemicals, the buddy should notify Ithaca College Police (ICPD) at 274-3333 of the name, location, and end time of the experiment involved. The buddy should also notify the person conducting the experiment. The person conducting the experiment should make an effort to complete the experiment in a safe manner and notify ICPD upon completion of the experiment. **Under no circumstances should the ICPD be used in place of a "lab buddy" as this will seriously undermine the safety of all involved.**

Please note: For rooms that are locked due to security needs, prior arrangements are required to allow the designated buddy access. Also understand that if the door to the lab does not have a window, or if the window is covered, then there is a chance that if something happened to a person working alone in a locked lab, then they may not be discovered until someone else from the lab goes into the room (which could be a day or more).

Examples of activities where working alone would be permissible include:

- Office work such as writing papers, calculations, computer work, and reading.
- Housekeeping activities such as general cleaning, reorganization of supplies or equipment, etc., as long as no moving of large quantities of chemicals is involved.
- Assembly or modification of laboratory apparatus when no chemical, electrical, or other physical hazards are present.
- Routine lab functions which are part of a standard operating procedure which has been demonstrated to be safe and does not involve hazardous materials.

Examples of activities where working using a "buddy system" should be considered include:

- Experiments involving toxic or otherwise hazardous chemicals especially poison inhalation hazards.
- Experiments involving high-pressure equipment.

- Experiments involving large quantities of cryogenic materials.
- Experiments involving work with unstable (explosives) materials.
- Experiments involving Class 3b or 4 Lasers.
- Transfer of large quantities of flammable materials, acids, bases, and other hazardous materials.
- Changing out compressed gas cylinders containing hazardous materials.

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.

5.7 Phones in Labs

All labs are strongly recommended to have a means of communication in the event of an emergency. This can include a phone or cell phone (if service is available) or two-way radio within the lab or access to a central phone located in the hallway. If a phone is not available within the lab, it is advisable to post a sign and/or map indicating where the nearest phone is located.

5.8 Unattended Operations

Whenever it is necessary to have unattended operations occurring in a lab, it is important to ensure safeguards are put into place in the event of an emergency. Laboratory personnel are strongly encouraged to adhere to the following guidelines when it is necessary to carry out unattended operations.

For unattended operations involving highly hazardous materials, a light should be left on and an appropriate warning/explanation sign should be placed on the laboratory door, or in a conspicuous place that could be easily seen without putting someone else in danger in the event of an emergency. The warning sign should list the following information:

- The nature of the experiment in progress.
- The chemicals in use.
- Hazards present (electrical, heat, etc.)
- The name of the person conducting the experiment and a contact number. (A secondary name and contact number is also recommended.)

When setting up an experiment that will be left unattended, try to take into account potential incidents that could occur if something went wrong. For example:

- Use secondary containment such as trays to contain any spills that may occur.
- Use safety shields and keep the hood sash down low to contain chemicals and glass in case an explosion occurs.
- Remove any chemicals or equipment that are not necessary for the experiment or items that could potentially react with the chemicals or other materials being used in the experiment.

- Whenever possible, use automatic shutoff devices to prevent accidents such as loss of cooling water shutoff, over-temperature shut off, etc.

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.

5.9 Access to Laboratories

Access to Ithaca College laboratories, workshops and other work areas housing hazardous materials or machinery is restricted to Ithaca College faculty, staff, students, or other persons on official business.

5.10 Chemical Purchasing

Before ordering new chemicals, search your existing inventories and use those chemicals currently in stock. An accurate and up-to-date chemical inventory can help to minimize purchase of chemicals already on hand. Ithaca College has an institutional subscription to the Chemtracker chemical inventory system that can help facilitate maintaining a chemical inventory. If you are interested in learning more about the Chemtracker system, then contact the EH&S Department or call EH&S at 274-3353.

If it is necessary to purchase new chemicals, laboratory personnel should order the smallest size necessary to carry out the experiment. Avoid ordering extra quantities because the chemical “might be needed in the future”. Try to take advantage of chemical vendors “Just-In-Time” delivery rather than stockpiling chemicals in your lab.

Some chemical purchases may require special approval or permits, such as those chemicals that are Drug Enforcement Agency (DEA) or Alcohol, Tobacco, and Firearms (ATF) listed substances, select agents or particularly hazardous substances. There are also building and fire codes that restrict the amount of flammable materials that can be stored in any one room, floors, and buildings at a time. For more information, contact EH&S at 274-3353.

5.11 Ordering New Equipment

Whenever large pieces of equipment are planned to be purchased and installed in laboratories, especially equipment that is required to be hooked up to building utility services such as electric, water, or gas, laboratory personnel must first consult with Facilities Engineering, EH&S, and the appropriate Facilities shops to ensure the building has the necessary resources to support the new piece of equipment. Labratory personnel **should not** assume they can purchase equipment first and then expect the building to be able to handle the service requirements later. By preplanning and communicating well in advance with appropriate campus groups (such as Facilities Engineering and EH&S), any potential issues can be identified ahead of time, which in turn will help make the transition to getting new pieces of equipment up and running quickly after the purchase is made.

Additionally, as with installation of fume hoods, certain pieces of equipment require special installation due to their potential impact on the rest of the building ventilation system and utilities, and cannot be hooked up by laboratory personnel, or private contractors without first consulting with Facilities and EH&S. Laboratory personnel are strongly encouraged to be proactive and to consult with the appropriate departments ahead of time, before purchasing new pieces of large equipment.

5.12 Work Orders

In the event of a maintenance issue or if repairs are needed to equipment, laboratory personnel should submit a work order on the facilities web site to have repairs initiated. Please note that due to NYS building codes and liability issues, laboratory personnel must not try to repair utility services (such as electrical, plumbing, or gas issues) by themselves. These repairs must be handled by qualified personnel only.

Whenever maintenance workers will be working on your hood system or in your laboratory, please remove all chemicals, laboratory apparatus, and equipment from the area requiring maintenance work. Ensure the work area is clean and inform the maintenance workers of any potential hazards present in the near vicinity either verbally or by leaving a sign with the appropriate information.

5.13 Changes in Lab Occupancy

Changes in laboratory occupancies can occur when faculty retire, new faculty come to campus, new lab staff are hired, students graduate or leave for another university, or when facility renovations take place. When changes in lab occupancy occur, it is important to address any potential issues **before** the occupants leave.
Failure to address the change in occupancy can result in:

- Old, unlabeled chemicals, samples, or hazardous waste being left behind in refrigerators, freezers, and cabinets.
- Valuable furniture or equipment being moved or thrown away.
- Unknown chemical spills or contamination being present.

These issues can result in costly remediation efforts and wasted resources for both the department and the College.

If you are planning to leave your laboratory or if you know of a research group or students that are planning to leave, there are a few simple steps that can be followed to ensure a smooth transition:

- Notify your department chairperson, lab supervisor, and Lab coordinator well in advance of the planned move.

- Ensure all chemical containers are properly labeled.
- Properly dispose of any hazardous and chemical waste left in the laboratory.
- Ensure all chemical spills and contamination has been cleaned up.
- Review the Lab Move Guide in Appendix L

5.14 Laboratory Design and Construction

To provide the best service during the construction/renovation process for laboratories, it is important to take health and safety considerations into account up front during the design process…well BEFORE construction begins. A Pre-Operational Safety, Health & Environmental Review (POSHER) Form is avialble in Appendix N

If you are planning a new lab construction or renovation, please contact the EH&S with the following information:

- Contact name, phone number, email
- Department, building and room(s) where the project will occur.
- Expected start date for project.
- Equipment planning to be installed – (fume hoods, biosafety cabinet, other capture devices, eyewash and emergency shower, toxic gas cabinet and monitoring devices, etc.).
- NOTE: A list of chemicals, including approximate usage (weekly/monthly) and storage quantities will be needed during the process to ensure proper ventilation rates and engineering controls.

5.15 Inspections

Laboratories and other research areas are regulated by OSHA laboratory safety standards and general industry regulations, EPA and DEC hazardous waste regulations, DOH regulations, NFPA life and fire safety standards, and building codes. Additionally, accreditation and granting agencies such as CDC, NIH, and USDA are increasing scrutiny over researchers and their compliance with state and federal laws. To assist researchers to be in compliance with these regulations and standards, Environmental Health & Safety (EH&S) will conduct required inspections of all campus research areas on a biannual basis.

The purpose of the inspections is to assist responsible faculty and staff members in identifying and correcting potential regulatory compliance issues or other issues that could affect granting activities, and identify potential health and safety hazards that could pose an unreasonable risk to laboratory personnel, students, and the campus community. To facilitate the correction of deficient items, a corrective action process has been implemented and will be tracked.

Research areas are strongly encouraged to conduct their own self inspections prior to EH&S conducting an inspection of their research area to address any potential issues before the EH&S inspection and to provide a training opportunity for research staff. To facilitate the self inspection process, EH&S is providing research areas with acopy of the inspection checklist they use for inspections. The copy is available in **Appendix M**.

5.16 Self Inspections

An important part of any research safety program is implementation of self inspections. Self inspections provide a number of useful benefits and further help to create a culture of safety within the lab. Benefits of self inspections include:

- Raising the level of awareness of laboratory personnel and determining the level of compliance with state and federal regulations.
- Identifying and addressing any potential issues before an inspection by a state or federal regulatory agency.
- Providing an opportunity for lab specific training by identifying potential issues within the lab and then training labratory personnel to look for these issues.
- Serving as a regular health and safety check of laboratory facilities.
- Serving as an outlet for faculty, staff, and student concerns.

EH&S recommends the following frequency for self inspections:

- On a daily basis lab personnel should maintain good housekeeping within their lab.
- Informal weekly lab walkthroughs or “Friday afternoon cleanups”.
- Ideally, self inspections should occur once per month. These could include participation of research staff, and/or safety committee members, and use of an inspection checklist.

The benefits of conducting inspections of laboratories on a regular basis cannot be overstated. In addition to providing for a healthier and safer work environment, lab inspections can reduce legal liability by identifying potential issues, and training lab personnel to look for and correct potential issues.

5.17 Inspections by Regulatory Agencies

Inspections by state and federal regulatory agencies can occur at any time and can result in citations and significant fines for the college. The best way to be prepared for these inspections is to understand what regulations apply to your area and what you need to do to comply with those regulations. You can obtain this information from resources such as this Chemical Hygiene Plan, by conducting your own self inspections, and by calling EH&S at 714-3353.

If a state or federal inspector shows up in your work area unescorted, ask them to please wait and contact EH&S immediately at 724-3333.

5.18 Laboratory Security

Laboratories need to take specific actions in order to provide security against theft of highly hazardous materials, valuable equipment, and to ensure compliance with state and federal regulations. EH&S encourages each unit (department, and research group) to review and develop procedures to ensure the security of all hazardous materials in their area of responsibility.

Many laboratories already implement various means of security, including requirements to lock up controlled substances, syringes and needles, and radioactive materials. EH&S recommends you review and assess the hazardous materials in your laboratory and consider security issues in protecting those materials. The intent is to minimize the risk of theft, especially targeting the very brief time periods in which the lab is left unattended.

***One easy way to increase security is to make sure your laboratory door is locked whenever the lab is left unattended, even for a few minutes.

5.18.1 Security Guidelines

The following are guidelines designed to minimize opportunities for intentional removal of any hazardous materials from your laboratory:

- Recognize that laboratory security is related to, but different from laboratory safety. Security is preventing intrusion into the laboratory and the theft of equipment or materials from the lab.
- Develop a site-specific security policy. Make an assessment of your laboratory area for hazardous materials and particular security issues. Then develop and implement lab security procedures for your lab group and train lab group members on security procedures and assign responsibilities.
- Control access to areas where hazardous chemicals are used and stored. Limit laboratory access to only those individuals who need to be in the lab and restrict off-hours access only to individuals authorized by the Principal Investigator.

    - Be sure to lock freezers, refrigerators, storage cabinets, and other containers where stocks of biological agents, hazardous chemicals, or radioactive materials are stored when they are not in direct view of workers (for example, when located in unattended storage areas).
    - Do not leave hazardous materials unattended or unsecured at any time. Most importantly, close and lock laboratory doors when no one is present. Note: If staff work alone and use the buddy system with someone outside of the research group, allowing access for that individual will need to be addressed prior to the initiation of working alone.
    - Know who is in the laboratory area at any given time. Consider using a logbook for staff to sign in and out each day or use carded access devices. Also give consideration to having all lab staff wear identification tags. Approach anyone who you don’t recognize and

    appears to be wandering in laboratory areas and hallways and ask if you can help direct them.

- Secure your highly hazardous materials. Consider using a log to sign hazardous materials in and out of secure storage and be sure to take a periodic inventory of all highly hazardous chemicals, biological agents/toxins, and controlled substances (this is required for use of radioactive materials). This could be as simple as frequently looking at your chemical containers to be sure that none are missing. Laboratories are strongly encouraged to maintain a chemical inventory. Report any missing inventory to Ithaca College Police immediatelyat 274-3333.
- Know what materials are being ordered and brought into the laboratory area. Visually screen packages before bringing them into your lab. Packages containing potentially infectious materials should be opened in a biological safety cabinet or other appropriate containment device. Know what materials are being removed from the laboratory area and consider tracking the use and disposal of hazardous materials.
- Develop an emergency plan and protocols for reporting incidents. Control of access to laboratory areas can make an emergency response more challenging. This must be considered when emergency plans are developed. Laboratory directors, in cooperation with facility safety and security officials, should have policies and procedures in place for the reporting and investigation of incidents or possible incidents, such as undocumented visitors, missing chemicals, or unusual or threatening phone calls. Review your protocols and emergency plans and update as necessary.
- Be aware of the classes of security risk for hazardous chemicals. Laboratory researchers should be aware of the highly hazardous materials or other special materials of concern. The Centers for Disease Control and Prevention maintains lists of biological diseases and chemical agents.
- Pay special attention to the following:
    - Open labs.
    - Unrestricted access to toxic chemicals.
    - Unlocked support rooms.
    - Toxic gas security.
    - Unsecured biological materials and waste.
    - Access to controlled substances.
    - Changes in chemical inventory.
    - Storeroom security.
    - Chemical waste collection areas.
    - Unusual activities.

Many of the laboratory supply catalogs carry information and products such as various locks, lock boxes, and other security devices for chemical storage in laboratories. For more information, you can contact EH&S and/or consult with the Ithaca College Lock Shop about security devices.

5.19 Children in Labs

Children are not permitted in Ithaca College laboratories and other areas where hazardous chemicals and equipment are used. Access to these areas is restricted to authorized faculty, staff, students and other permitted individuals conducting business on campus.

Supervisors of laboratories and areas where hazardous materials and equipment are used or stored are responsible for ensuring that children are not allowed in these areas.

6.0 Specific Laboratory Practices

6.1 Administrative Controls

Administrative controls include policies and procedures that result in providing proper guidance for safe laboratory work practices and set the standard for behavior within the laboratory. Once developed, administrative controls must be implemented and adhered to by all personnel working in the laboratory.

Labs are responsible for developing policies and written guidelines to ensure laboratory workers are protected against exposure to hazardous chemicals as outlined in the OSHA Laboratory Standard and physical hazards that may be present, including the development of written Standard Operating Procedures

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 Chemical Hygiene Plan

6.2 Standard Operating Procedures

There are approximately 75 laboratories at Ithaca College and most of these involve the use of hazardous chemicals. EH&S will assist laboratories in developing general and specific standard operating procedures (SOPs) for chemical use in laboratories. (Refer to SOP form in **Appendix C**.) Due to the variety of research and the number of laboratories involved, it is the responsibility of each professor or department to ensure that their practices and procedures are adequate to protect those who use hazardous chemicals. It is the responsibility of the professor or department head to ensure that written safety procedures are developed for work in their labs and that controls and protective equipment are adequate to prevent overexposure. Most laboratories can refer to the generally accepted laboratory safety practices referenced in *Prudent Practices in the Laboratory*, published by the National Research Council, or *Safety in Academic Chemical Laboratories*, published by the American Chemical Society. A copy of Prudent Practices in the Laboratory is available from EH&S.

SOPs can be stand-alone documents or supplemental information included as part of research notebooks, experiment documentation, or research proposals. The requirement for SOPs is to ensure a process is in place to document and addresses relevant health and safety issues as part of every experiment. At a minimum, SOPs should include details such as:

- The chemicals involved and their hazards.
- Special hazards and circumstances.
- Use of engineering controls (such as fume hoods).
- Required PPE.

- Spill response measures.
- Waste disposal procedures.
- Decontamination procedures.
- Description of how to perform the experiment or operation.

While the OSHA Laboratory Standard specifies the requirement for SOPs for work involving hazardous chemicals, laboratories should also develop SOPs for use with any piece of equipment or operation that may pose any physical hazards. Examples include:

- Safe use and considerations of LASERs.
- Use of cryogenic liquids and fill procedures.
- Connecting regulators to gas cylinders and cylinder change outs.
- Use of equipment with high voltage.
- Etc…

SOPs do not need to be lengthy dissertations and it is perfectly acceptable to point laboratory personnel to other sources of information. Some examples of what to include as part of SOPs are:

"To use this piece of equipment, see page 4 in the operator's manual (located in file cabinet #4)." "The chemical and physical hazards of this chemical can be found in the MSDS – attached to this document. Read the MSDS before using this chemical." "When using chemical X, wear safety goggles, nitrile gloves, and a lab coat."

EH&S can assist laboratories with developing general and specific SOPs. Due to the variety of research and the large number of laboratories at Ithaca College, it is the responsibility of each laboratory, and department to ensure that SOPs are developed and the practices and procedures are adequate to protect lab workers who use hazardous chemicals.

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.

7.0 Safe Chemical Use

Safe chemical use includes minimizing exposure to chemicals, proper training, understanding chemical hazards, proper labeling, proper storage and segregation, and proper transport.

7.1 Minimize Exposure to Chemicals

The best way laboratory personnel can protect themselves from chemical hazards is to minimize their exposure to them. In order to minimize chemical exposure:

- Substitute less hazardous chemicals in your experiments whenever possible.
- Always use the smallest possible quantity of chemical for all experiments. Consider micro scale experiments and activities.
- Minimize chemical exposures to all potential routes of entry - inhalation, ingestion, skin and eye absorption, and injection through proper use of engineering controls and personal protective equipment.
- Be sure to select the proper PPE and regularly inspect it for contamination, leaks, cracks, and holes. Pay particular attention to gloves.
- Do not pipette or apply suction by mouth.
- Do not smell or taste chemicals. When it is necessary to identify a chemical’s odor, lab personnel should hold the chemical container away from their face and gently waft their hand over the container without inhaling large quantities of chemical vapor.
- Do not underestimate the risk of exposure to chemicals - even for substances of no known significant hazard.
- In order to identify potential hazards, laboratory personnel should plan out their experiments in advance. These plans should include the specific measures that will be taken to minimize exposure to all chemicals to be used, the proper positioning of equipment, and the organization of dry runs.
- Chemicals that are particularly hazardous substances require prior approval from your supervisor and special precautions to be taken.
- When working with mixtures of chemicals, laboratory personnel should assume the mixture to be more toxic than the most toxic component in the mixture.
- Consider all substances of unknown toxicity to be toxic until proven otherwise.
- Request exposure monitoring to ensure the Permissible Exposure Limits (PELs) of OSHA and the current Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists are not exceeded.
- Promptly clean up all chemicals spills regardless whether the chemical is considered hazardous or nonhazardous. When cleaning up spills, remember to clean up any splashes that may have occurred on the sides of cabinets and doors in the immediate area.
- Be aware of the potential asphyxiation hazard when using cryogenic materials and compressed gases in confined areas. If necessary, install an oxygen monitor/oxygen deficiency alarm and/or toxic gas monitor before working with these materials in confined areas. Contact EH&S for more assistance.

- Do not eat, drink, chew gum, or apply cosmetics in areas where hazardous chemicals are being used.
- Keep all food and drink out of refrigerators and freezers used to store chemicals. Refrigerators used to store chemicals should be labeled as “Chemicals Only – No Food”. Refrigerators used to store food should be labeled as “Food Only – No Chemicals”.
- Always wash hands with soap and water after handling chemicals and especially before leaving the lab and eating – even if gloves were worn during chemical handling.
- Always remove personal protective equipment, such as gloves and lab coats, before leaving the lab.
- Do not attempt to scale up experiments until after you have run the experiment according to published protocols and you are thoroughly familiar with the potential hazards. When scaling up an experiment – change only one variable at a time, i.e. don’t change the heat source, the volumes, and the glassware all at once. It is also advisable to let one of your other lab group members to check your setup prior to each run.

7.2 Understanding Chemical Hazards

Chemicals pose both health and physical hazards. For the purposes of this document, health hazard will be used interchangeably with chemical hazard and health effects on the body will be used interchangeably with chemical effects on the body.

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

According to OSHA, physical hazard means “a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.” Physical hazards are covered in other sections within this manual.

7.3 Hazardous Communication System (HCS) and Globally Harmonized System (GHS)

As part of the 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.”

The Globally Harmonized System (GHS) is a world-wide system adopted by OSHA for standardizing and harmonizing the classification and labeling of chemicals. The objectives of the GHS are to:

- Define health, physical, and environmental hazards of chemicals;
- Create classification processes that use available data on chemicals for comparison with the defined hazard criteria and
- Communicate hazard information, as well as protective measures, on labels and Safety Data Sheet (SDS), formerly known as Material Safety Data Sheets (MSDS).

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.

7.4 Chemical Labeling

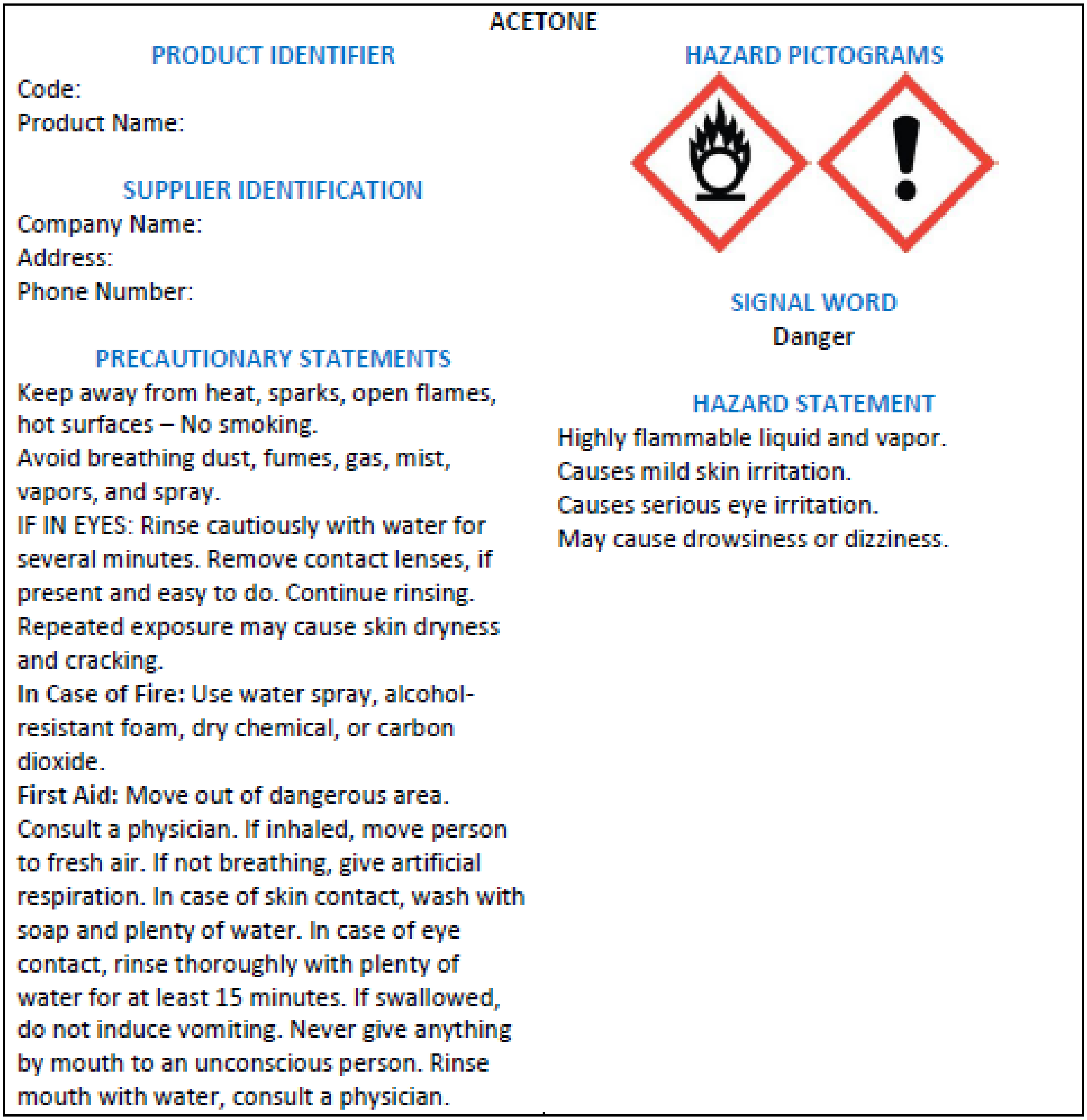
The GHS standardized label elements, which are not subject to variation and must appear on the chemical label, contain the following elements:

- Symbols (hazard pictograms) are used to convey health, physical and environmental hazard information, assigned to a GHS hazard class and category;
- Signal Words such as “Danger" (for more severe hazards) or "Warning" (for less severe hazards), are used to emphasize hazards and indicate the relative level of severity of the hazard assigned to a GHS hazard class and category;
- Hazard statements (e.g., “Danger! Extremely Flammable Liquid and Vapor”) are standard phrases assigned to a hazard class and category that describe the nature of the hazard; and
- Precautionary statements are recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to the hazardous chemical.

The GHS also standardizes the hazard pictograms that are to be used on all hazard labels and SDSs. There are 9 pictograms that represent several defined hazards, and include the harmonized hazard symbols which are intended to convey specific information about each hazard. These GHS hazard pictograms.

		
Carcinogen, Respiratory Sensitizer, Reproductive Toxicity, Target Organ Toxicity, Mutagenicity	Flammable, Pyrophoric, Self-Heating, Emits Flammable Gas, Organic Peroxide	Irritant, Dermal Sensitizer, Acute Toxicity (harmful), Narcotic Effects
		
Gas Under Pressure	Corrosive	Explosive, Organic Peroxide, Self-Reactive
		
Oxidizer	Environmental Toxicity	Acute Toxicity (Severe)

GHS labeling requirements are only applicable to chemical manufacturers, distributors, and shippers of chemicals. GHS labeling requirements are not required for chemicals being stored in a laboratory. However, since most chemicals stored in the laboratory have been purchased from a chemical manufacturer, the GHS labeling and pictogram requirements are very relevant and must be understood by laboratory employees. The GHS label format showing the required elements.



ACETONE

PRODUCT IDENTIFIER

Code:
Product Name:

SUPPLIER IDENTIFICATION

Company Name:
Address:
Phone Number:

PRECAUTIONARY STATEMENTS

Keep away from heat, sparks, open flames, hot surfaces – No smoking.
Avoid breathing dust, fumes, gas, mist, vapors, and spray.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Repeated exposure may cause skin dryness and cracking.
In Case of Fire: Use water spray, alcohol-resistant foam, dry chemical, or carbon dioxide.
First Aid: Move out of dangerous area. Consult a physician. If inhaled, move person to fresh air. If not breathing, give artificial respiration. In case of skin contact, wash with soap and plenty of water. In case of eye contact, rinse thoroughly with plenty of water for at least 15 minutes. If swallowed, do not induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water, consult a physician.

HAZARD PICTOGRAMS

SIGNAL WORD

Danger

HAZARD STATEMENT

Highly flammable liquid and vapor.
Causes mild skin irritation.
Causes serious eye irritation.
May cause drowsiness or dizziness.

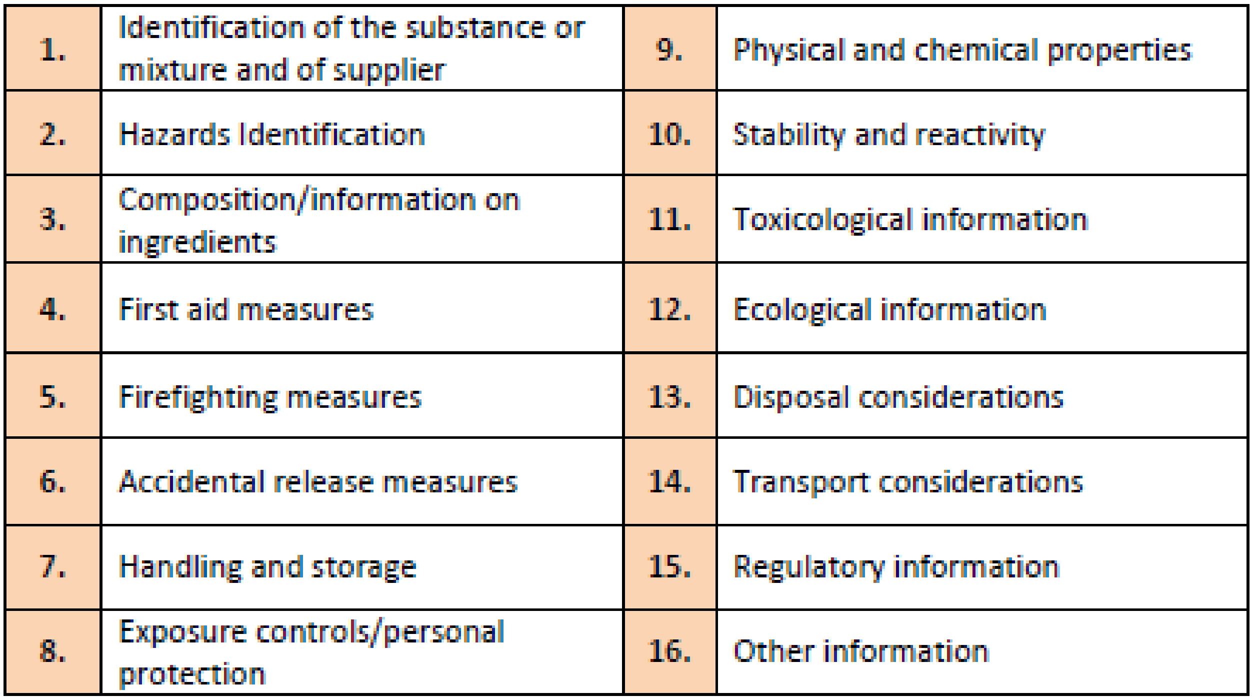
7.5 Safety Data Sheets

Safety Data Sheets (SDS) provide specific health and safety information, chemical data, physical properties, personal protection measures, handling precautions, etc., on hazardous chemicals used in the work place. As required by OSHA regulations, all employees must have unobstructed access to an SDS for each chemical product they may use or potentially be exposed to during their work, Ithaca College Velocity EHS MSDS online service to get SDS's. Each lab has a poster with a QR code that allow user access to the service with electronic devices. The system is also available from The EHS webite.

A direct link is available at https://myapps.microsoft.com/signin/f092f139-dc86-487b-b074-84110f32c02a?tenantId=fa1ac8f6-5e54-4857-9f0b-4aa422c09689

For security reason all staff, faculty and Student must login to the system using your IC username and password.

The SDS provides comprehensive information that is imperative for the safe handling of hazardous chemicals. Laboratory personnel should use the SDS as a resource to obtain information about hazards and safety precautions. Chemical manufacturers are required to use a standard format when developing SDSs. The SDS will contain 16 headings which are illustrated below



1.	Identification of the substance or mixture and of supplier	9.	Physical and chemical properties
2.	Hazards Identification	10.	Stability and reactivity
3.	Composition/information on ingredients	11.	Toxicological information
4.	First aid measures	12.	Ecological information
5.	Firefighting measures	13.	Disposal considerations
6.	Accidental release measures	14.	Transport considerations
7.	Handling and storage	15.	Regulatory information
8.	Exposure controls/personal protection	16.	Other information

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 manufacturer’s website first (or call the manufacturer directly).

If you have questions on how to read SDSs, or questions about the terminology or data used in SDSs, you can contact EH&S for more information.

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 hazards

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.

7.6 Routes of Chemical Entry

The potential health effect that may result from exposure to chemicals depends on a number of factors. These factors include the properties of the specific chemical including toxicity), the dose and concentration of the chemical, the route of exposure, duration of exposure, individual susceptibility, and any other effects resulting from mixtures with other chemicals. In order to understand how chemical hazards can affect you, it is important to first understand how chemicals can get into your body and cause damage. The four main routes of entry are inhalation, ingestion, injection, and absorption through the skin and eyes.

7.7 Inhalation

Inhalation of chemicals occurs by absorption via the respiratory system which includes the lungs. Once chemicals have entered into the respiratory system, 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 collapsation. 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, and avoiding bench top use of hazardous chemicals, ensuring chemical containers are kept tightly capped, and ensuring all chemical spills are promptly cleaned up.

7.8 Ingestion

Chemical exposure through ingestion is caused by absorption of chemicals through the digestive system. 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 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, chemical exposure can ocur, 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 Ithaca College Police at 911 from a campus phone or 274-3333 from a cell phone or off campus phone.** After seeking medical attention, complete an Injury/Illness Report.

The best protections against ingestion of chemicals is to properly label all chemical containers, never consume food or drink or chew gum in laboratories, and always wear PPE

7.9 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 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. Should other items that can cause cuts or puncture wounds, such as needles and razor blades, never be left 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 to remove any chemical contamination. Administer first aid and seek medical attention if necessary, and then complete an Injury/Illness Report.

7.10 Eye and Skin 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 yourself 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. This is important 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.

7.11 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 MSDSs. 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 Chemical Hygiene Plan – 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.

7.12 Chemical Exposure Monitoring

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 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 and they 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

8.0 Chemical Hazards

Chemicals can be broken down into hazard classes and exhibit both physical and health hazards. It is important to keep in mind, that chemicals can exhibit more than one hazard or combinations of several hazards. Several factors factors can influence how a chemical will behave and the hazards the chemical presents, including the severity of the response:

- Concentration of the chemical.
- Physical state of the chemical (solid, liquid, gas).
- Physical processes involved in using the chemical (cutting, grinding, heating, cooling, etc.).
- Chemical processes involved in using the chemical (mixing with other chemicals, purification, distillation, etc.).
- Other processes (improper storage, addition of moisture, storage in sunlight, refrigeration, etc.).

The following sections describe general information and safety precautions about specific hazard classes. The chemical hazards listed are based on the Department of Transportation (DOT) hazard class system

It is important to note that the following sections are general guidelines. Laboratory personnel should always review MSDSs and other resources FIRST, before working with any chemical.

8.1 Explosives

The OSHA Laboratory Standard defines an explosive as a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. Under the Department of Transportation (DOT) hazard class system, explosives are listed as hazard class 1.

Fortunately, most laboratories do not use many explosives; however, there are a number of chemicals that can become unstable and/or potentially explosive over time due to contamination with air, water, other materials such as metals, or when the chemical dries out.

If you ever come across any chemical that you suspect could be potentially shock sensitive and/or explosive, do not attempt to move the container as some of these compounds are shock, heat, and friction sensitive. In these instances, you should contact EH&S at 274-3333 immediately.

Explosives can result in damage to surrounding materials (hoods, glassware, windows, people, etc.), generation of toxic gases, and fires. If you plan to conduct an experiment where the potential for an explosion exists, first ask yourself the question; “Is there another chemical that could be substituted in the experiment that does not have an explosion potential?” If you must use a chemical that is potentially explosive, or for those compounds that you know are explosive, (even low powered explosives) you must first obtain prior approval from the Principal Investigator to use such chemicals. After obtaining prior approval from your Principal Investigator, thoroughly read the MSDSs and any other chemical resources related to the potentially explosive compound(s) to ensure potential incidents are minimized.

Whenever setting up experiments using potentially explosive compounds:

- Always use the smallest quantity of the chemical possible.
- Always conduct the experiment within a fume hood and use in conjunction with a properly rated safety shield.
- Be sure to remove any unnecessary equipment and other chemicals (particularly highly toxic and flammables) away from the immediate work area.
- Be sure to notify other people in the laboratory what experiment is being conducted, what the potential hazards are, and when the experiment will be run.
- Do not use metal or wooden devices when stirring, cutting, scraping, etc. with potentially explosive compounds. Non-sparking plastic devices should be used instead.
- Ensure other safety devices such as high temperature controls, water overflow devices, etc., are used in combination to help minimize any potential incidents.
- Properly dispose of any hazardous waste and note on the hazardous waste tag any special precautions that may need to be taken if the chemical is potentially explosive.
- Always wear appropriate PPE, including the correct gloves, lab coat or apron, safety goggles used in conjunction with a face shield, and explosion-proof shields when working with potentially explosive chemicals.
- For storage purposes, always date chemical containers when received and opened. Pay particular attention to those compounds that must remain moist or wet so they do not become explosive (ex. Picric acid, 2,4Dinitrophenyl hydrazine, etc.). Pay particular attention to any potentially explosive compounds that appear to exhibit the following signs of contamination:

    - Deterioration of the outside of the container.
    - Crystalline growth in or outside the container.
    - Discoloration of the chemical.

If you discover a potentially explosive compound that exhibits any of these signs of contamination, contact EH&S at 274-3333 for more assistance.

Examples of explosive and potentially explosive chemicals include:

- Compounds containing the functional groups azide, acetylide, diazo, nitroso, haloamine, peroxide, and ozonide .

- Nitrocellulose.
- Di- and Tri-nitro compounds.
- Peroxide forming compounds.
- Picric acid (dry).
- 2,4-Dinitrophenylhydrazine (dry).
- Benzoyl peroxide (dry).

8.2 Flammable and Combustible Liquids

The OSHA Laboratory Standard defines a **flammable liquid** as any liquid having a flashpoint below 100 degrees F (37.8 degrees C), except any mixture having components with flashpoints of 100 degrees F (37.8 degrees C) or higher, the total of which make up 99% or more of the total volume of the mixture.

Flashpoint is defined as the minimum temperature at which a liquid gives off enough vapor to ignite in the presence of an ignition source. The risk of a fire requires that the temperature be above the flashpoint and the airborne concentration be in the flammable range above the Lower Explosive Limit (LEL) and below the Upper Explosive Limit (UEL).

The OSHA Laboratory Standard defines a **combustible liquid** as any liquid having a flashpoint at or above 100 degrees F (37.8 degrees C), but below 200 degrees F (93.3 degrees C), except any mixture having components with flashpoints of 200 degrees F (93.3 degrees C), or higher, the total volume of which make up 99% or more of the total volume of the mixture. OSHA further breaks down flammables into Class I liquids, and combustibles into Class II and Class III liquids. Please note this classification is different than the criteria used for DOT classification. This distinction is important because allowable container sizes and storage amounts are based on the particular OSHA Class of the flammable liquid.

Classification	Flash Point	Boiling Point
Flammable Liquids		
Class IA	<73 degrees F	<100 degrees F
Class IB	<73 degrees F	>=100 degrees F
Class IC	>=73 degrees F, <100 degrees F	>100 degrees F
Combustible Liquids		
Class II	>=100 degrees F, <140 degrees F	----
-- Class IIIA	>=140 degrees F, < 200 degrees F	----
-- Class IIIB	>=200 degrees F	

Under the Department of Transportation (DOT) hazard class system, flammable liquids are listed as hazard class 3.

Flammable and combustible liquids are one of the most common types of chemicals used at Ithaca College and are an important component in a number of laboratory processes. However, in addition to the flammable hazard, some flammable liquids also may possess other hazards such as being toxic and/or corrosive.

When using flammable liquids, keep containers away from open flames; it is best to use heating sources such as steam baths, water baths, oil baths, and heating mantels. Never use a heat gun to heat a flammable liquid. Any areas using flammables should have a fire extinguisher present. If a fire extinguisher is not present, then contact EH&S for more assistance.

Always keep flammable liquids stored away from oxidizers and away from heat or ignition sources such as radiators, electric power panels, etc..

When pouring flammable liquids, it is possible to generate enough static electricity to cause the flammable liquid to ignite. If possible, make sure both containers are electrically interconnected to each other by bonding the containers, and connecting to a ground.

Always clean up any spills of flammable liquids promptly. Be aware that flammable vapors are usually heavier than air (vapor density > 1). For those chemicals with vapor densities heavier than air (applies to most chemicals), it is possible for the vapors to travel along floors and, if an ignition source is present, result in a flashback fire.

8.3 Flammable Storage in Refrigerators/Freezers

It is important to store flammable liquids only in specially designed flammable storage refrigerators/freezers or explosion-proof refrigerators/freezers. Do not store flammable liquids in standard (non-flammable rated) refrigerators/freezers. Standard refrigerators are not electrically designed to store flammable liquids. If flammable liquids are stored in a standard refrigerator, the build up of flammable vapors can be in sufficient quantities to ignite when the refrigerator’s compressor or light turns on, resulting in a fire or an explosion.

Properly rated flammable liquid storage refrigerators/freezers have protected internal electrical components and are designed for the storage of flammable liquids. Explosion-proof refrigerators/freezers have both the internal and external electrical components properly protected and are designed for the storage of flammable liquids. Refrigerators and freezers rated for the storage of flammable materials will be clearly identified as such by the manufacturer.

For most laboratory applications, a flammable storage refrigerator/freezer is acceptable. However, some operations may require an explosion-proof refrigerator/freezer. Flammable storage refrigerators currently cost approximately $1500 - $3000 each. In the case of limited funding where a laboratory cannot purchase a flammable storage refrigerator for the laboratory’s own use, EH&S requires departments and laboratory groups on each floor to consider purchasing a communal flammable storage refrigerator for the proper and safe storage of flammable liquids.

8.4 Flammable Storage Cabinets

The requirements for use of flammable storage cabinets are determined by the classification of the flammable liquids, the quantities kept on hand, the building construction (fire wall ratings), and the floor of the building the flammables are being stored on. As a general rule of thumb, if you have more than 10 gallons of flammable liquids, including materials in use, then you should store the flammable liquids in a properly rated flammable liquid storage cabinet.

All flammable liquids not in use should be kept in the flammable liquid storage cabinet. For stand-alone flammable cabinets (as opposed to cabinets underneath fume hoods), there are vent holes on each side of the cabinet (called bung holes) that must have the metal bungs screwed into place for the cabinet to maintain its fire rating. Venting of flammable cabinets is NOT required, however, if a flammable cabinet is vented, it must be vented properly according to the manufacturer's specifications and NFPA 30. Typically, proper flammable cabinet ventilation requires that air be supplied to the cabinet and the air be taken away via non-combustible pipes. If you are planning on venting your flammable storage cabinet, please contact EH&S for more information.

8.5 Flammable Solids

The OSHA Laboratory Standard defines a flammable solid as a "solid, other than a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited, burn so vigorously and persistently to create a serious hazard." An example of a flammable solid is gun powder.

Under the DOT hazard class system, flammable solids are listed as hazard class 4. Flammable solids are further broken down into three subcategories:

- Flammable Solids – Class 4.1
- Spontaneously Combustible – Class 4.2
- Dangerous When Wet – Class 4.3

Many of the same principles for handling and storage of flammable liquids apply to flammable solids. Always keep flammable solids stored away from oxidizers, and away from heat or ignition sources such as radiators, electric power panels, etc.

8.6 Spontaneously Combustible

Spontaneously combustible materials are also known as pyrophorics; these chemicals can spontaneously ignite in the presence of air, some are reactive with water vapor, and most are reactive with oxygen. Two common examples are tert-Butyllithium under Hexanes and White Phosphorus. In addition to the hazard of the spontaneously combustible chemical itself, many of these chemicals are also stored under flammable liquids. In the event of an accident, such as a bottle being knocked off a shelf, the chemical can spontaneously ignite and a fire can occur. Extra care must be taken when handling spontaneously combustible chemicals. When transporting these chemicals, it is best to use a bottle carrier and carts.

8.7 Dangerous When Wet

Dangerous when wet compounds react violently with water to form toxic vapors and/or flammable gases that can ignite and cause a fire. Please note, attempting to put out a fire involving dangerous when wet materials with water will only make the situation worse. Special “Class D” fire extinguishers are required for use with dangerous when wet compounds. Common examples include sodium metal and potassium metal.

It is important to note that any paper toweling, gloves, etc., that have come into contact with these materials need to be quenched with water before disposing of in metal trash cans in order to prevent potential fires.

If you are using dangerous when wet compounds and do not have a Class D fire extinguisher present, then please contact EH&S for more assistance.

8.8 Oxidizers and Organic Peroxides

The OSHA Laboratory Standard defines an oxidizer as “a chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.” Under the DOT hazard class system, oxidizers are listed as hazard class 5.1 and organic peroxides are listed as hazard class 5.2.

The OSHA Laboratory Standard defines organic peroxide as “an organic compound that contains the bivalent –O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical.” Oxidizers and organic peroxides are a concern for laboratory safety due to their ability to promote and enhance the potential for fires in labs.

As a reminder of the fire triangle (now referred to as the fire tetrahedron), in order to have a fire, you need:

- A fuel source.
- An oxygen source.
- An ignition source.
- A chemical reaction.

Oxidizers can supply the oxygen needed for the fire, whereas organic peroxides supply both the oxygen and the fuel source. Both oxidizers and organic peroxides may become shock sensitive when they dry out, are stored in sunlight, or due to contamination with other materials, particularly when contaminated with heavy metals. Most organic peroxides are also temperature sensitive.

As with any chemicals, but particularly with oxidizers and organic peroxides, quantities stored on hand should be kept to a minimum. Whenever planning an experiment, be sure to read the MSDS and other reference documents to understand the hazards and special handling precautions that may be required, including use of a safety shield. Also be aware of the melting and auto ignition temperatures for these compounds and ensure any device used to heat oxidizers has an over temperature safety switch to prevent the compounds from overheating.

Laboratory staff should be particularly careful when handling oxidizers (especially high surface area oxidizers such as finely divided powders) around organic materials.

Avoid using metal objects when stirring or removing oxidizers or organic peroxides from chemical containers. Plastic or ceramic implements should be used instead. Laboratory personnel should avoid friction, grinding, and impact with solid oxidizers and organic peroxides. Glass stoppers and screw cap lids should always be avoided and plastic/polyethylene lined bottles and caps should be used instead.

If you suspect your oxidizer or organic peroxide has been contaminated (evident by discoloration of the chemical, or if there is crystalline growth in the container or around the cap), then dispose of the chemical as hazardous waste or contact EH&S Indicate on the hazardous waste tag that the chemical is an oxidizer or organic peroxide and that you suspect contamination.

8.9 Peroxide Forming Compounds

Many commonly used chemicals; organic solvents in particular, can form shock, heat, or friction sensitive peroxides upon exposure to oxygen. Once peroxides have formed, an explosion can result during routine handling, such as twisting the cap off a bottle – if peroxides are formed in the threads of the cap. Explosions are more likely when concentrating, evaporating, or distilling these compounds if they contain peroxides. When these compounds are improperly handled and stored, a serious fire and explosion hazard exists. The following guidelines should be adhered to when using peroxide forming chemicals:

- Each peroxide forming chemical container **MUST** be dated when received and opened. A list of common peroxide forming chemicals can be found in the **Appendix E**. Those compounds in the appendix listed in Table A should be disposed of within 3 months of opening, and those compounds in the appendix listed in Tables B, C, and D should be disposed of within 12 months of opening.

- Each peroxide forming chemical container must be tested for peroxides when opened and at least every 6 months thereafter. The results of the peroxide test and the test date must be marked on the outside of the container. Peroxide labels are available from EH&S.
- Peroxide test strips can be purchased from a variety of safety supply vendors, such as VWR and Laboratory Safety Supply. An alternative to peroxide test strips is the KI (potassium iodide) test. References such as **Prudent Practices in the Laboratory** and the American Chemical Society booklet, **Safety in Academic Chemistry Laboratories** outline ways to test for peroxides and ways to remove them if discovered. When using the test strips, if the strip turns blue, then peroxides **are** present. Light blue test results may be acceptable for use if your procedure does not call for concentrating, evaporating or distilling. Containers with darker blue test results must be deactivated or disposed of. You can test older test strips for efficacy with a dilute solution of hydrogen peroxide.
- Due to sunlight's ability to promote formation of peroxides, all peroxidizable compounds should be stored away from heat and sunlight.
- Peroxide forming chemicals should not be refrigerated at or below the temperature at which the peroxide forming compound freezes or precipitates as these forms of peroxides are especially sensitive to shock and heat. Refrigeration does not prevent peroxide formation.
- As with any hazardous chemical, but particularly with peroxide forming chemicals, the amount of chemical purchased and stored should be kept to an absolute minimum. Only order the amount of chemical needed for the immediate experiment.
- Ensure containers of peroxide forming chemicals are tightly sealed after each use and consider adding a blanket of an inert gas, such as Nitrogen, to the container to help slow peroxide formation.
- A number of peroxide forming chemicals can be purchased with inhibitors added. Unless absolutely necessary for the research, labs should never purchase uninhibited peroxide formers.
- Before distilling any peroxide forming chemicals, always test the chemical first with peroxide test strips to ensure there are no peroxides present. Never distill peroxide forming chemicals to dryness. Leave at least 10-20% still bottoms to help prevent possible explosions.

While no definitive amount of peroxide concentration is given in the literature, a concentration of 50 ppm should be considered dangerous, and a concentration of >100 ppm should be disposed of immediately. In both cases, procedures should be followed for removing peroxides or the containers should be disposed of as hazardous waste.

***However, compounds that are suspected of having very high peroxide levels because of age, unusual viscosity, discoloration, or crystal formation should be considered extremely dangerous. If you discover a container that meets this description, DO NOT attempt to open or move the container. Notify other people in the lab about the potential explosion hazard and notify EH&S at 274-3333 immediately.

For those compounds that must be handled by an outside environmental “bomb squad” company, the cost for such an operation can result in charges of >$1000 per container. However, if laboratory staff follow the guidelines listed above, the chances for requiring special handling for these types of containers or for an explosion to occur is greatly diminished.

Appendix E contains a listing of common peroxide forming chemicals. Please note this list is not all-inclusive, there are numerous other chemicals that can form peroxides. Be sure to read chemical container labels, MSDSs, and other chemical references.

8.10 Poisons

For the purpose of this manual the word “Poison” will be used interchangeably with the word “Toxic”. OSHA defines “Toxic” as a chemical falling within any of the following categories:

a) A chemical that has a median lethal dose (LD50) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

b) A chemical that has a median lethal dose (LD50) of more than 200 milligrams per kilogram, but not more than 1000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

c) A chemical that has a median lethal concentration (LC50) in air of more than 200 parts per million, but not more than 2000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, 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.

OSHA draws a distinction between toxic chemicals and acutely toxic chemicals. For more information on acutely toxic chemicals, see the Particularly Hazardous Substances section. A list of Particularly Hazardous Substances is available in **Appendix D**. OSHA also provides definitions for other health hazards on their website. Under the DOT hazard class system, poisons are listed as hazard class 6.

As a general rule of thumb, all chemicals should be treated as poisons and proper procedures such as maintaining good housekeeping, use of proper PPE, good personal hygiene, etc., should be followed. When working with known poisons, it is very important to have thought an experiment through, addressing health and safety issues before working with the poison. Safety Data Sheets (SDS) and other chemical references should be consulted before beginning the experiment. Some questions to ask before working with poisonous chemicals:

- Do I need to use the poisonous chemical or can a less toxic chemical be substituted?
- What are the routes of entry into the body for the poison (inhalation, ingestion, injection, or skin absorption)?
- What are the signs and symptoms of potential chemical exposure?
- What are the proper PPE required (type of glove, safety glasses vs. splash goggles, face shield, etc.)?
- Does the chemical require any special antidote?
- What are the emergency procedures to be followed?

When working with highly toxic chemicals, you should **not work alone.** Always wear proper PPE and always wash your hands with soap and water when finished, even if gloves were worn. Be aware that poisonous mixtures, vapors, and gases can be formed during an experiment. Be sure to research both the reactants and products of the chemicals you will be working with first. Additional information can be found in the Routes of *Chemical Entry* section 7.5.

If you think you may have been exposed to a poisonous substance, or may have accidentally ingested a chemical, seek medical attention immediately and/or call the Poison Control Center at 1-(800) 222-1222 or the College Public Safety at 911 from a campus phone or 274-3333 from a cell phone or off campus phone. If possible, bring a copy of the SDS with you. Upon completion of seeking medical attention, complete an Injury/Illness Report.

8.11 Corrosives

OSHA defines a corrosive as “a chemical that causes visible destruction of, or irreversible alterations in living tissue by chemical action at the site of contact.”
Under the DOT hazard class system, corrosives are listed as hazard class 8.
Corrosive chemicals can be further subdivided as acids and bases. Corrosives can be in the liquid, solid, or gaseous state. Corrosive chemicals can have a severe effect on eyes, skin, respiratory tract, and gastrointestinal tract if an exposure occurs. Corrosive solids and their dusts can react with moisture on the skin or in the respiratory tract and result in an exposure.

Whenever working with concentrated corrosive solutions, splash goggles should be worn instead of safety glasses. Splash goggles used in conjunction with a face shield provides better protection. Please note that a face shield alone does not provide adequate protection. Use of rubber gloves such as butyl rubber and a rubber apron may also be required.

Corrosive chemicals should be handled in a fume hood to avoid breathing corrosive vapors and gases. When mixing concentrated acids with water, always add acid slowly to the water (specifically, add the more concentrated acid to the dilute acid). Never add water to acid, this can result in a boiling effect and cause acid to splatter. Do not pour the acid directly into the water; it should be poured in a manner that allows it to run down the sides of the container. Never store corrosive chemicals above eye level and always use a protective bottle carrier when transporting corrosive chemicals.

Some chemicals can react with acids and liberate toxic and/or flammable vapors. When working with corrosive materials, ensure spill cleanup material is available for neutralization, such as Calcium carbonate for acids and Citric acid for bases.

Wherever acids and bases are used, an eyewash and emergency shower must be available. If any corrosive chemical gets splashed in the 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.

For small splashes of corrosives 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 splashes of corrosives 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.

8.12 Safe Use and Storage of Perchloric Acid

Perchloric Acid (PCA) is a clear liquid that has no odor, is destructive to human tissue and is very reactive. Solutions below 70% at room temperature are very strong non-oxidizing acids. PCA becomes a strong oxidizer when heated or at concentrations at or above 70%. **Anhydrous PCA must never be purchased or prepared** as it is unstable at room temperature and will decompose with a violent explosion.

8.12.1 Hazard Control for PCA

The following procedures must be followed to ensure safety is maintained while using and storing PCA:

- **Anhydrous solutions of PCA are prohibited!**
- Purchase the smallest quantity available for your needs.
- Immediately, upon receipt, label all containers of concentrated PCA with the date received to ensure safe handeling and timely disposal.
- Promptly dilute the entire contents of concentrated PCA to the lowest morality practical and label all containers upon receipt

- **DO NOT perform PCA digestion in laboratory fume hood.** Any heating of PCA of 70% or greater concentration requires a special dedicated laboratory fume hood equipped with a wash down system. ***Currently Ithaca College does not have a PCA wash down hood.***
- Standard operating procedures (SOP) need to be developed and a written copy sent to EH&S and another placed in the Chemical Hygiene Plan. The SOP should include engineering controls, work practice controls, necessary PPE and emergency procedures.
- All lab personnel shall be trained on the specific SOP's prior to working with PCA
- The lab area must have a functioning emergency eyewash and safety shower.
- Chemical splash and impact rated goggles or a face shield with safety glasses, gloves (vinyl are listed as excellent) and a protective apron must be worn at all times
- Low temperatures and low concentrations (less than 60%) laboratory procedures shall always be done in a fume hood with no other chemical present.
- Always transfer PCA over a suitable containment in order to catch any spills and afford a ready means of cleanup and disposal.
- When possible, use alterative techniques not requiring PCA.
- Do not attempt to clean up a spill of concentrated PCA yourself as contact with oxidizable materials can cause an immediate explosion. If you spill concentrated PCA call Public Safety at 911 from a campus phone or 607-274-3333 from a cell phone, and EH&S will respond to clean up the spill.

8.12.2 Storage of PCA

Quantities of PCA stored within the laboratory should be kept to a minimum.

- The maximum limit within the lab must be kept below 450 grams (1 pound). It must be inspected monthly and if it discolors dispose of immediately.
- **The storage of anhydrous PCA is forbidden.** Storage for even a short time poses a severe risk.
- PCA must be stored separately from other compounds includingbut limited to: acetic acid, acetic anhydride, alcohols, aniline, bismuth and bismuth alloys, combustible materials, dehydrating agents, ethyl benzene, hydrochloric acid, grease, iodines, ketones, other organic materials oxidizers and pyridine.
- DO NOT use or store PCA on wooden lab furniture or cracked or porous bench top materials because explosive compounds can form
- Store container(s) of PCA and diluted solutions in compatible secondary containers, preferably made of ceramic, glass, or polyethylene large enough to contain the entire contents of the bottle(s).

8.12.3 Accidents and Spills of PCA

Be prepared for accidents before they occur. Ensure all emergency equipment is ready for use (e.g. eyewash and safety shower are working and not blocked and spill equipment is available).

- If PCA comes in contact with skin and/or clothes removed clothing and wash exposed area for 15 minutes. If PCA comes in contact with the eyes, rinse for at least 15 minutes in the eyewash station.
- DO NOT allow spill to dry.
- DO NOT mop up or soak up with dry combustible materials such as paper towels.
- For all minute, incidental spills of concentrated and dilute PCA, always neutralize with sodium bicarbonate solution and soak up with wet rags or spill pillows. These should be kept wet and sealed in a plastic bag and contact EH&S immediately.

Never directly flush or rinse PCA with solely water as it will react violently. Dial 911 from a campus phone or 607-274-3333 from a cell phone.

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 are 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 and Safety in Academic Chemical Laboratories.

9.1 Establishment of a Designated Area

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.

9.2 Safe Removal of Contaminated Materials 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 Procedures

Some particularly hazardous substances may require special decontamination or deactivation procedures (such as Diaminobenzidine waste or Ethidium bromide) for safe handling. Review MSDSs 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
- 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 Group.
- Use of Human Subjects - contact the All College Review Board for Human Subjects Research.

9.7 Select Carcinogens

A carcinogen is any substance or agent that is capable of causing cancer – the abnormal or uncontrolled growth of new cells in any part of the body in humans or animals. 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:

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

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 g/m(3);
b. After repeated skin application of less than 300 (mg/kg of body weight) per week; or
c. 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 Sustances Section 9.4.

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 Reproductive 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 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.

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) 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.
b) 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).
c) 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 MSDSs 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 section. In addition to following the Guidelines for Working with Particularly Hazardous Substances, other 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.

10.0 Personal Protective Equipment (PPE)

Laboratory personnel need to conduct hazard assessments of specific operations occurring in their laboratories to determine what PPE is necessary to safely carry out the operations. PPE must be made available to laboratory workers to reduce exposures to hazardous chemicals in the lab. Proper PPE includes items such as gloves, eye protection, lab coats, face shields, aprons, boots, hearing protection, etc. PPE must be readily available and most equipment is provided at no cost to the employee.

When deciding on the appropriate PPE to wear when performing any operations or experiments, a number of factors must be taken into consideration such as:

- The chemicals being used, including concentration and quantity.
- The hazards the chemicals pose.
- The routes of exposure for the chemicals.
- The material the PPE is constructed of.
- The permeation and degradation rates specific chemicals will have on the material.
- The length of time the PPE will be in contact with the chemicals.

Careful consideration should be given to the comfort and fit of PPE to ensure that it will be used by laboratory personnel. All personal protective equipment and clothing must be maintained in a sanitary and reliable condition. Only those items that meet NIOSH (National Institute of Occupational Safety and Health) or ANSI (American National Standards Insitute) standards should be purchased or accepted for use.

10.1 Training for Personal Protective Equipment

Laboratory personnel must be trained in the selection, proper use, limitations, care, and maintenance of PPE. Training requirements can be met in a variety of ways including videos, group training sessions, and handouts. Periodic retraining should be offered to both the employees and supervisors as appropriate. Examples of topics to be covered during the training include:

- When PPE must be worn.
- What PPE is necessary to carry out a procedure or experiment.
- How to properly put on, take off, adjust, and wear PPE.
- The proper cleaning, care, maintenance, useful life, limitations, and disposal of the PPE.

As with any training sessions, PPE training must be documented, including a description of the information covered during the training session and a copy of the sign-in sheet. Training records must be kept of the names of the persons trained, the type of training provided, and the dates when training occurred. EH&S will maintain records of employees who attend EH&S training sessions. Information on the specific PPE required to carry out procedures within the laboratory using hazardous chemicals must also be included in the laboratory’s Standard Operating Procedures.

Please note: while EH&S can provide information, training, and assistance with conducting hazard assessments and the selection and use of proper PPE. 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.

10.2 Eye Protection

Eye protection is one of the most important and easiest forms of PPE to wear. Laboratory personnel should use eye protection for many of the chemical and physical hazards found in laboratories including flying particles, broken glass, molten metal, acids or caustic liquids, chemical liquids, chemical gases or vapors, or potentially injurious light radiation.

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.

All laboratory employees and visitors should wear protective eyewear while in laboratories where chemicals are being handled or stored, at all times, even when not working directly with chemicals.

Additional information can be found on the OSHA Health and Safety Topics Page for eye and face protection.

10.2.1 Eye Protection Selection

All protective eye and face devices must comply with ANSI Z87.1-2003, "American National Standard Practice for Occupational and Educational Eye and Face Protection" and be marked to identify the manufacturer. When choosing proper eye protection, be aware there are a number of different styles of eyewear that serve different functions.

Prescription Safety Eyewear

OSHA regulations require that employees who wear prescription lenses while engaged in operations that involve eye hazards shall wear eye protection that incorporates the prescription in its design, or must wear eye protection that can be worn over the prescription lenses without disturbing the proper position of the prescription lenses or the protective lenses. Any prescription eyewear purchase must comply with ANSI Z87.1-1989.

Note: Contact lenses by themselves are not considered as protective eyewear.

10.2.2 Safety Glasses

Safety glasses provide eye protection from moderate impact and particles associated with grinding, sawing, scaling, broken glass, and minor chemical splashes, etc. Side protectors are required when there is a hazard from flying objects. Safety glasses are available in prescription form for those persons needing corrective lenses. Safety glasses do not provide adequate protection for processes that involve heavy chemical use such as stirring, pouring, or mixing. In these instances, splash goggles should be used.

10.2.3 Splash Goggles

Splash goggles provide adequate eye protection from many hazards, including potential chemical splash hazards, use of concentrated corrosive material, and bulk chemical transfer. Goggles are available with clear or tinted lenses, fog proofing, and vented or non-vented frames. Be aware that goggles designed for woodworking are not appropriate for working with chemicals. These types of goggles can be identified by the numerous small holes throughout the facepiece. In the event of a splash, chemicals could enter into the small holes, and result in a chemical exposure to the face. Ensure the goggles you choose are rated for use with chemicals.

10.2.4 Welder's/Chippers' Goggles

Welder's goggles provide protection from sparking, scaling, or splashing metals and harmful light rays. Lenses are impact resistant and are available in graduated lens shades. Chippers'/Grinders' goggles provide protection from flying particles. A dual protective eyecup houses impact resistant clear lenses with individual cover plates.

10.2.5 Face Shields

Face shields provide additional protection to the eyes and face when used in combination with safety glasses or splash goggles. Face shields consist of an adjustable headgear and face shield of tinted or clear lenses or a mesh wire screen. They should be used in operations when the entire face needs protection and should be worn to protect the eyes and face from flying particles, metal sparks, and chemical/biological splashes. Face shields with a mesh wire screen are not appropriate for use with chemicals. Face shields must ***not*** be used alone and are ***not*** a substitute for appropriate eyewear. Face shields should always be worn in conjunction with a primary form of eye protection such as safety glasses or goggles.

10.2.6 Welding Shields

Welding shields are similar in design to face shields but offer additional protection from infrared or radiant light burns, flying sparks, metal splatter, and slag chips encountered during welding, brazing, soldering, resistance welding, bare or shielded electric arc welding, and oxyacetylene welding and cutting operations. Equipment fitted with appropriate filter lenses must be used to protect against light radiation. Tinted and shaded lenses are not filter lenses unless they are marked or identified as such.

10.2.7 LASER Eye Protection

A single pair of safety glasses is not available for protection from all LASER outputs. The type of eye protection required is dependent on the spectral frequency or specific wavelength of the laser source. If you have questions on the type of eyewear that should be worn with your specific LASER, contact the Principal investigator for that LASER.

10.2.8 Contact Lens Use

Contact Lenses are not eye protection devices, but may be worn when handeling hazardous chemicals provided that the following safety guidelines are followed and that contact lenses are not banned by regulations or contraindicated by medical recommendations. Principal investigators and supervisors must identify all contact lens wearers in their area to ensure the proper hazard assessment is completed and the appropriate protective equipment is provided.

1. Conduct an eye injury/chemical exposure assessment.

    Chemical exposure assessment should include, at a minimum, an evaluation of the properties of the chemical in use – including known eye irritants/injury properties, concentration, permissible exposure limits, form of chemical (powder, liquid, vapor), review of the manufacturer‘s SDS and warning label for special handling instructions, and possible routes of exposure.

    OSHA currently recommends against contact lens use when working with acrylonitrile, methylene chloride, 1,2 dibromom-3-chloropropane, ethylene oxide, and methylene dianiline.

2. Provide suitable eye and face protection for all exposed to eye injury hazards.

    At a minimum, a well-fitting non-vented or indirect vent splash goggles must be worn. Close fitting safety glasses with side protection provide limited chemical protection but do not prevent chemicals from bypassing the protection. Workers can wear face shields over safety glasses when needed, but they should not wear face shields instead of goggles or safety glasses.

3. Establish restricted areas by work location and task and inform workers and visitors (e.g., signage) of these restricted areas/tasks where contact lens use is not allowed.

4. In the event of a chemical exposure, begin irrigation immediately and remove contact lenses as soon as practical. If medical attention is necessary, call **Public Safety at 911 from a campus phone or 274-3333 from a cell phone.**

5. Instruct individuals who wear contact lenses to remove them at the first sign of eye redness or irritation. Contact lenses should only be removed in a clean environment after the wearer has thoroughly washed their hands.

10.3 Hand Protection

Most accidents involving hands and arms can be classified under four main hazard categories: chemicals, abrasions, cuts, and heat/cold. Gloves must be worn whenever significant potential hazards from chemicals, cuts, lacerations, abrasions, punctures, burns, biological, or harmful temperature extremes are present. The proper use of hand protection can help protect from potential chemical and physical hazards. Gloves must be worn when using chemicals that are easily absorbed through the skin and/or particularly hazardous substances (such as “select carcinogens”, reproductive toxins, and substances with a high degree of acute toxicity).

***There is not one type of glove that offers the best protection against all chemicals or one glove that totally resists degradation and permeation to all chemicals. All gloves must be replaced periodically, depending on the type and concentration of the chemical, performance characteristics of the gloves, conditions and duration of use, hazards present, and the length of time a chemical has been in contact with the glove.

All glove materials are eventually permeated by chemicals; however, they can be used safely for limited time periods if specific use and other characteristics (i.e., thickness, permeation rate, and time) are known. EH&S can provide assistance with determining the resistance to chemicals of common glove materials and determining the specific type of glove material that should be worn for use with a particular chemical.

10.3.1 Selecting the Proper Gloves

Before working with any chemical, always read manufacturer instructions and warnings on chemical container labels and MSDSs. Recommended glove types are sometimes listed in the PPE section of the MSDSs. If the recommended glove type is not listed on the MSDS, then laboratory personnel should consult with the manufacturers’ glove selection charts. These charts typically include commonly used chemicals that have been tested for the manufacturers’ different glove types. Different manufacturers use different formulations so check the glove chart of the specific manufacturer for the glove you plan to use. An example is available in **Appendix I**.

If the manufacturers' glove chart does not list the specific chemical you will be using, then call the manufacturer directly and speak with their technical representatives to determine which glove is best suited for your particular application.

It is important to know that not all chemicals or mixtures have been tested by glove manufacturers. It is especially important in these situations to contact the glove manufacturer directly.

In some cases, you may need to consider hiring a testing laboratory that specializes in determining which glove material will be most resistant to the chemical you are using. There is a local company that is capable of testing gloves for chemical resistance for a modest fee. For more information, contact EH&S

Some general guidelines for glove use include:

- Wear appropriate gloves when the potential for contact with hazardous materials exists. Laboratory personnel should inspect gloves for holes, cracks, or contamination before each use. Any gloves found to be questionable should be discarded immediately.
- Gloves should be replaced periodically, depending on the frequency of use and permeability to the substance(s) handled. Reusable Gloves should be rinsed with soap and water and then carefully removed after use. Discard disposable gloves after each use and whenever they become contaminated.
- Due to potential chemical contamination, which may not always be visible, gloves must be removed before leaving the laboratory. Do not wear gloves while performing common tasks such as answering the phone, grabbing a door handle, using an elevator, etc.

10.3.2 Double Gloving

A common practice to use with disposable gloves is "double-gloving". This is accomplished when two pairs of gloves are worn over each other to provide a double layer of protection. If the outer glove becomes contaminated, starts to degrade, or tears open, the inner glove continues to offer protection until the gloves are removed and replaced. The best practice is to check outer gloves frequently, watching for signs of degradation (change of color, change of texture, tears, etc.). At the first sign of degradation or contamination, always remove and dispose of the contaminated disposable gloves immediately and double-glove with a new set of gloves. If the inner glove appears to have any contamination or degradation, remove both pairs of gloves, and double glove with a new pair.

Another approach to double gloving is to wear a thin disposable glove (4 mil Nitrile) under a heavier glove (8 mil Nitrile). The outer glove is the primary protective barrier while the under glove retains dexterity and acts as a secondary barrier in the event of degradation or permeation of the chemical through the outer glove. Alternately, you could wear a heavier (and usually more expensive and durable) 8 mil Nitrile glove as an under glove and wear thinner, disposable 4 mil Nitrile glove as the outer glove (which can help improve dexterity). However, remember to change the thinner outer gloves frequently.

When working with mixtures of chemicals, it may be advisable to double glove with two sets of gloves made from different materials. This method can offer protection in case the outer glove material becomes permeated by one chemical in the mixture, while allowing for enough protection until both gloves can be removed. The type of glove materials selected for this type of application will be based on the specific chemicals used as part of the mixture. Check chemical manufacturers glove selection charts first before choosing which type of glove to use.

To properly remove disposable gloves, grab the cuff of the left glove with the gloved right hand and remove the left glove. While holding the removed left glove in the palm of the gloved right hand, insert a finger under the cuff of the right glove and gently invert the right glove over the glove in the palm of your hand and dispose of them properly. Be sure to wash your hands thoroughly with soap and water after the gloves have been removed.

10.3.3 Types of Gloves

As with protective eyewear, there are a number of different types of gloves that are available for laboratory personnel that serve different functions:

Fabric Gloves

Fabric gloves are made of cotton or fabric blends and are generally used to improve grip when handling slippery objects. They also help insulate hands from mild heat or cold. These gloves are not appropriate for use with chemicals because the fabric can absorb and hold the chemical against a user’s hands, resulting in a chemical exposure.

Leather Gloves

Leather gloves are used to guard against injuries from sparks, scraping against rough surfaces, or cuts from sharp objects like broken glass. They are also used in combination with an insulated liner when working with electricity. These gloves are not appropriate for use with chemicals because the leather can absorb and hold the chemical against a user’s hands, resulting in a chemical exposure.

Metal Mesh Gloves

Metal mesh gloves are used to protect hands from accidental cuts and scratches. They are most commonly used when working with cutting tools, knives, and other sharp instruments.

Cryogenic Gloves

Cryogenic gloves are used to protect hands from extremely cold temperatures. These gloves should be used when handling dry ice and when dispensing or working with liquid nitrogen and other cryogenic liquids.

Chemically Resistant Gloves

Chemically resistant gloves come in a wide variety of materials. The recommendations given below for the specific glove materials are based on incidental contact. Once the chemical makes contact with the gloved hand, the gloves should be removed and replaced as soon as practical. Often a glove specified for incidental contact is not suitable for extended contact, such as when the gloved hand can become covered or immersed in the chemical in use. Before selecting chemical resistant gloves, consult the glove manufacturers' recommendations or their glove selection charts, or contact EH&S for more assistance.

Some general guidelines for different glove materials include:

- Natural Rubber Latex***** -** Resistant to ketones, alcohols, caustics, and organic acids. (See note below.)
- Neoprene - Resistant to mineral acids, organic acids, caustics, alcohols, and petroleum solvents.
- Nitrile - Resistant to alcohols, caustics, organic acids, and some ketones.
- Norfoil **-** Rated for chemicals considered highly toxic and chemicals that are easily absorbed through the skin. These gloves are chemically resistant to a wide range of materials that readily attack other glove materials. These gloves are not recommended for use with Chloroform. Common brand names include: Silver Shield by North Hand Protection, 4H by Safety4, or New Barrier by Ansell Edmont.
- Polyvinyl chloride (PVC) - Resistant to mineral acids, caustics, organic acids, and alcohols.
- Polyvinyl alcohol (PVA) - Resistant to chlorinated solvents, petroleum solvents, and aromatics.

***** A note about latex gloves**

The use of latex gloves, especially thin, disposable exam gloves, for chemical handling is discouraged because latex offers little protection from commonly used chemicals. Latex gloves can degrade severely in minutes or seconds, when used with common lab and shop chemicals. Latex gloves also can cause an allergic reaction in a percentage of the population due to several proteins found in latex. Symptoms can include nasal, eye, or sinus irritation, hives, shortness of breath, coughing, wheezing, or unexplained shock. If any of these symptoms become apparent in personnel wearing latex gloves, discontinue using the gloves and seek medical attention immediately.

The use of latex gloves is only appropriate for:

- Most biological materials.
- Nonhazardous chemicals.

- Clean room requirements.
- Medical or veterinary applications.
- Very dilute, aqueous solutions containing <1% for most hazardous chemicals or less than 0.1% of a known or suspected human carcinogen.

Staff required to wear latex gloves should receive training on the potential health effects related to latex. Hypoallergenic, non-powdered gloves should be used whenever possible. If a good substitute glove material is available, then use nonlatex gloves. A general purpose substitute for disposable latex gloves are disposable Nitrile gloves.

See **Appendix I** for a list of recommended gloves for specific chemicals, definitions for terms used in glove selection charts, glove materials and characteristics, and a list of useful references.

10.4 Protective Clothing

Protective clothing includes lab coats or other protective garments such as aprons, boots, shoe covers, Tyvek coveralls, and other items, that can be used to protect street clothing from biological or chemical contamination and splashes as well as providing additional body protection from some physical hazards.

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.

The following characteristics should be taken into account when choosing protective clothing:

- The specific hazard(s) and the degree of protection required, including the potential exposure to chemicals, radiation, biological materials, and physical hazards such as heat.
- The type of material the clothing is made of and its resistance to the specific hazard(s) that will be encountered.
- The comfort of the protective clothing, which impacts the acceptance and ease of use by laboratory personnel.
- Whether the clothing is disposable or reusable - which impacts cost, maintenance, and cleaning requirements.
- How quickly the clothing can be removed during an emergency. It is recommended that lab coats use snaps or other easy to remove fasteners instead of buttons.

Laboratory personnel who are planning experiments that may require special protective clothing or have questions regarding the best protective clothing to choose for their experiment(s) should contact EH&S for recommendations.

10.5 Respiratory Protection

10.5.1 Respirators

Respiratory protection includes disposable respirators (such as N95 filtering facepieces, commonly referred to as “dust masks”), air purifying, and atmosphere supplying respirators. Respirators are generally not recommended for laboratory workers. Engineering controls, such as dilution ventilation, fume hoods, and other devices, which capture and remove vapors, fumes, and gases from the breathing zone of the user are preferred over the use of respirators in most laboratory environments.

The use of all types of respiratory protection at Ithaca College is governed by the OSHA standards and the Ithaca College Respiratory Protection Program.

A laboratory worker at Ithaca College may not purchase a respirator and bring it to their lab for personal use without prior consultation with EH&S.

The following are situations where respiratory protection would be appropriate for laboratory workers (after consultation with EH&S):

- The use of disposable respirators (e.g., N95 filtering facepieces/dust masks) for weighing powdery or dusty materials. Note: Most disposable respirators do not offer protection against chemical vapors and fumes; they are for use of nuisance dust only. The use of disposable respirators may or may not be regulated by OSHA depending upon the circumstances of use. In order to determine if OSHA regulations apply, please contact EH&S to schedule a hazard assessment prior to using a disposable respirator.
- The voluntary use of N-95 respirators in the laboratory is permitted. OSHA requires the following reading: Mandatory Information for Employees Using Respirators When not Required Under Standard – 29 CFR 1910.134 **Appendix O**.
- The use of large volumes of certain hazardous chemicals, such as formaldehyde in a room where dilution ventilation or capture devices will not be able to offer adequate protection.
- Cleaning up hazardous chemical spills. (Additional training is required.)
- To reduce exposure to some chemicals which certain individuals may be or become sensitive.
- When mixing chemicals that may result in more hazardous vapors from the combination of chemicals versus the exposure to each chemical alone or when the potential for an unknown exposure exists. However, laboratory staff should try to conduct such experiments in a fume hood.

Please note, 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.

There are some situations in which the use of a respirator would be prohibited:

- When the air in a laboratory is severely contaminated and immediately dangerous to life and health (IDLH).
- When the air in a room does not have enough oxygen to support life (less than 19.5%).
- When dangerous vapors are present that have inadequate warning properties (such as odor) should the respirator fail.
- When the air contaminants can penetrate or damage skin and eyes unless other suitable protection is worn.

10.5.1.1 Respiratory Protection Program

Ithaca College has established a program for the use of respirators on campus. The program is designed for those College personnel who, during their normal duties are, or could be, exposed to hazardous substances or atmospheres that may affect their health and safety.

The Ithaca College Respiratory Protection Program includes the following:

- You will receive a medical evaluation by Hammond Health Center to ensure you are physically fit to wear a respirator. Wearing any type of respirator puts a large amount of stress on the body.
- You will be given a fit test to determine which size respirator fits you best. Due to the differences in the sizes and shapes of faces, there is no one respirator that fits all sizes and shapes of faces.
- You will be shown how to properly put on and take off the respirator, and how to check to make sure it is functioning properly.
- You will be shown how to properly clean and care for your respirator, including proper maintenance.
- You will be shown how to choose the right respirator or respirator cartridge for the specific processes and types of chemicals you will be using. NOTE: As with chemical protective gloves, there is no one universal respirator cartridge that can be used with every chemical.

For more information about the use of respirators at Ithaca College, call EH&S. If the use of a respirator is required to perform your job duties, then your department will pay for the respirator.

10.6 Hearing Protection

Hearing protective devices includes earplugs, earmuffs, or similar devices designed to protect your hearing. If occupational noise exposures exceed permissible levels and cannot be reduced through engineering or other controls, then hearing protective devices must be worn. The Ithaca College Hearing Conservation Program protects employees who, during their normal duties experience an Occupational Noise Exposure as defined by the Occupational Safety and Health Administration (OSHA) General Industry Standard "Occupational Exposure to Noise" Part 1910.95 and the Hearing Conservation Amendment.

If you have questions about whether you are receiving an occupational noise exposure, or would like to request workplace monitoring or information about the Ithaca College Hearing Conservation Program, then contact EH&S. Additional information can be obtained from the OSHA Health and Safety Topics page for Noise and Hearing Conservation.

10.7 Foot Protection

Laboratory personnel (and other personnel) must wear foot protection at all times in laboratories, laboratory support areas, and other areas with chemical, biological and physical hazards are present. Laboratory personnel should not wear sandals or similar types of perforated or open toes shoes whenever working with or around hazardous chemicals or physical hazards. This is due to the potential exposure to toxic chemicals and the potential associated with physical hazards such as dropping pieces of equipment or broken glass being present. In general, shoes should be comfortable, and leather shoes are preferable to cloth shoes due to the better chemical resistance of leather compared to cloth. Leather shoes also tend to absorb fewer chemicals than cloth shoes. However, leather shoes are not designed for long term exposure to direct contact with chemicals. In such instances, chemically resistant rubber boots are necessary.

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.

11.0 Hazardous Waste Disposal

Current regulations and laws hold Ithaca College responsible for any adverse environmental effects from discarded chemicals forever, despite disposal location or manner of disposal.

The New York State Department of Environmental Conservation (NYSDEC) has jurisdiction over hazardous waste disposal under the federal Resource Conservation and Recovery Act (RCRA) in conjunction with federal regulatory programs initiated by the U.S. Environmental Protection Agency (USEPA). The U.S. Department of Transportation (USDOT) regulations govern the labeling, packaging and transportation of chemical waste. Environmental Health & Safety is the federally registered College department responsible for the management of hazardous waste. Federal and state regulations carry criminal penalties for the abandonment, misrepresentation or improper disposal of hazardous waste.

The procedures and recommendations presented in this section are intended to:

- Ensure that Ithaca College is in compliance with all federal, state and local laws governing the management and disposal of hazardous materials.
- Reduce the impact of hazardous materials on the environment by implementing a waste minimization program.
- Reduce the College's costs and liability associated with the management and disposal of hazardous waste.
- Provide Ithaca College laboratory workers with a comprehensive reference source for proper preparation (e.g., containerization, labeling, etc.) of hazardous materials for disposal.

11.1 Hazardous Waste Definition

A waste is any discarded, abandoned, unwanted or unusable material. State and federal law define a hazardous waste as a waste, or combination of wastes, that because of its concentration, physical, chemical, or infectious characteristics may cause harm to human health and the environment when improperly stored, transported, and disposed of or otherwise mismanaged. Hazardous waste can be defined as either a “listed” or a “characteristic” waste.

Listed Waste. Waste is considered hazardous if it appears on one of four lists published in the *Code of Federal Regulations* (40 CFR Part 261).” (See **Appendix J**.) Wastes are listed because they are known to be harmful to human health and the environment when not managed properly.

Characteristic Waste. If waste does not appear on one of the four federal lists (see **Appendix J**), it still might be considered hazardous if it demonstrates *any* of the following characteristics (40 CFR 261.20).

Ignitable. A waste is considered ignitable if a representative sample of the waste has any of the following properties:

a. It is a liquid and has a flashpoint of less than 60° C (140° F).
b. It is not a liquid and is capable, under standard temperature and pressure, of catching fire through friction, absorption of moisture or spontaneous chemical changes and when ignited, burns so vigorously and persistently that it creates a hazard.
c. It is an ignitable compressed gas as defined by the USEPA (49 CFR 173).
d. It is an oxidizer as defined by the USEPA (49 CFR 173).

Corrosive. A waste is considered corrosive if a representative sample of the waste has either of the following properties:

a. It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5.
b. It is a liquid and corrodes steel at a rate greater than 6.35 mm per year.

Reactive. A waste is considered reactive if a representative sample of the waste has *any* of the following properties:

a. It is normally unstable and readily undergoes violent change without detonating.
b. It reacts violently with water.
c. It forms potentially explosive mixtures with water.
d. When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
e. It is a cyanide or sulfide bearing waste which, when exposed to pH concentrations between 2 and 12.5, can generate toxic gases, vapors or fumes in quantities sufficient to present a danger to human health and the environment.
f. It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or heated under confinement.
g. It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
h. It is a forbidden explosive as defined by the USEPA (49 CFR 173).

Toxic. A waste is considered toxic if a representative sample of the waste contains any of the contaminants listed in the table provided in **Appendix K** of this CHP at the concentration equal to or greater than the respective value given.

11.2 Waste Reduction

State and federal regulations require that the College implement a program to reduce the volume of hazardous waste generated on campus. The quantity of hazardous waste can be reduced by the following measures:

- Purchase the smallest reasonable quantity of chemicals. Avoid the need to dispose of surplus (e.g., due to expiration). Waste disposal cost is generally much higher than the original cost of the chemical.
- Exchange usable surplus chemicals with other laboratories/departments. This will keep purchase costs down, prevent waste and minimize the disposal costs.
- Reduce the scale of reactions whenever possible.

- Before running an experiment, consider the waste produced and determine a safe disposal method. Environmental Health & Safety may be able to provide reference materials to assist you.
- When possible, neutralize an acidic or basic waste in its original container if it can be done safely. The EPA allows *elementary neutralization (40 CFR 260.10)* for neutralizing wastes that are hazardous wastes only because they exhibit the corrosivity characteristic defined in section 6.1.2 of this CHP. Care must be taken to ensure that the material is not a listed waste or exhibits any of the other hazardous waste characteristics. Simple neutralization may considerably decrease the hazards of a reaction waste and make disposal easier and less expensive.
- Include consideration of alternative methods using less-hazardous or non-hazardous chemicals.
- Recover and reuse solvents whenever feasible.
- Clearly label all chemical containers, reaction products, etc.. Replace deteriorating labels before they become illegible or separated from the container. Unidentified chemicals cannot be disposed of and will require an expensive waste determination analysis.
- Determine methods of decontaminating disposables (e.g., filter paper, weighing boats, etc.) to allow disposal in the regular trash. Contaminated non-chemical waste cannot be disposed of with the chemical waste.

EH&S provides the following chemical waste compliance services:

- Management of College main hazardous waste accumulation area.
- Collection of chemical waste.
- General compliance assistance.

11.3 Hazardous Chemical Waste Container Requirements

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

1) Determine if your unwanted materials pose a significant risk requiring management as hazardous waste.
2) Label containers of hazardous chemical wastes with the identity of the chemical(s) **AND** the words “Hazardous Waste” or label with an Ithaca College Hazardous Waste label.
3) Keep containers of hazardous chemical wastes closed at all times when they are not in use.
4) Store hazardous waste containers within the room in which they are generated in.
   - 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 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.

11.4 Satellite Hazardous Waste Accumulation

Each laboratory in which hazardous waste is generated must establish a dedicated “Satellite Accumulation Area,” usually in a hood with secondary containment, where active collection bottles are kept. Storage of waste on the floor, with or without a tray, is unacceptable.

The following are requirements for storing hazardous waste in the satellite accumulation area:

- Waste accumulated at or near the point of generation and "under the control of the operator" (e.g., locked up when not in use).
- Container is clearly marked with the words "Hazardous Waste" and other identifying information (e.g., "Spent Acetone").
- All of the fields on the hazardous waste label are clearly filled out AND full chemical name (i.e., no abbreviations or formulas) listed for each waste in container(s).
- "Pick-up date" field on hazardous waste label is blank. (Date will be completed by EH&S upon removal from area).
- Total storage in all containers have less than 55 gallons of hazardous waste or less than 1 quart of acute hazardous waste.
- Chemicals have not exceeded manufacturer's specified shelf-life. (All expired chemicals are "hazardous waste." Contact EH&S for pick-up prior to expiration).
- Waste containers are stored in a designated location.
- Containers are in good condition and non-leaking.
- Container lids/covers are in good condition and not damaged.
- Incompatible wastes are stored in separate containers and structurally segregated (or at least 20 feet away from each other).
- Waste containers stored near sinks or drains (e.g., fume hood) are in secondary containment.
- Waste is compatible with container that it is stored in.
- Container is tightly closed except when adding or removing waste.
- Full containers are removed within 72 hours. (Contact EH&S for pick-up).
- All applicable students, staff, and faculty have been instructed in the proper hazardous waste storage, handling, and disposal procedures for the area. (All training must be documented).

Departments generating large quantities of waste must arrange regular waste pick-ups with EH&S.

11.5 Empty Containers

The EPAs definition of a *RCRA* “empty” container (40 CFR 261.7) has three parts and is dependent on the type of waste the container held.

The first part of the definition applies to containers that held hazardous wastes other than compressed gases or acute hazardous wastes. For such containers, the regulations provide that an empty container is one from which all wastes have been removed that can be removed using practices commonly employed to remove materials from that type of container, (e.g., pouring, pumping, aspirating), and that no more than 2.5 centimeters (1 inch) of residue remain on the bottom of the container.

The second part of the definition covers containers which have held hazardous wastes which are compressed gases. For these containers to be considered empty under RCRA, the pressure inside the container must approach atmospheric pressure.

The third part of the definition covers containers that have held acute hazardous wastes, see **Appendix J** (P-list). For such a container to meet the definition of “empty” the container must be triple rinsed with an appropriate solvent. The rinse ate most be collected and treated as hazardous waste.

11.6 Arranging Waste Pickup

Call Environmental Health & Safety at 4-1613 to arrange an appointment for screening and pickup of waste bottles. Laboratories consistently generating a large volume of waste will normally be scheduled for regular pickups from their satellite waste storage area.

If waste is unacceptable for pickup (e.g., poor container condition, unlabeled, etc.), it will be left in the laboratory along with a “Chemical Waste Non-Pickup Notice” giving the reasons. The waste generator is responsible for promptly correcting the problem(s) and scheduling another pickup or alternate disposal method. Do not leave unacceptable waste in the laboratory indefinitely; it constitutes a hazard, takes up space and may cause the College to exceed regulatory waste storage time limits. If you are unsure of why your waste was unacceptable for pickup, call EH&S at 274-1613.

In case of extreme hazard or imminent danger, immediately call Campus Safety at 4-3333.

12.0 Emergency Preparedness

IN CASE OF AN EMERGENCY:
CALL 911 from any campus phone or dial 274-3333 from any cell phone, or off campus phone to reach Ithaca College Police.
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 Ithaca College community handle crises and emergencies with appropriate responses, and could save lives. Every member of the Ithaca College community shares responsibility for emergency preparedness. Department heads are responsible for ensuring that their departments have emergency plans in place, and that all persons – including faculty, staff and students – are familiar with those emergency plans. Unit heads are also responsible for assigning emergency preparedness and response duties to appropriate staff members.

12.1 Emergency Evacuation Procedures

A building evacuation is mandatory whenever a fire alarm sounds. Building occupants should exit immediately and meet at the designated assembly area. After the building has been evacuated, occupants must wait for a safety inspection. DO NOT RETURN TO AN EVACUATED BUILDING unless told to do so by a College official.

NOTE: If you become trapped in a building during a fire and a window is available, place an article of clothing (shirt, coat, etc.) outside the window as a marker for rescue crews. If there is no window stay near the floor where the air will be less toxic. Shout at regular intervals to alert emergency crews to your location. DO NOT PANIC!

To Implement an Evacuation

- Remain calm.
- Take personal items, such as a coat and keys.
- DO NOT use the elevators.
- Assist persons with disabilities.
- Turn equipment off, if possible.
- Close doors.
- Keep exiting groups together.
- Instructors assist students.
- Gather at the evacuation site and await instructions.
- Account for faculty, staff and students.

12.2 Emergency Procedures

Emergencies can include both fire and non-fire emergencies. Fires are an "expected" emergency in all lab situations and almost all lab staff are 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 as HVAC systems and emergency 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.

12.3 Laboratory Emergency Shutdown Procedures

Each laboratory facility should develop a non-fire emergency plan. Employees must be trained on the contents of the plan and how to respond in a non-fire emergency. 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. Check the disconnects of large LASERs, radio frequency generators, etc. 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/moistureless 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.

12.4 Medical Emergency Procedures

Call 911 or 274-3333 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. Do not delay in obtaining trained medical assistance if it is safe to do so.
- Notify Ithaca College Police of the location, nature and extent of the injury by calling 911 from a college phone or 274-3333 from a cell phone, 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.

12.5 First Aid Kits

Although there are areas at Ithaca College where people work that could be considered hazardous, Ithaca College's main campus has no legal requirements to have first aid kits in work spaces within the campus buildings. This reasoning is addressed by OSHA (29 CFR 1910.151) and cited in the ANSI standard (Z308.1-1998) that states if medical attention can be reached within a reasonable time, or distance, to rely on the professionals and make that part of an emergency plan. Ithaca College's Office of Public Safety department has fully training emergency responders on call 24 hours a day, 7 days a week. Injured personnel are encouraged to take advantage of this service by calling 911 from a campus phone or 274-3333 from a cell phone.

If you choose to have 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 an Ithaca College laboratory.
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.

EH&S can provide information on where to obtain the appropriate training if you choose to keep a first aid kit in your work space.

12.6 Fire or Explosion Emergency Procedures

All fires must be reported to Ithaca College Police, 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 Ithaca College Police of the location and size of the fire by calling 911 from a campus phone, or 274-3333 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 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.

12.7 Fire Extinguishers

- All fire extinguishers are inspected annually and maintained by EH&S.
- Laboratory personnel should perform regular visual checks 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 EH&S at 274-3333 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 EH&S 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 274-3333.

12.8 Chemical Spill Procedures

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 the proper spill cleanup materials available. Note: The following advice is intended for spills that occur within a college building. A release to the outside environment may require the college file a report with the EPA. Calling Ithaca College Police will initiate this determination by the EH&S Department.

12.8.1 Incidental 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.
- 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.

12.8.2 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, and dispose of through the hazardous waste management program.
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.

13) Restock any spill cleanup supplies that you may have used from any spill kits.

12.8.3 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 274-3333 for advice.*

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

For liquid base spills:
- Use Sodium bicarbonate to lower the pH sufficiently for drain disposal.

For oil spills:
- Use ground corn cobs (SlikQwik), vermiculite, or absorbent clay (kitty litter).

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 911 or EH&S at 274-3333.
- 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 assistance in assembling spill kits for laboratories and offers a training class on "Cleaning Up Small Spills". More information can be obtained by contacting Environmental Health and Safety.

12.8.4 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 Ithaca College Police are notified of a spill by calling 911 from a campus phone or 274-3333 from a cell phone or off campus phone.

Major Spill Cleanup Procedures

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 Ithaca College Police by calling 911 or 274-3333 or using a Blue Light or Emergency Telephone. Always call from a safe location.

Be prepared to provide Ithaca College Police 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.

12.8.5 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.

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:

Eyewashes

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 you 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 911 after you have finished flushing your eyes for at least **15 minutes**.
7) Seek medical attention.
8) Complete an 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 **911 from a college phone or 274-3333 from a cell phone**. After calling for help, 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 911 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 **911from a college phone or 274-3333 from a cell phone**. After calling for help, 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 to see if the rinsate needs to be collected as hazardous waste.

It is the responsibility of the Principal Investigator and laboratory supervisor to ensure all injuries are reported to college officials through the use of the Ithaca College injury/illness reporting system.

12.8.6 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. 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 **Appendix G**.

12.8.6.1 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 Material Safety Data Sheet (MSDS) 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.

12.8.6.2 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 Hammond Health Center in accordance with 29 CFR 1910.1020.

13.0 Employee Information and Training

Federal and state laws and Ithaca College 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 through 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**) 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 (**Appendix G**).
- 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, MSDSs received from the chemical supplier.

The Laboratory Standard goes on to state this training shall include:

- Methods and observations that may be used to detect the presence or release of a hazardous chemical.
- The physical and health hazards of chemicals in the work area.
- 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. The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

.***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.***

14.0 Biohazards

14.1 Institutional Biosafety Committee

The Institutional Biosafety Committee (IBC) reviews research and teaching activities involving the use of recombinant DNA, infectious and pathogenic agents, select agents and toxins, and gene therapy.

A Registration Form must be submitted to the IBC to initiate a review. Reviews ensure that all work involving materials and activities described above and the facilities used to conduct such work are in compliance with guidance and regulations put forth by external agencies (e.g. NIH, CDC, OSHA, etc.) and applicable College policies.

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.

14.1.1 Recombinant DNA

Ithaca College requires that all recombinant DNA work done at Ithaca College by employees or affiliates be registered with the IBC, **EVEN IF IT IS EXEMPT** from the NIH Guidelines. Recombinant DNA is defined as:

1) Molecules that are constructed outside living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in a living cell.

OR

2) DNA molecules that result from the replication of those described above.

14.1.2 Infectious and Pathogenic Agents

Infectious/pathogenic agents to humans, classified in the following categories: Risk Group 2, 3, and 4 bacterial, fungal, parasitic, viral, rickettsial, Chlamydia, and prion agents.

See the following for information regarding the classification of infectious agents:

- National Institutes of Health (NIH).
- Centers for Disease Control and Prevention (CDC).
- American Biological Safety Association (ABSA).

14.1.3 Select Biological Agents and Toxins

Select agents and toxins are biological agents and toxins that have the potential to pose a severe threat to public health and safety, and animal or plant health. The possession and use of these agents is highly regulated. More information can be found at the CDC Select Agent Program and USDA Agricultural Select Agent Program. If you wish to work with these agents, you must first notify and register with the Biosafety Committee. Unregistered possession and use can result in significant fines and jail time.

Other agents that have the potential for causing disease in animals or plants are regulated by the Animal Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA). APHIS has published a list of regulated plant pests and your research must be reviewed if you are working with or in possession of any of these plant pathogens/pests.

14.1.4 Gene Therapy

Gene therapy experiments include the delivery of exogenous genetic material (DNA or RNA) to somatic cells for the purpose of modifying those cells.

14.2 Animal Use

It is a violation of federal regulations to carry out studies using vertebrate animals without an approved animal use protocol or to maintain animals after expiration of a previously approved protocol. Federal regulations mandate the establishment of an Institutional Animal Care and Use Committee (IACUC) to provide guidance, to oversee the animal care and use program, and to ensure compliance with applicable laws, regulations, and policies. The IACUC oversees the animal use program as mandated by the United States Public Health Service Policy and Animal Welfare Act. Principal Investigators must complete a Protocol Form for the Use of Live Vertebrate Animals whenever vertebrate animals will be used for research, teaching, or testing.

Federal regulations and standards stipulate that personnel must be trained so they are qualified to perform research on animals. Ithaca College is given the responsibility for providing training to perform research on animals, and as the self-regulating unit of the institution for animal research, the IACUC must ensure that personnel are qualified to perform the procedures proposed in animals as part of the review process. For more information, contact the IACUC administrator.

14.3 Human Participants

The All-College Review Board for Human Subjects Research exists as a safeguard to promote ethical and responsible treatment of human subjects/participants in research. As the institution's official Institutional Review Board (IRB), all research projects that use human subjects -- regardless of the source of funding -- must be reviewed and approved by the All-College Review Board for Human Subjects Research before the investigator may commence with the study. Research investigators may ***not*** make the final determination of exemption from applicable Federal regulations. Only the All-College

Review Board for Human Subjects Research Chairperson or his/her designee can designate a research project as "exempt."

The ultimate responsibility for treatment of human research subjects, however, rests with the principal investigator. Principal investigator's informed participation in this process helps to ensure a positive, ethical, and responsible climate for scholarly research at Ithaca College.

All Ithaca College investigators, as well as research staff, undergraduate and graduate students who will be working with human subjects or the data collected on human subjects ***must*** complete training in the use of human subjects ***before*** applications are submitted for review to the All College Committee on Human Subjects.

For more information, see the All-College Review Board for Human Subjects Research Policies and Procedures and Guidelines for Investigators As contained in the Ithaca College Policy Manual, Volume II, and Section 21.

14.3.1 Shipping Biological Materials

Shipping certain biological materials such as human or animal infectious agents or diagnostic/clinical samples - collectively referred to as dangerous goods - involves certain risks and incurs many potential liabilities. If you offer for transport, or transport dangerous goods, or cause dangerous goods to be transported, you must be a trained individual. **There are NO exceptions.** The trained shipper is responsible for properly classifying, identifying, packaging, marking, labeling, and documenting shipments for transport by air or ground. Training and compliance with the regulations are not optional; they are the legal requirements under the U.S Department of Transportation.

Categories of regulated materials include:

- Infectious substances: Substances known or reasonably expected to contain pathogens. Pathogens are defined as microorganisms, including bacteria, viruses, rickettsiae, parasites, fungi, and other agents such as prions, which can cause disease in humans and/or animals. This category also includes diagnostic or clinical (patient) specimens.
- Plant and insect pathogens, and microorganisms that are not pathogenic to humans or animals are excluded from dangerous goods regulations. However, permits issued by the US Department of Agriculture/Animal Plant Health Inspection Service (USDA/APHIS) may still be required even if transportation regulations do not apply
- Biological Products: Products derived from living organisms that are used for prevention, treatment, or diagnosis of disease in humans or animals. They can include finished or unfinished products such as vaccines. If products are known or reasonably believed to contain infectious substances, the products must be shipped as such.

- Genetically modified microorganisms and organisms: Microorganisms and organisms in which genetic material has been purposely altered and meets the definition of an infectious substance, or can genetically modify other organisms, or are known to be dangerous to the environment, animals, or humans. Some genetically modified organisms that produce pharmaceutical or industrial products may be regulated by agencies such as USDA or Food and Drug Administration.

14.3.2 Permits for the Import and Export of Biological Materials

Permits issued by federal agencies such as the US Department of Agriculture or Centers for Disease Control and Prevention are required to import disease causing agents for humans, animals, vectors, plant pests, and animal and plant products. The Department of Commerce controls the export of certain microorganisms and toxins.

Agents Regulated by the Centers for Disease Control and Prevention for Import Agents of human disease and any materials, including live animals or insects which may contain them. Examples include:

- Any infectious agent known or suspected to cause disease in man.
- Unsterilized specimens of human and animal tissues (such as blood, body discharges, fluids, excretions or similar material) containing an infectious agent.
- Any animal known or suspected of being infected with an organism capable of causing disease transmissible to man. Importation of live turtles of less than 4 inches in shell length and all nonhuman primates requires an importation permit issued by the Division of Quarantine.
- All live bats require an import permit from the CDC and the U.S. Department of Interior, Fish and Wildlife Services.
- All live fleas, flies, lice, mites, mosquitoes, or ticks, regardless of infection status, including adult forms, as well as eggs, larvae, pupae, and nymph stages. Additionally, any other living insect or arthropod, known or suspected of being infected with any disease transmissible to man.
- Any snail species capable of transmitting a human pathogen.

For more information or to download a permit application, see the CDC Import Permit Program.

Agents Regulated by the United States Department of Agriculture/Animal and Plant Health Inspection Service for Import and Interstate Transport Import and interstate transport of materials that could potentially harm U.S. agricultural products including livestock, poultry, and crops. Examples include:

Animal-related materials that require an APHIS Import Permit include:

- Live animals, animal semen, and animal embryos from horses, birds, dogs, sheep, cattle, and fish.
- Foreign import or interstate transfer of infectious agents (bacteria, viruses, protozoa, and fungi) of animals, and vectors that might contain these infectious agents.
- Materials derived from animals or exposed to animal-source material including:
    - Animal tissues.
    - Blood, cells or cell lines of livestock or poultry origin.
    - RNA/DNA extracts.
    - Hormones or enzymes.
    - Monoclonal antibodies for in-vivo use in non-human species.
    - Certain polyclonal antibodies, antisera, and bulk shipments of test kit reagents.
- Various other animal materials such as dairy (except butter and cheese), and meat products (e.g., meat pies, prepared foods) from countries with livestock diseases exotic to the U.S.

Certain items do not need a USDA import permit, but will be reviewed at the port of entry by USDA inspectors.

Plant-related materials that are subject to Import and/or Interstate restrictions include:

- Bees and bee related articles.
- Biological control organisms.
- Butterflies and moths.
- Earthworms.
- Fruits and vegetables.
- Noxious weeds and parasitic plants.
- Plants and plant products.
- Plant pests.
- Snails and slugs.
- Soil.
- Wood products.
- *Genetically modified organisms (GMOs).*

The Biotechnology Regulatory Services regulates the field testing (confined release into the environment), interstate movement, and importation of genetically engineered organisms through the permit and notification processes. Included are:

- Genetically engineered plants and microorganisms.
- Transgenic arthropods.

GMOs that are not controlled or regulated may still be held at customs.

Department of Commerce

An export license may be required when exporting certain infectious agents of human, plant, and animal diseases, including genetic material, toxins, and products which might be used for culture of large amounts of agents. Consult the Commerce Department's Export Control webpage.

U.S. Fish and Wildlife

A permit may be required to import/export non-agricultural animal and plant species. These can include: CITES (Convention on International Trade in Endangered Species) plants and wildlife, migratory and wild birds, marine mammals, endangered and threatened species.

Food and Drug Administration
Food (exception of most meat and poultry - these are regulated by the USDA), drugs, biologics, cosmetics, medical devices, and electronic products that emit radiation, being imported or offered for import into the United States are regulated by the Food and Drug Administration.

14.4 Biological Safety Cabinets

Biological Safety Cabinets (BSC) are engineering devices that reduce the risk of working with biohazardous and infectious microorganisms. Cabinets are also used for maintaining aseptic conditions when working with cell cultures. BSCs utilize High Efficiency Particulate Air (HEPA) filters in the supply air and exhaust systems to create a nearly sterile work environment. Thus, BSCs provide personnel, environmental, and product protection when appropriate practices and procedures are followed.

14.4.1 Biological Safety Cabinet Certifications

All biological safety cabinets must be certified to ensure proper operation. Certification is required:

- Before a cabinet is put into service.
- After a cabinet has been repaired or relocated.
- After a filter has been replaced.
- At least annually.

This certification must be performed by a contractor that is trained to National Sanitation Foundation Standard No. 49.

Please note: EH&S does not certify biological safety cabinets.

It is the responsibility of the Principal Investigator or laboratory supervisor to ensure biological safety cabinets within laboratories under their supervision are certified annually.

14.4.2 BSC Work Practices and Procedures

The proper use of biological safety cabinets (BSC) can complement good microbiological practices, and result in effective containment and control of biohazardous and infectious agents. These general guidelines should be followed:

- Locate the BSC “deep” in the laboratory away from air currents produced by ventilation inlets, opening/closing of the laboratory door(s), and away from areas of heavy traffic. If possible, close laboratory doors, limiting entry and egress, and walking traffic during operation. Air currents and movements create turbulence that disrupts the protective envelope of the cabinet. Additionally, other nearby laboratory equipment such as centrifuges, vacuum pumps, etc. can affect the performance of the BSC. Cabinets should not be located directly opposite of each other or opposite a chemical fume hood, as laminar airflow will be hindered.
- Observe the magnehelic gauge and note its relative position each time you operate the BSC. The magnehelic gauge measures the pressure drop across the HEPA filters, and thus indicates filter load and integrity. A significant increase or decrease in the pressure over a short period of time may indicate clogging or leaking of the filter.
- Plan and prepare for your work in the cabinet by having a checklist of materials needed, and place those materials in the BSC before commencing work. This reduces the number of disruptions and arm movements across the air barrier of the cabinet, thereby preserving the protective envelope and containment properties. Slow movement of arms in and out of the cabinet will reduce the risk of potential contamination.

14.4.3 BSC Operational Procedures

1) Operate the cabinet blowers for at least five minutes before beginning work to allow the cabinet to purge or remove particulates from the cabinet.
2) Disinfect and ready the work area. Wipe the work surface, interior walls, and interior surface of the window with a suitable disinfectant such as 70% ethanol, or quaternary ammonium compound, and keep wet for at least 5 - 10 minutes.
3) Assemble material. Introduce only those items that are required to perform the procedures and arrange the items such that work “flows” from the least to the most contaminated item. Avoid having to reach for supplies or discard items outside of the cabinet. Consequently, place pipette discard trays (containing disinfectant), biohazard bags, sharps containers, etc. inside the BSC to the most contaminated side. Limited motion in and out of the cabinet preserves the protective envelope, and prevents the release of infectious materials outside of the BSC.
4) Don protective clothing. Wear laboratory coats or solid front gowns over street clothing, and long-cuffed latex or other appropriate gloves (e.g., nitrile,

vinyl). The cuffs of the gloves should be pulled up and over the cuffs of the coat sleeves.

5) Avoid rapid movements inside the cabinet, and perform procedures slowly to avoid disrupting the containment properties of the cabinet.
6) Do not block the front grille with papers, equipment, etc. as this may cause air to enter the workspace instead of flowing through the front grille and to the HEPA filter. Raise arms slightly, and perform operations in the middle third area of the work surface. Likewise, do not block the rear exhaust grille with any operations or equipment.
7) Avoid using open flames inside the cabinet as this can create turbulence and disrupt the pattern of air, and compromise the safety of the operator and affect product protection (i.e., cause contamination). Flames can also damage the interior of the cabinet and the HEPA filters, and in certain circumstances, cause explosions (especially when flammable materials such as ethanol are present). Reevaluate your procedures to determine if sterilization is required (e.g., it is not necessary to flame the necks of flasks). Use devices such as electric furnaces to sterilize any tools, or use disposable, sterile instruments. Lastly, if a burner is necessary, use a touch plate device that provides a flame on demand, and place it to the rear of the cabinet.
8) Connect suction or aspirator flasks to an overflow collection flask that contains a disinfectant (the aspirated materials can then be discarded down the sanitary sewer). Couple the flasks to an inline hydrophobic or HEPA filter designed to protect the vacuum system.
9) When the work is completed, remove all items within the cabinet. Do not use the interior of the BSC as a storage area since stray organisms may become “trapped” and contaminate the cabinet. Clean all the interior surfaces of the cabinet with a suitable disinfectant. Let the blowers operate for at least five minutes with no activity inside the cabinet, to purge the BSC of contaminants.
10) Investigators should remove their gowns and gloves and thoroughly wash their hands with soap and water before exiting the laboratory.

14.4.4 Use of Ultraviolet Lights in the BSC

Ultraviolet lights are a common accessory of many BSCs. These lamps are regarded as biocidal devices “protecting” the operator from exposure to infectious agents, and experimental materials from contamination. However, the actual effectiveness of UV light in providing this “sterile” environment is unclear. Additionally, there are potential occupational hazards that carry significant risks (e.g., serious eye and skin injury) associated with the use and misuse of these lamps. Ultraviolet lamps must be periodically tested to ensure that the energy output is adequate to kill microorganisms. The radiation output should be at least 40 microwatts/cm2 at 254 nm when measured with a UV flux meter placed in the center of the work surface. Dust that accumulates on the surface of the lamps (UV light is unable to penetrate through dust or other materials), can affect the output performance of the lamps. Microorganisms adhering to floating dust particles or other fixed objects are also “protected” and unaffected by UV illumination.

The effective life spans of the lamps are relatively short and the bulbs are expensive to replace. However, ultraviolet damage to the eyes and skin can occur well after the output of the lamps has dropped below the biocidal level. As a result, EH&S does not recommend the use of UV lights to maintain a clean working environment. Instead, a more effective strategy to reduce or eliminate contamination utilizes well-practiced microbiological procedures, good aseptic techniques, operational procedures as outlined in this manual, and thorough decontamination procedures before and after BSC use.

14.5 Biohazardous Waste (Regulated Medical Waste)

In New York State, the Department of Health (DOH) defines biohazardous or regulated medical waste (RMW) as "waste which is generated in the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, or in production and testing of biologicals". This includes:

- Cultures and stocks of agents infectious to humans (including human, primate, and mammalian cell lines), associated biologicals (e.g., serums, vaccines), and culture dishes and devices used to transfer, inoculate or mix cultures (e.g., Petri dishes, vials, flasks, inoculation loops, disposable gloves).
- Human pathological wastes including tissue, organs, and body parts, and specimens of body fluids and their containers
- Human blood and blood products.
- Sharps such as syringes and needles, razor blades, scalpels, blood vials, etc.
- Animal wastes including carcasses, body parts, body fluids, blood, or bedding originating from animals known to be contaminated with (zoonotic organisms) or intentionally inoculated with infectious agents.

14.5.1 Hypodermic Syringes and Needles

All users of hypodermic syringes and needles must comply with New York State Department of Health regulations, and are responsible for appropriate procurement, storage, and distribution.

- All non-medical and non-veterinary use of syringes and needles (e.g., teaching, research) require a Department of Health Certificate of Need. Generally, individual academic departments at Ithaca College possess Certificates that cover all members within the respective department (please consult with your administrative manager or department chair).
- The Principal Investigator or supervisor of the laboratory or work area should assign an individual (i.e., custodian) who is responsible for the storage, security, and maintaining records of purchases and distribution.
- Individual users are responsible for securing hypodermic syringes and needles not in use in a locked drawer or cabinet, and maintaining a written log of use and distribution.

- Follow the guidelines for disposal in one of the waste segregation and disposal tables.

15.0 Radiation Hazards

Ionizing radiation is a form of energy. Unlike some other types of energy, such as heat (infrared radiation) or visible light, the human body cannot sense exposure to ionizing radiation. Nonetheless, absorption of ionizing radiation energy by body tissues causes changes to the chemical makeup of living cells.

The type and thickness of material needed to make an effective barrier or shield around a source of ionizing radiation varies a great deal depending on the type of ionizing radiation. Beta radiation is a stream of tiny charged particles that can be stopped by a thin layer of plastic, glass, wood, metal and most other common materials. X-rays and Gamma rays are very similar to sunlight in that they are not particles, just electromagnetic waves. While sunlight will pass through only a few materials, such as window glass, X-rays and Gamma rays penetrate easily through most materials. However, even they can be blocked by a sufficient thickness of lead.

Ionizing radiation is also similar to other forms of radiation in that the intensity of the radiation exposure decreases very quickly as you move away from the radiation source. Just as moving a short distance closer to or farther from a fireplace causes a large change in how warm you feel; keeping just a few feet away from where someone is handling radioactive material will almost eliminate your exposure.

15.1 Where Ionizing Radiation is Used

Ionizing radiation can also be produced by certain electrical equipment, including X-ray machines and particle accelerators. Radiation levels produced by this equipment are also very low because of shielding.

You can tell if a room contains a source of ionizing radiation because each entrance is plainly marked by warning labels. Within the room, additional labels and warning tape will be found on each piece of radiation producing equipment and on all areas used to work with or store radioactive material.

15.2 Potential Hazards

Like any form of energy, ionizing radiation can be harmful if a person is exposed to an excessive amount. Exposure to ionizing radiation causes chemical damage to body tissues and can be harmful. Just as with exposure to any toxic chemical, the human body can tolerate exposure to ionizing radiation up to a point without producing any immediate injury. However, just as with toxic chemicals, high levels of exposure can cause serious injuries including skin burns, hair loss, internal bleeding, anemia and immune system suppression. In addition, exposure to high levels of ionizing radiation has been proven to cause an increased lifetime risk of cancer.

15.3 How to Protect Yourself

Responsibility for protecting themselves, co-workers and others from exposure to ionizing radiation is delegated by the Radiation Safety Committee to the Principal

Investigator or area supervisor and to each of the individual users. Appropriate safety requirements, that are specific to each use and location, are written into each approval granted by the Committee. Every user is trained in radiation safety principles and on the specific safety requirements of their operations before they are allowed to begin working with radioactive material.

Other individuals in these areas, who are not trained to use radioactive material or radiation producing equipment, need to follow the safety procedures established for those working with ionizing radiation. Primarily this means:

1) Never operate equipment that produces ionizing radiation.
2) Never handle items or containers that are labeled with radioactive material warnings or that are within areas marked as storage or use areas for radioactive material

15.4 Control of Ionizing Radiation

All use of material or equipment that produces ionizing radiation requires prior approval by the Ithaca College Radiation Safety Committee. This group of faculty members set policies and personally reviews each operation to ensure safety and compliance with state and federal regulations. The College Radiation Safety Officer and EH&S provide training and other services to help individuals work safely. In addition, they perform routine inspections of all use areas and require correction of all violations of radiation safety requirements. Detailed information on the college radiation safety program is available in the Ithaca College Radiation Safety Manual.

The performance of the Itahca College Radiation Safety Program is reviewed continuously. The Radiation Safety Committee meets 2 times each year to keep policies up-to-date, resolve problems and compliance issues and to monitor the level of radiation exposure to individuals on campus. Historically, less than 1% of the individuals using ionizing radiation at Ithaca College receive more than 1% of the annual allowable dose limit. The Committee also audits EH&S programs and services. In addition, the New York State Department of Health performs an on campus assessment of our program every two years.

The information presented here is only a brief overview of how sources of ionizing radiation are used at Ithaca College. While Ithaca College has demonstrated that it has a solid and consistent safety program, it is important not to take safety for granted. If you have questions or concerns about the use of ionizing radiation where you work, you are entitled to answers and information. The Principal Investigator, area supervisor or any authorized user is willing and able to help you and you should feel free to speak with them. They understand that many individuals have never had formal training about radiation safety. If you need additional assistance or have any other questions, please contact EH&S at 274-3353.

16.0 Physical Hazards

In addition to the chemical hazards found in laboratories, there are also numerous physical hazards encountered by laboratory staff on a day-to-day basis. As with chemical hazards, having good awareness of these hazards, good preplanning, use of personal protective equipment and following basic safety rules can go a long way in preventing accidents involving physical hazards.

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.

16.1 Electrical Safety

Electricity travels in closed circuits, and its normal route is through a conductor. Shock occurs when the body becomes a part of the electric circuit. Electric shock can cause direct injuries such as electrical burns, arc burns, and thermal contact burns. It can also cause injuries of an indirect or secondary nature in which involuntary muscle reaction from the electric shock can cause bruises, bone fractures, and even death resulting from collisions or falls. Shock normally occurs in one of three ways. The person must be in contact with ground and must contact with:

- Both wires of the electric circuit, or
- One wire of the energized circuit and the ground, or
- A metallic part that has become energized by being in contact with an energized wire.

The severity of the shock received when a person becomes a part of an electric circuit is affected by three primary factors:

- The amount of current flowing through the body (measured in amperes).
- The path of the current through the body.
- The length of time the body is in the circuit
.

Other factors that may affect the severity of shock are the frequency of the current, the phase of the heart cycle when shock occurs, and the general health of the person prior to shock. The effects of an electrical shock can range from a barely perceptible tingle to immediate cardiac arrest. Although there are no absolute limits or even known values that show the exact injury from any given amperage, the table above shows the general relationship between the degree of injury and the amount of amperage for a 60-cycle hand-to-foot path of one second's duration of shock.

EFFECTS OF ELECTRIC CURRENT IN THE BODY

Current	**Reaction**
1 Milliampere	Perception level. Just a faint tingle.
5 Milliamperes	Slight shock felt. Average individual can let go. However, strong involuntary reactions to shocks in this range can lead to injuries.
6-30 Milliamperes	Milliamperes Painful shock. Muscular control lost.
50-150 Milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Individual cannot let go. Death is possible.
1,000-4,300 Milliamperes	Ventricular fibrillation. Muscular contraction and nerve damage occur. Death is most likely.
10,000- Milliamperes	Cardiac arrest, severe burns and probable death.

As this table illustrates, a difference of less than 100 milliamperes exists between a current that is barely perceptible and one that can kill. Muscular contraction caused by stimulation may not allow the victim to free himself/herself from the circuit, and the increased duration of exposure increases the dangers to the shock victim. For example, a current of 100 milliamperes for 3 seconds is equivalent to a current of 900 milliamperes applied for 0.03 seconds in causing fibrillation. The so-called low voltages can be extremely dangerous because, all other factors being equal, the degree of injury is proportional to the length of time the body is in the circuit. Simply put, low voltage does not mean low hazard.

In the event of an accident involving electricity, if the individual is down or unconscious, or not breathing: **CALL Ithaca College Police at 911 (274-3333 from a cell phone or off campus phone) immediately.** If an individual must be physically removed from an electrical source, it is always best to eliminate the power source first (i.e.: switch off the circuit breaker) but time, or circumstance may not allow this option - be sure to use a nonconductive item such as a dry board. Failure to think and react properly could make you an additional victim. If the individual is not breathing and you have been trained in CPR, have someone call Ithaca College Police and begin CPR IMMEDIATELY!

16.2 Common Electrical Hazards and Preventative Steps

Many common electrical hazards can be easily identified before a serious problem exists.

- Read and follow all equipment operating instructions for proper use. Ask yourself, "Do I have the skills, knowledge, tools, and experience to do this work safely?"
- Do not attempt electrical repairs unless you are a qualified electrical technician *assigned to perform electrical work by your supervisor. Qualified individuals* must receive training in safety related work practices and procedures, be able to recognize specific hazards associated with electrical energy, and be trained to understand the relationship between electrical hazards and possible injury. Fixed wiring may only be repaired or modified by Facilities Services.
- All electrical devices fabricated for experimental purposes must meet state and University construction and grounding requirements. Extension cords, power strips, and other purchased electrical equipment must be Underwriters Laboratories (UL) listed.
- Remove all jewelry before working with electricity. This includes rings, watches, bracelets, and necklaces.
- Determine appropriate personal protective equipment (PPE) based on potential hazards present. Before use, inspect safety glasses and gloves for signs of wear and tear, and other damage.
- Use insulated tools and testing equipment to work on electrical equipment. Use power tools that are double-insulated or that have Ground Fault Circuit Interrupters protecting the circuit. Do not use aluminum ladders while working with electricity; choose either wood or fiberglass.
- Do not work on energized circuits. The accidental or unexpected starting of electrical equipment can cause severe injury or death. Before any inspections or repairs are made, the current must be turned off at the switch box and the switch padlocked or tagged out in the off position. At the same time, the switch or controls of the machine or the other equipment being locked out of service should be securely tagged to show which equipment or circuits are being worked on. Test the equipment to make sure there is no residual energy before attempting to work on the circuit. Employees must follow the Ithaca College lock-out/tag-out procedures.
- If you need additional power supply, the best solution is to have additional outlets installed by Facilities Services. Do not use extension cords or power strips ("power taps") as a substitute for permanent wiring.
- Extension cords and power strips may be used for experimental or developmental purposes on a temporary basis only. Extension cords can only be used for portable tools or equipment and must be unplugged after use. Do not use extension cords for fixed equipment such as computers, refrigerators/freezers, etc.; use a power strip in these cases. In general, the use of power strips is preferred over use of extension cords.
- Power strips must have a built-in overload protection (circuit breaker) and must not be connected to another power strip or extension cord (commonly referred to as daisy chained or piggy-backed). As mentioned above though, extension cords and power strips are not a substitute for permanent wiring.

- Ensure any power strips or extension cords are listed by a third-party testing laboratory, such as Underwriters Laboratory (UL). Make sure the extension cord thickness is at least as big as the electrical cord for the tool.
- Inspect all electrical and extension cords for wear and tear. Pay particular attention near the plug and where the cord connects to the piece of equipment. If you discover a frayed electrical cord, contact your Lab Coordinator for assistance. Do not use equipment having worn or damaged power cords, plugs, switches, receptacles, or cracked casings. Running electrical cords under doors or rugs, through windows, or through holes in walls is a common cause of frayed or damaged cords and plugs.
- Do not use 2-prong ungrounded electrical devices. All department purchased electrical equipment must be 3-prong grounded with very limited exceptions.
- Never store flammable liquids near electrical equipment, even temporarily.
- Keep work areas clean and dry. Cluttered work areas and benches invite accidents and injuries. Good housekeeping and a well-planned layout of temporary wiring will reduce the dangers of fire, shock, and tripping hazards.
- Common scenarios that may indicate an electrical problem include: flickering lights, warm switches or receptacles, burning odors, sparking sounds when cords are moved, loose connections, and frayed, cracked, or broken wires. If you notice any of these problems, have a qualified electrician address the issue immediately.
- To protect against electrical hazards and to respond to electrical emergencies it is important to identify the electrical panels that serve each room. Access to these panels must be unobstructed; a minimum of 3’ of clearance is required in front of every electrical panel. Each panel must have all the circuit breakers labeled as to what they control.
- When performing laboratory inspections, it is a good idea to verify the location of the power panel and to open the door to ensure any breakers that are missing have breaker caps in its place. If no breaker is present and no breaker cap is covering the hole, contact your Building Coordinator for assistance.
- Avoid operating or working with electrical equipment in a wet or damp environment. If you must work in a wet or damp environment, be sure your outlets or circuit breakers are Ground Fault Circuit Interrupter (GFCI) protected. Temporary GFCI plug adapters can also be used, but are not a substitute for GFCI outlets or circuit breakers.
- Fuses, circuit breakers, and Ground-Fault Circuit Interrupters are three well-known examples of circuit protection devices.

    - Fuses and circuit breakers are over-current devices that are placed in circuits to monitor the amount of current that the circuit will carry. They automatically open or break the circuit when the amount of the current flow becomes excessive and therefore unsafe. Fuses are designed to melt when too much current flows through them. Circuit breakers, on the other hand, are designed to trip open the circuit by electro-mechanical means.
    - Fuses and circuit breakers are intended primarily for the protection of conductors and equipment. They prevent overheating of wires and components that might otherwise create hazards for operators.

  - The Ground Fault Circuit Interrupter (GFCI) is designed to shut off electric power within as little as 1/40 of a second, thereby protecting the person, not just the equipment. It works by comparing the amount of current going to an electric device against the amount of current returning from the device along the circuit conductors. A fixed or portable GFCI should be used in high-risk areas such as wet locations and construction sites.

- Entrances to rooms and other guarded locations containing exposed live parts must be marked with conspicuous warning signs forbidding unqualified persons to enter. Live parts of electric equipment operating at 50 volts or more must be guarded against accidental contact. Guarding of live parts may be accomplished by:
  - Location in a room, vault, or similar enclosure accessible only to qualified persons.
  - Use of permanent, substantial partitions or screens to exclude unqualified persons.
  - Location on a suitable balcony, gallery, or platform elevated and arranged to exclude unqualified persons, or
  - Elevation of 8 feet or more above the floor.

16.3 Safe Use of Electrophoresis Equipment

Electrophoresis units present several possible hazards including electrical, chemical, and radiological hazards. All of these hazards need to be addressed before using the units. EH&S has prepared these guidelines to assist researchers in safely operating electrophoresis units.

1) Proper Equipment Set-Up

Place electrophoresis units and their power supplies so that the on/off switch is easy to reach and the power-indicator lights are easily seen. Locate the equipment where it will not be easy to knock or trip over.

Because electrophoresis work involves handling conductive liquids around electricity, power supplies should be protected by Ground Fault Circuit Interrupters (GFCIs). GFCIs act as very sensitive circuit breakers and, in the event of a short circuit, will stop the power before it can hurt a person. You can identify GFCIs by their "test" and "reset" buttons. They are found on some outlets or breaker boxes. An adapter type, which plugs into a standard outlet and does not require installation by an electrician, can be purchased at local hardware stores at prices starting at $10.

2) Addressing Electrical Hazards

Electrophoresis units use very high voltage (approximately 2000 volts) and potentially hazardous current (80 milliamps or more). This high power output has the potential to cause a fatal electrical shock if not properly handled. Routinely inspect electrophoresis units and their power supplies to ensure they are working properly. Power supplies should be inspected to ensure that all switches and lights

are in proper working condition, that power cords and leads are undamaged and properly insulated, and that "Danger--High Voltage" warning signs are in place on the power supply and buffer tanks. You can download free High Voltage labels from the EH&S.
Inspect the buffer tanks for cracks or leaks, exposed connectors, or missing covers. If your units have such hazards, replace the units with new models that have these safety features built in, or contact EH&S

16.3.1 Training and Work Procedures

Principal Investigators are responsible for providing instruction on the safe use of electrophoresis units to those in the laboratory who work with them. The instruction should cover the operating procedures written by the manufacturer or laboratory, as well as the associated hazards, the correct personal protective equipment, and applicable emergency procedures. As with all safety training, this instruction should be documented. Employees must wear all appropriate personal protective equipment when working with electrophoresis units, including lab coats, gloves, and eye protection.

Do not leave electrophoresis units unattended for long periods of time since unauthorized persons may accidentally come in contact with the unit, or the buffer tank liquid may evaporate, resulting in a risk of fire. Laboratories that perform electrophoresis work during off hours should consider using a "buddy system" to ensure that emergency services can be notified if someone is injured or exposed. It is also recommended that laboratory personnel be trained in CPR and in First Aid. EH&S provides CPR and First Aid.

16.4 Machine Guarding

Safeguards are essential for protecting workers from needless and preventable machinery-related injuries. The point of operation, as well as all parts of the machine that move while the machine is working, must be safeguarded. A good rule to remember is: *Any machine part, function, or process which may cause injury, must be safeguarded.*

Moving machine parts have the potential for causing severe workplace injuries, such as crushed fingers or hands, amputations, burns, or blindness. Safeguards are essential for protecting workers from these needless and preventable injuries. When the operation of a machine or accidental contact with it can injure the operator or others in the vicinity, the hazards must be either eliminated or controlled.

16.4.1 Requirements for safeguards:

Prevent contact - prevent worker’s body or clothing from contacting hazardous moving parts.

- Secure - must be firmly secured to the machine and not easily removed.

- Protect from falling objects - ensure that no objects can fall into moving parts.
- Create no new hazards - must not have shear points, jagged edges or unfinished surfaces.
- Create no interference - must not prevent worker from performing the job quickly and comfortably.
- Allow safe lubrication - if possible, be able to lubricate the machine without removing the safeguards.

16.4.2 Machine Safety Responsibilities

The following responsibilities are assigned to employees as follows:

Management

- Ensure all machinery is properly guarded.

Supervisors

- Train employees on specific machine guarding rules in their areas.
- Ensure machine guards remain in place and are functional.
- Immediately correct machine guard deficiencies.

Employees

- Do not remove guards unless machine is locked and tagged out.
- Report machine guard problems to supervisors immediately.
- Do not operate equipment unless guards are in place.

Operators should receive the following training:

- Hazards associated with particular machines.
- How the safeguards provide protection and the hazards for which they are intended.
- How and why to use the safeguards.
- How and when safeguards can be removed and by whom.
- What to do if a safeguard is damaged, missing, or unable to provide adequate protection.

Hazards to machine operators that can't be designed around must be shielded to protect the operator from injury or death. Guards, decals and labels which identify the danger must be kept in place whenever the machine is operated.
Guards or shields removed for maintenance must be properly replaced before use. Moving parts present the greatest hazard because of the swiftness of their action and unforgiving and relentless motion.

16.4.3 Common Machine Hazards

Common machine hazards occurring around moving parts include:

1) **Pinch Points**

Where two parts move together and at least one of the parts moves in a circle; also called mesh points, run-on points, and entry points. Examples include: Belt drives, chain drives, gear drives, and feed rolls.

When shields cannot be provided, operators must avoid contact with hands or clothing in pinch point areas. Never attempt to service or unclog a machine while it is operating or the engine is running.

2) **Wrap Points**

Any exposed component that rotates.
Examples include: Rotating shafts such as a PTO shaft or shafts that protrude beyond bearings or sprockets. Watch components on rotating shafts, such as couplers, universal joints, keys, keyways, pins, or other fastening devices. Splined, square, and hexagon-shaped shafts are usually more dangerous than round shafts because the edges tend to grab fingers or clothing more easily than a round shaft, but round shafts may not be smooth and can also grab quickly. Once a finger, thread, article of clothing, or hair is caught it begins to wrap; pulling only causes the wrap to become tighter.

3) **Shear Points**

Where the edges of two moving parts move across one another or where a single sharp part moves with enough speed or force to cut soft material. Remember that crop cutting devices cannot be totally guarded to keep hands and feet out and still perform their intended function. Recognize the potential hazards of cutting and shear points on implements and equipment that are not designed to cut or shear. Guarding may not be feasible for these hazards.

4) **Crush Points**

Points that occur between two objects moving toward each other or one object moving toward a stationary object. Never stand between two objects moving toward one another. Use adequate blocking or lock-out devices when working under equipment.

5) **Pull-In Points**

Points where objects are pulled into equipment, usually for some type of processing. Machines are faster and stronger than people. Never attempt to hand-feed materials into moving feed rollers. Always stop the equipment before attempting to remove an item that has plugged a roller or that has become wrapped around a rotating shaft. Remember that guards cannot be provided for all situations - equipment must be able to function in the capacity for which it is designed. Freewheeling parts, rotating or moving parts that continue to move after the power is shut off are particularly dangerous because time delays are necessary before service can begin. Allow sufficient time for freewheeling parts to stop moving. Stay alert! Listen and Watch for Motion!

6) Thrown Objects

Any object that can become airborne because of moving parts. Keep shields in place to reduce the potential for thrown objects. Wear protective gear such as goggles to reduce the risk of personal injury if you cannot prevent particles from being thrown. All guards, shields or access doors must be in place when equipment is operating. Electrically powered equipment must have a lockout control on the switch or an electrical switch, mechanical clutch or other positive shut-off device mounted directly on the equipment. Circuit interruption devices on an electric motor, such as circuit breakers or overload protection, must require manual reset to restart the motor.

16.5 Lighting

Having a properly lighted work area is essential to working safely. A couple of key points to remember about proper lighting:

- Lighting should be adequate for safe illumination of all work areas (100- 200 lumens for laboratories). For more information, see the PDC Design and Construction Standard 16500 – Lighting.
- Light bulbs that are mounted low and susceptible to contact should be guarded.
- If the risk of electrocution exists when changing light bulbs, practice lockout tag-out.
- For proper disposal of fluorescent bulbs (“universal waste”), see light bulb recycling.
- As an energy conservation measure, please remember to turn off your lights when you leave your lab.

16.6 Compressed Gases

Compressed gases are commonly used in laboratories for a number of different operations. While compressed gases are very useful, they present a number of hazards for the laboratory worker:

- Gas cylinders may contain gases that are flammable, toxic, corrosive, asphyxiants, or oxidizers.
- Unsecured cylinders can be easily knocked over, causing serious injury and damage. Impact can shear the valve from an uncapped cylinder, causing a catastrophic release of pressure leading to personal injury and extensive damage.
- Mechanical failure of the cylinder, cylinder valve, or regulator can result in rapid diffusion of the pressurized contents of the cylinder into the atmosphere; leading to explosion, fire, runaway reactions, or burst reaction vessels.

16.6.1 Handling Compressed Gas Cylinders

There are a number of ways that compressed gases can be handled safely. Always practice the following when handling compressed gases:

- The contents of any compressed gas cylinder must be clearly identified. Such identification should be stenciled or stamped on the cylinder or a label or tag should be attached. Do not rely on the color of the cylinder for identification because color-coding is not standardized and may vary with the manufacturer or supplier.
- When transporting cylinders:
    - Always use a hand truck equipped with a chain or belt for securing the cylinder.
    - Make sure the protective cap covers the cylinder valve.
    - Never transport a cylinder while a regulator is attached.
    - Always use caution when transporting cylinders – cylinders are heavy.

- Avoid riding in elevators with compressed gas cylinders. If this is necessary, consider using a buddy system to have one person send the properly secured cylinders on the elevator, while the other person waits at the floor by the elevator doors where the cylinders will arrive.
- Do not move compressed gas cylinders by carrying, rolling, sliding, or dragging them across the floor.
- Do not transport oxygen and combustible gases at the same time.
- Do not drop cylinders or permit them to strike anything violently.

16.6.2 Safe Storage of Compressed Gas Cylinders

Procedures to follow for safe storage of compressed gas cylinders include:

- Gas cylinders must be secured to prevent them from falling over. Chains are recommended over clamp-plus-strap assemblies due to the hazards involved in a fire and straps melting or burning. Be sure the chain is high enough (at least half way up) on the cylinder to keep it from tipping over.
- Do not store incompatible gases right next to each other. Cylinders of oxygen must be stored at least 20 feet away from cylinders of hydrogen or other flammable gas, or the storage areas must be separated by a firewall five feet high with a fire rating of 1/2 hour.
- All cylinders should be stored away from heat and away from areas where they might be subjected to mechanical damage.
- Keep cylinders away from locations where they might form part of an electrical circuit, such as next to electric power panels or electric wiring.

- The protective cap that comes with a cylinder of gas should always be left on the cylinder when it is not in use. The cap keeps the main cylinder valve from being damaged or broken.

16.6.3 Operation of Compressed Gas Cylinders

The cylinder valve hand wheel opens and closes the cylinder valve. The pressure relief valve is designed to keep a cylinder from exploding in case of fire or extreme temperature. Cylinders of very toxic gases do not have a pressure relief valve, but they are constructed with special safety features. The valve outlet connection is the joint used to attach the regulator. The pressure regulator is attached to the valve outlet connector in order to reduce the gas flow to a working level. The Compressed Gas Association has intentionally made certain types of regulators incompatible with certain valve outlet connections to avoid accidental mixing of gases that react with each other. Gases should always be used with the appropriate regulator. Do not use adaptors with regulators. The cylinder connection is a metal-to-metal pressure seal. Make sure the curved mating surfaces are clean before attaching a regulator to a cylinder. Do not use Teflon tape on the threaded parts, because this may actually cause the metal seal not to form properly. Always leak test the connection.

<u>Basic operating guidelines include:</u>

1) Make sure that the cylinder is secured.
2) Attach the proper regulator to the cylinder. If the regulator does not fit, it may not be suitable for the gas you are using.
3) Attach the appropriate hose connections to the flow control valve. Secure any tubing with clamps so that it will not whip around when pressure is turned on. Use suitable materials for connections; toxic and corrosive gases require connections made of special materials.
4) Install a trap between the regulator and the reaction mixture to avoid backflow into the cylinder.
5) To prevent a surge of pressure, turn the delivery pressure adjusting screw counterclockwise until it turns freely and then close the flow control valve.
6) Slowly open the cylinder valve hand wheel until the cylinder pressure gauge reads the cylinder pressure.
7) With the flow control valve closed, turn the delivery pressure screw clockwise until the delivery pressure gauge reads the desired pressure.
8) Adjust the gas flow to the system by using the flow control valve or another flow control device between the regulator and the experiment.
9) After an experiment is completed, turn the cylinder valve off first, and then allow gas to bleed from the regulator. When both gauges read “zero”, remove the regulator and replace the protective cap on the cylinder head.
10) When the cylinder is empty, mark it as “Empty”, and store empty cylinders separate from full cylinders.
11) Attach a “Full/In Use/Empty” tag to all of your cylinders, these tags are perforated and can be obtained from the gas cylinder vendor.

Precautions to follow:

- Use a regulator only with gas for which it is intended. The use of adaptors or homemade connectors has caused serious and even fatal accidents.
- Toxic gases should be purchased with a flow-limiting orifice.
- When using more than one gas, be sure to install one-way flow valves from each cylinder to prevent mixing. Otherwise accidental mixing can cause contamination of a cylinder.
- Do not attempt to put any gas into a commercial gas cylinder.
- Do not allow a cylinder to become completely empty. Leave at least 25 psi of residual gas to avoid contamination of the cylinder by reverse flow.
- Do not tamper with or use force on a cylinder valve.

16.6.4 Return of Cylinders

- Disposal of cylinders and lecture bottles is expensive, especially if the contents are unknown.
- Make sure that all cylinders and lecture bottles are labeled and included in your chemical inventory. Before you place an order for a cylinder or lecture bottle, determine if the manufacturer will take back the cylinder or lecture bottle when it becomes empty. If at all possible, only order from manufacturers who will accept cylinders or lecture bottles for return.

16.6.5 Hazards of Specific Gases

1) Inert Gases

- Examples: Helium, Argon, Nitrogen.
- Can cause asphyxiation by displacing the air necessary for the support of life.
- Cryogens are capable of causing freezing burns, frostbite, and destruction of tissue.

2) Cryogenic Liquids

- Cryogenic liquids are extremely cold and their vapors can rapidly freeze human tissue.
- Boiling and splashing will occur when the cryogen contacts warm objects.
- Can cause common materials such as plastic and rubber to become brittle and fracture under stress.
- Liquid to gas expansion ratio: one volume of liquid will vaporize and expand to about 700 times that volume, as a gas, and thus can build up tremendous pressures in a closed system. Therefore dispensing areas need to be well ventilated. Avoid storing cryogenics in cold rooms, environmental chambers, and other areas with poor ventilation. If necessary, install an oxygen monitor/oxygen deficiency alarm and/or toxic gas monitor before working these materials in confined areas.

3) **Oxidizers**
   - Examples: Oxygen, Chlorine.
   - Oxidizers vigorously accelerate combustion; therefore keep away from all flammable and organic materials. Greasy and oily materials should never be stored around oxygen. Oil or grease should never be applied to fittings or connectors.

4) **Flammable Gases**
   - Examples: Methane, Propane, Hydrogen, Acetylene.
   - Flammable gases present serious fire and explosion hazards.
   - Do not store near open flames or other sources of ignition.
   - Cylinders containing Acetylene should never be stored on their side.

   - Flammable gases are easily ignited by heat, sparks, or flames, and may form explosive mixtures with air. Vapors from liquefied gas often are heavier than air, and may spread along ground and travel to a source of ignition and result in a flashback fire.

5) **Corrosive Gases**
   - Examples: Chlorine, Hydrogen Chloride, Ammonia
   - There can be an accelerated corrosion of materials in the presence of moisture.
   - Corrosive gases readily attack the skin, mucous membranes, and eyes. Some corrosive gases are also toxic.
   - Due to the corrosive nature of the gases, corrosive cylinders should only be kept on hand for 6 months (up to one year maximum). Only order the smallest size needed for your experiments.

6) **Poison Gases**
   - Examples: Arsine, Phosphine, Phosgene.
   - Poison gases are extremely toxic and present a serious hazard to laboratory staff.
   - Poisonous gases require special ventilation systems and equipment and must only be used by properly trained experts. There are also special building code regulations that must be followed with regard to quantities kept on hand and storage.
   - The purchase and use of poisonous gases require prior approval from EH&S.

16.7 Battery Charging

Lead acid batteries contain corrosive liquids and also generate Hydrogen gas during charging which poses an explosion hazard. The following guidelines should be followed for battery charging areas:

- A “No smoking” sign should be posted.
- Before working, remove all jewelry from hands and arms and any dangling jewelry to prevent accidental contact with battery connections (this can cause sparks which can ignite vapors).
- Always wear appropriate PPE such as rubber or synthetic aprons, splash goggles (ideally in combination with a face shield), and thick Neoprene, Viton, or Butyl gloves.
- A plumbed emergency eyewash station must be readily available near the station (please note, hand held eyewash bottles do not meet this criteria).
- A class B rated fire extinguisher needs to be readily available. If none is available, contact EH&S at 274-3353.
- Ensure there is adequate ventilation available to prevent the buildup of potentially flammable and explosive gases.
- Keep all ignition sources away from the area.
- Stand clear of batteries while charging.
- Keep vent caps tight and level.
- Only use the appropriate equipment for charging.
- Store unused batteries in secondary containment to prevent spills.
- Have an acid spill kit available. The waste from a spill may contain lead and neutralized wastes may be toxic. Contact EH&S for hazardous waste disposal.
- Properly dispose of your used batteries.

16.8 Heat and Heating Devices

Heat hazards within laboratories can occur from a number of sources; however, there are some simple guidelines that can be followed to prevent heat related injuries. These guidelines include:

- Heating devices should be set up on a sturdy fixture and away from any ignitable materials (such as flammable solvents, paper products and other combustibles). Do not leave open flames (from Bunsen burners) unattended.
- Heating devices should not be installed near drench showers or other water spraying apparatus due to electrical shock concerns and potential splattering of hot water.
- Heating devices should have a backup power cutoff or temperature controllers to prevent overheating. If a backup controller is used, an alarm should notify the user that the main controller has failed.
- Provisions should be included in processes to make sure reaction temperatures do not cause violent reactions and a means to cool the dangerous reactions should be available.
- Post signs to warn people of the heat hazard to prevent burns.

When using **ovens**, the follow additional guidelines should be followed:

- Heat generated should be adequately removed from the area.

- If toxic, flammable, or otherwise hazardous chemicals are evolved from the oven, then only use ovens with a single pass through design where air is ventilated out of the lab and the exhausted air is not allowed to come into contact with electrical components or heating elements.
- Heating flammables should only be done with a heating mantle or steam bath.

When using **heating baths**, these additional guidelines should be followed:

- Heating baths should be durable and set up with firm support. Since combustible liquids are often used in heat baths, the thermostat should be set so the temperature never rises above the flash point of the liquid. Check the MSDS for the chemical to determine the flashpoint. Compare that flashpoint with the expected temperature of the reaction to gauge risk of starting a fire.

16.9 Autoclaves

Autoclaves have the following potential hazards:

- Heat, steam, and pressure.
- Thermal burns from steam and hot liquids.
- Cuts from exploding glass.

Some general safety guidelines to follow when using autoclaves:

- All users should be given training in proper operating procedures for using the autoclave.
- Read the owner’s manual before using the autoclave for the first time.
- Operating instructions should be posted near the autoclave.
- Follow the manufacturer’s directions for loading the autoclave.
- Be sure to close and latch the autoclave door.
- Some kinds of bottles containing liquids can crack in the autoclave, or when they are removed from the autoclave. Use a tray to provide secondary containment in case of a spill, and add a little water to the tray to ensure even heating.
- Only fill bottles half way to allow for liquid expansion and loosen screw caps on bottles and tubes of liquid before autoclaving, to prevent them from shattering.
- Do not overload the autoclave compartment and allow for enough space between items for the steam to circulate.
- Be aware that liquids, especially in large quantities, can be superheated when the autoclave is opened. Jarring them may cause sudden boiling, and result in burns.
- At the end of the run, open the autoclave slowly: first open the door only a crack to let any steam escape slowly for several minutes, and then open all the way. Opening the door suddenly can scald a bare hand, arm, or face.
- Wait at least five minutes after opening the door before removing items.

- Large flasks or bottles of liquid removed immediately from the autoclave can cause serious burns by scalding if they break in your hands. Immediately transfer hot items with liquid to a cart; never carry in your hands.
- Wear appropriate PPE, including eye protection and insulating heat resistant gloves.

16.10 Centrifuges

Some general safety guidelines to follow when using centrifuges:

- Be familiar with the operating procedures written by the manufacturer. Keep the operating manual near the unit for easy reference. If necessary contact the manufacturer to replace lost manuals.
- Handle, load, clean, and inspect rotors as recommended by the manufacturer.
- Pay careful attention to instructions on balancing samples -- tolerances for balancing are often very restricted. Check the condition of tubes and bottles. Make sure you have secured the lid to the rotor and the rotor to the centrifuge.
- Maintain a logbook of rotor use for each rotor, recording the speed and length of time for each use.
- To avoid catastrophic rotor failure, many types of rotors must be "derated" (limited to a maximum rotation speed that is less than the maximum rotation speed specified for the rotor when it is new) after a specified amount of use, and eventually taken out of service and discarded.
- Use only the types of rotors that are specifically approved for use in a given centrifuge unit.
- Maintain the centrifuge in good condition. Broken door latches and other problems should be repaired before using the centrifuge.
- Whenever centrifuging biohazardous materials, always load and unload the centrifuge rotor in a Biosafety cabinet.

16.10.1 Centrifuge Rotor Care

Basic centrifuge rotor care includes:

- Keep the rotor clean and dry, to prevent corrosion.
- Remove adapters after use and inspect for corrosion.
- Store the rotor upside down, in a warm, dry place to prevent condensation in the tubes.
- Read and follow the recommendations in the manual regarding:
    - Regular cleaning.
    - Routine inspections.
    - Regular polishing.
    - Lubricating O-rings.
    - Decontaminating the rotor after use with radioactive or biological materials.

- Remove any rotor from use that has been dropped or shows any sign of defect, and report it to a manufacturer's representative for inspection.

16.11 Cryogenic Safety

A cryogenic gas is a material that is normally a gas at standard temperature and pressure, but which has been super cooled such that it is a liquid or solid at standard pressure. Commonly used cryogenic materials include the liquids nitrogen, argon, and helium, and solid carbon dioxide (dry ice).

Hazards associated with direct personal exposure to cryogenic fluids include:

- Frostbite - Potential hazards in handling liquefied gases and solids result because they are extremely cold and can cause severe cold contact burns by the liquid, and frostbite or cold exposure by the vapor.
- Asphyxiation - The ability of the liquid to rapidly convert to large quantities of gas associated with evaporation of cryogenic liquid spills can result in asphyxiation. For instance, nitrogen expands approximately 700 times in volume going from liquid to gas at ambient temperature. Total displacement of oxygen by another gas, such as Carbon dioxide, will result in unconsciousness, followed by death. Exposure to oxygen deficient atmospheres may produce dizziness, nausea, vomiting, loss of consciousness, and death. Such symptoms may occur in seconds without warning. Death may result from errors in judgment, confusion, or loss of consciousness that prevents self-rescue.

  Working with cryogenic substances in confined spaces, such as walk-in coolers, can be especially hazardous. Where cryogenic materials are used, a hazard assessment is required to determine the potential for an oxygen-deficient condition. Controls such as ventilation and/or gas detection systems may be required to safeguard employees. Asphyxiation and chemical toxicity are hazards encountered when entering an area that has been used to store cryogenic liquids if proper ventilation/purging techniques are not employed.

- Toxicity - Many of the commonly used cryogenic gases are considered to be of low toxicity, but still pose a hazard from asphyxiation. Check the properties of the gases you are using, because some gases are toxic, for example, Carbon monoxide, Fluorine, and Nitrous oxide.
- Flammability and Explosion Hazards - Fire or explosion may result from the evaporation and vapor buildup of flammable gases such as hydrogen, carbon monoxide, or methane. Liquid oxygen, while not itself a flammable gas, can combine with combustible materials and greatly accelerate combustion. Oxygen clings to clothing and cloth items, and presents an acute fire hazard.
- High Pressure Gas Hazards - Potential hazards exist in highly compressed gases because of the stored energy. In cryogenic systems, high pressures are obtained by gas compression during refrigeration, by pumping of liquids to high pressures followed by rapid evaporation, and by confinement of cryogenic fluids with

subsequent evaporation. If this confined fluid is suddenly released through a rupture or break in a line, a significant thrust may be experienced. Over-pressurization of cryogenic equipment can occur due to the phase change from liquid to gas if not vented properly. All cryogenic fluids produce large volumes of gas when they vaporize.

- Materials and Construction Hazards - The selection of materials calls for consideration of the effects of low temperatures on the properties of those materials. Some materials become brittle at low temperatures. Brittle materials fracture easily and can result in almost instantaneous material failure. Low temperature equipment can also fail due to thermal stresses caused by differential thermal contraction of the materials. Over pressurization of cryogenic equipment can occur due to the phase change from liquid to gas if not vented properly. All cryogenic fluids produce large volumes of gas when they vaporize.

16.11.1 Cryogenic Safety Guidelines

1) Responsibilities

Personnel who are responsible for any cryogenic equipment must conduct a safety review prior to the commencement of operation of the equipment. Supplementary safety reviews must follow any system modification to ensure that no potentially hazardous condition is overlooked or created and that updated operational and safety procedures remain adequate.

2) Personal Protective Equipment

Wear the appropriate PPE when working with cryogenic materials. Face shields and splash goggles must be worn during the transfer and normal handling of cryogenic fluids. Loose fitting, heavy leather or other insulating protective gloves must be worn when handling cryogenic fluids. Shirt sleeves should be rolled down and buttoned over glove cuffs, or an equivalent protection such as a lab coat, should be worn in order to prevent liquid from spraying or spilling inside the gloves. Trousers without cuffs should be worn.

3) Safety Practices

- Cryogenic fluids must be handled and stored only in containers and systems specifically designed for these products and in accordance with applicable standards, procedures, and proven safe practices.
- Transfer operations involving open cryogenic containers such as dewars must be conducted slowly to minimize boiling and splashing of the cryogenic fluid. Transfer of cryogenic fluids from open containers must occur below chest level of the person pouring the liquid.
- Only conduct such operations in well-ventilated areas, such as the laboratory, to prevent possible gas or vapor accumulation that may produce an oxygen-deficient atmosphere and lead to asphyxiation. If this is not possible, an oxygen meter must be installed.

- Equipment and systems designed for the storage, transfer, and dispensing of cryogenic fluids need to be constructed of materials compatible with the products being handled and the temperatures encountered.
- All cryogenic systems including piping must be equipped with pressure relief devices to prevent excessive pressure build-up. Pressure reliefs must be directed to a safe location. It should be noted that two closed valves in a line form a closed system. The vacuum insulation jacket should also be protected by an over pressure device if the service is below 77 degrees Kelvin. In the event a pressure relief device fails, do not attempt to remove the blockage; instead, call EH&S.
- The caps of liquid nitrogen dewars are designed to fit snugly to contain the liquid nitrogen, but also allow the periodic venting that will occur to prevent an over pressurization of the vessel. Do not ever attempt to seal the caps of liquid nitrogen dewars. Doing so can present a significant hazard of over pressurization that could rupture the container and cause splashes of liquid nitrogen and, depending on the quantity of liquid nitrogen that may get spilled, cause an oxygen deficient atmosphere within a laboratory due to a sudden release and vaporization of the liquid nitrogen.
- If liquid nitrogen or helium traps are used to remove condensable gas impurities from a vacuum system that may be closed off by valves, the condensed gases will be released when the trap warms up. Adequate means for relieving resultant build-up of pressure must be provided.

4) <u>First Aid</u>

Workers will rarely, if ever, come into contact with cryogenic fluids if proper handling procedures are used. In the unlikely event of contact with a cryogenic liquid or gas, a contact “burn” may occur. The skin or eye tissue will freeze. The recommended emergency treatment is as follows:

- If the cryogenic fluid comes in contact with the skin or eyes, flush the affected area with generous quantities of cold water. Never use dry heat. Splashes on bare skin cause a stinging sensation, but, in general, are not harmful.
- If clothing becomes soaked with liquid, it should be removed as quickly as possible and the affected area should be flooded with water as above. Where clothing has frozen to the underlying skin, cold water should be poured on the area, but no attempt should be made to remove the clothing until it is completely free.
- Seek medical attention if necessary and complete an Injury/Illness Report.

16.11.2 Cryogenic Chemical Specific Information

A. Liquid Helium

Liquid helium must be transferred via helium pressurization in properly designed transfer lines. A major safety hazard may occur if liquid helium comes in contact with air. Air solidifies in contact with liquid helium, and precautions must be taken when transferring liquid helium from one vessel to another or when venting. Over-pressurization and rupture of the container may result. All liquid helium containers must be equipped with a pressure-relief device. The latent heat of vaporization of liquid helium is extremely low (20.5 J/gm); therefore, small heat leaks can cause rapid pressure rises.

B. Liquid Nitrogen

Since the boiling point of liquid nitrogen is below that of liquid oxygen, it is possible for oxygen to condense on any surface cooled by liquid nitrogen. If the system is subsequently closed and the liquid nitrogen removed, the evaporation of the condensed oxygen may over-pressurize the equipment or cause a chemical explosion if exposed to combustible materials, e.g., the oil in a rotary vacuum pump. In addition, if the mixture is exposed to radiation, ozone is formed, which freezes out as ice and is very unstable. An explosion can result if this ice is disturbed. For this reason, air should not be admitted to enclosed equipment that is below the boiling point of oxygen unless specifically required by a written procedure.

Any transfer operations involving open containers such as wide-mouth Dewars must be conducted slowly to minimize boiling and splashing of liquid nitrogen. The transfer of liquid nitrogen from open containers must occur below chest level of the person pouring the liquid.

C. Liquid Hydrogen

- Anyone proposing the use of liquid hydrogen must first obtain prior approval of EH&S.
- Because of its wide flammability range and ease of ignition, special safety measures must be invoked when using liquid hydrogen.
- Liquid hydrogen must be transferred by helium pressurization in properly designed transfer lines in order to avoid contact with air. Properly constructed and certified vacuum insulated transfer lines should be used.
- Only trained personnel familiar with liquid hydrogen properties, equipment, and operating procedures are permitted to perform transfer operations. Transfer lines in liquid hydrogen service must be purged with helium or gaseous hydrogen, with proper precautions, before using.
- The safety philosophy in the use of liquid hydrogen can be summarized as the following:
    - Isolation of the experiment.
    - Provision of adequate ventilation.
    - Exclusion of ignition sources plus system grounding/bonding to prevent static charge build-up.
    - Containment in helium purged vessels.
    - Efficient monitoring for hydrogen leakage.
    - Limiting the amount of hydrogen cryopumped in the vacuum system.

16.12 Extractions and Distillations

Extractions

- Do not attempt to extract a solution until it is cooler than the boiling point of the extractant due to the risk of over pressurization, which could cause the vessel to burst.
- When a volatile solvent is used, the solution should be swirled and vented repeatedly to reduce pressure before separation.
- When opening the stopcock, your hand should keep the plug firmly in place.
- The stopcock should be lubricated.
- Vent funnels away from ignition sources and people, preferably into a hood.
- Keep volumes small to reduce the risk of overpressure and if large volumes are needed, break them up into smaller batches.

Distillations

- Avoid bumping (sudden boiling) since the force can break apart the apparatus and result in splashes. Bumping can be avoided by even heating, such as using a heat mantle. Also, stirring can prevent bumping. Boiling stones can be used only if the process is at atmospheric pressure.
- Do not add solid items such as boiling stones to liquid that is near boiling since it may result in the liquid boiling over spontaneously.
- Organic compounds should never be allowed to boil to dryness unless they are known to be free of peroxides, which can result in an explosion hazard.

Reduced pressure distillation

- Do not overheat the liquid. Superheating can result in decomposition and uncontrolled reactions.
- Superheating and bumping often occur at reduced pressures so it is especially important to abide by the previous point on bumping and to ensure even, controlled heating. Inserting a nitrogen bleed tube may help alleviate this issue.
- Evacuate the assembly gradually to minimize bumping.
- Allow the system to cool and then slowly bleed in air. Air can cause an explosion in a hot system (pure nitrogen is preferable to air for cooling).
- See “reduced pressure” for vacuum conditions.

16.13 Glass Under Vacuum

Reduced pressure

Some general guidelines for glass under vacuum include:

- Inspect glassware that will be used for reduced pressure to make sure there are no defects such as chips or cracks that may compromise its integrity.

- Only glassware that is approved for low pressure should be used. Never use a flat bottom flask (unless it is a heavy walled filter flask) or other thin walled flask that are not appropriate to handle low pressure.
- Use a shield between the user and any glass under vacuum or wrap the glass with tape to contain any glass in the event of an implosion.

<u>Vacuum pumps</u>

- Cold traps should be used to prevent pump oil from being contaminated which can create a hazardous waste.
- Pump exhaust should be vented into a hood when possible.
- Ensure all belts and other moving parts are properly guarded.
- Whenever working on or servicing.

16.14 Glassware Washing

In most cases laboratory glassware can be cleaned effectively by using detergents and water. In some cases it may be necessary to use strong chemicals for cleaning glassware. Strong acids should be avoided unless necessary. In particular, Chromic acid should not be used due to its toxicity and disposal concerns. One product that may be substituted for Chromic acid is “Nochromix Reagent”. The Fisher catalog describes this material as: “Nochromix Reagent. Inorganic oxidizer chemically cleans glassware. Contains no metal ions. Rinses freely—leaving no metal residue, making this product valuable for trace analysis, enzymology, and tissue culture work. (Mix with sulfuric acid).” Unused Nochromix Reagent can be neutralized to a pH between 5.5 and 9.5 and drain disposed. Acid/base baths should have appropriate labeling and secondary containment. Additionally a Standard Operating Procedure (SOP), proper personal protective equipment (PPE), and spill materials should be available. Proper disposal for spent acid/base bath contents is neutralization and drain disposal.

When handling glassware, check for cracks and chips before washing, autoclaving or using it. Dispose of chipped and broken glassware immediately in an approved collection unit. DO NOT put broken glassware in the regular trash. Handle glassware with care – avoid impacts, scratches or intense heating of glassware. Make sure you use the appropriate labware for the procedures and chemicals. Use care when inserting glass tubing into stoppers: use glass tubing that has been fire-polished, lubricate the glass, and protect your hands with heavy gloves.

Glassware and Plastic ware

- Borosilicate glassware (i.e. Pyrex) is recommended for all lab glassware, except for special experiments using UV or other light sources. Soft glass should only be used for things such as reagent bottles, measuring equipment, stirring rods and tubing.
- Any glass equipment being evacuated, such as suction flasks, should be specially designed with heavy walls. Dewar flasks and large vacuum vessels should be taped or guarded in case of flying glass from an implosion. Household thermos bottles have thin walls and are not acceptable substitutes for lab Dewar flasks.

- Glass containers containing hazardous chemicals should be transported in rubber bottle carriers or buckets to protect them from breakage and contain any spills or leaks. It is recommended to transport plastic containers this way as well since they also can break or leak.

Preparation of Glass Tubing and Stoppers

To cut glass tubing:

- Hold the tube against a firm support and make one firm quick stroke with a sharp triangular file or glass cutter to score the glass long enough to extend approximately one third around the circumference.
- Cover the tubing with cloth and hold the tubing in both hands away from the body. Place thumbs on the tubing opposite the nick 2 to 3 cm and extended toward each other.
- Push out on the tubing with the thumbs as you pull the sections apart, but do not deliberately bend the glass with the hands. If the tubing does not break, re-score the tube in the same place and try again. Be careful to not contact anyone nearby with your motion or with long pieces of tubing.
- All glass tubing, including stir rods, should be fire polished before use. Unpolished tubing can cut skin as well as inhibit insertion into stoppers

After polishing or bending glass, give ample time for it to cool before grasping it.
When drilling a stopper:

    - Use only a sharp borer one size smaller than that which will just slip over the tube to be inserted. For rubber stoppers, lubricate with water or glycerol. Holes should be bored by slicing through the stopper, twisting with moderate forward pressure, grasping the stopper only with the fingers, and keeping the hand away from the back of the stopper.
    - Keep the index finger of the drilling hand against the barrel of the borer and close to the stopper to stop the borer when it breaks through. Preferably, drill only part way through and then finish by drilling from the opposite side.
    - Discard a stopper if a hole is irregular or does not fit the inserted tube snugly, if it is cracked, or if it leaks.
    - Corks should have been previously softened by rolling and kneading. Rubber or cork stoppers should fit into a joint so that one-third to one–half of the stopper is inserted.
- When available, glassware with ground joints is preferable. Glass stoppers and joints should be clean, dry and lightly lubricated.

Insertion of Glass Tubes or Rods into Stoppers

The following practices will help prevent accidents:

- Make sure the diameter of the tube or rod is compatible with the diameter of the hose or stopper.

- If not already fire polished, fire polish the end of the glass to be inserted; let it cool.
- Lubricate the glass. Water may be sufficient, but glycerol is a better lubricant.
- Wear heavy gloves or wrap layers of cloth around the glass and protect the other hand by holding the hose or stopper with a layered cloth pad.
- Hold the glass not more than 5 cm from the end to be inserted.
- Insert the glass with a slight twisting motion, avoiding too much pressure and torque.
- When helpful, use a cork borer as a sleeve for insertion of glass tubes.
- If appropriate, substitute a piece of metal tubing for glass tubing.
- Remove stuck tubes by slitting the hose or stopper with a sharp knife.

Assembling Apparatus

Following these recommendations will help make apparatus assembly easier and equipment safer:

- Keep your work space free of clutter.
- Set up clean, dry apparatus, firmly clamped and well back from the edge of the lab bench making adequate space between your apparatus and others work. Choose sizes that can properly accommodate the operation to be performed. As a rule, leave about 20% free space around your work.
- Use only equipment that is free from flaws such as cracks, chips, frayed wire, and obvious defects. Glassware can be examined in polarized light for strains. Even the smallest crack or chip can render glassware unusable. Cracked or chipped glassware should be repaired or discarded.
- A properly placed pan under a reaction vessel or container will act as secondary containment to confine spilled liquids in the event of glass breakage.
- When working with flammable gases or liquids, do not allow burners or other ignition sources in the vicinity. Use appropriate traps, condensers, or scrubbers to minimize release of material to the environment. If a hot plate is used, ensure the temperatures of all exposed surfaces are less than the auto ignition temperature of the chemicals likely to be released and that the temperature control device and the stirring / ventilation motor (if present) do not spark.
- Whenever possible, use controlled electrical heaters or steam in place of gas burners.
- Addition and separatory funnels should be properly supported and oriented so that the stopcock will not be loosened by gravity. A retainer ring should be used on the stopcock plug. Glass stopcocks should be freshly lubricated. Teflon stopcocks should not be lubricated.
- Condensers should be properly supported with securely positioned clamps and the attached water hoses secured with wire or clamps.
- Stirrer motors and vessels should be secured to maintain proper alignment. Magnetic stirring is preferable. Only non-sparking motors should be used in chemical laboratories. Air motors may be an option.

- Apparatus attached to a ring stand should be positioned so that the center of gravity of the system is over the base and not to one side. There should be adequate provision for removing burners or baths quickly. Standards bearing heavy loads should be firmly attached to the bench top. Equipment racks should be securely anchored at the top and bottom.
- Apparatus, equipment, or chemical bottles should not be placed on the floor. If necessary, keep these items under tables and out of aisle ways to prevent creating a tripping hazard.
- Never heat a closed container. Provide a vent as part of the apparatus for chemicals that are to be heated. Prior to heating a liquid, place boiling stones in unstirred vessels (except test tubes). If a burner is used, distribute the heat with ceramic-centered wire gauze. Use the thermometer with its bulb in the boiling liquid if there is the possibility of a dangerous exothermic decomposition as in some distillations. This will provide a warning and may allow time to remove the heat and apply external cooling. The setup should allow for fast removal of heat.
- Whenever hazardous gases or fumes are likely to be evolved, an appropriate gas trap should be used and the operation confined to a fume hood.
- Fume hoods are recommended for all operations in which toxic or flammable vapors are evolved as is the case with many distillations. Most vapors have a density greater than air and will settle on a bench top or floor where they may diffuse to a distant burner or ignition source. These vapors will roll out over astonishingly long distances and, if flammable, an ignition can cause a flash back to the source of vapors. Once diluted with significant amounts of air, vapors move in air essentially as air itself.
- Use a hood when working with a system under reduced pressure (which may implode). Close the sash to provide a shield. If a hood is not available, use a standing shield. Shields that can be knocked over must be stabilized with weights or fasteners. Standing shields are preferably secured near the top. Proper eye and face protection must be worn even when using safety shields or fume hoods.

16.15 Mercury Containing Equipment

Elemental Mercury (Hg) or liquid Mercury is commonly seen in thermometers, barometers, diffusion pumps, sphygmomanometers, thermostats, high intensity microscope bulbs, fluorescent bulbs, UV lamps, batteries, Coulter Counter, boilers, ovens, welding machines, etc.

Most of these items can be substituted with equipment without Mercury, thus greatly decreasing the hazard potential. Larger laboratory equipment may be more difficult to identify as “Mercury containing” due to the fact that mercury can be hidden inside inner components such as switches or gauges.

The concerns surrounding mercury containing equipment are as follows:

- It is difficult to identify exposures or cross-contamination due to Mercury leaks or spills.

- The amount of Mercury used is usually much greater than the Department of Environmental Conservation (DEC) reportable quantities for releases to the environment.
- People may be unaware of the Mercury and thus may not be properly trained for use, maintenance, spills, transport or disposal or may not use the appropriate engineering controls or Personal Protective Equipment (PPE).
- There is legal liability if human health and the environment are not properly protected.

To minimize the potential for Mercury spills and possible exposures, laboratory personnel is strongly encouraged to follow these recommendations:

- Identify and label “Mercury Containing Equipment”.
- Write a Standard Operating Procedure (SOP).
- Train personnel on proper use, maintenance, transport and disposal.
- Conduct periodic inspections of equipment to ensure no leaks or spills have occurred.
- Consider replacing Mercury with electronic or other replacement components.
- Have available proper PPE such as nitrile gloves.
- Use secondary containment, such as trays as a precaution for spills.
- Plan for emergency such as a spill or release of mercury.
- Decontaminate and remove Mercury before long-term storage, transport or disposal.
- For new equipment purchases, please attempt to procure instruments with no or little Mercury.

Appendix A
OSHA Laboratory Standard

ATTACHMENT 1
OSHA Laboratory Standard
29 CFR 1910.1450

PART 1910-OCCUPATIONAL SAFETY AND HEALTH STANDARDS

1. The authority citation for part 1910, subpart Z is amended by adding the following citation at the end. (Citation which precedes asterisk indicates general rulemaking authority.)

Authority: Secs. 6 and 8, Occupational Safety and Health Act, 29 U.S.C. 655, 657; Secretary of Labor's Orders Nos. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable; and 29 CFR part 1911.
* * * Section 1910.1450 is also issued under sec. 6(b), 8(c) and 8(g)(2), Pub.L. 91-596, 84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657.

2. Section 1910.1450 is added to subpart Z, part 1910 to read as follows:

191.1450 Occupational exposure to hazardous chemicals in laboratories.

(a) *Scope and application.* (1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(2) Where the section applies it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

(i) For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

(ii) Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

(iii) Where the action level (or in the absence of action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements, paragraphs (d0 and (g)(1)(ii) of this section shall apply.

(3) This section shall not apply to:

(i) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart 2, even if such occurs in a laboratory.

(ii) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

(A) Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color chart supplied by the manufacturer of the test strip; and

(B) Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

(b) *Definitions*-

"Action level" means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

"Assistant Secretary" means the Assistant Secretary of labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Carcinogen" (see "select carcinogen").

"Chemical Hygiene Officer" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitation on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

"Chemical Hygiene Plan" means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

"Combustible liquid" means any liquid having a flashpoint at or above 100 ^{o}F (37.8 ^{o}C), but below 200 ^{o}F (93.3 ^{o}C), except any mixture having components with flashpoints of 200 ^{o}F (93.3 ^{o}C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"Compressed Gas" means"

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

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

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

"Designated Area" means an area which may be used for work with "select carcinogens" reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

"Emergency" means any occurrence such as, but not limited to, equipment failure, rupture or containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

"Employee" means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

"Explosive" means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

"Flammable" means a chemical that falls into one of the following categories:

(i) "*Aerosol, flammable"* means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) *"Gas, flammable"* means:

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

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

(iii) *"Liquid, flammable"* means any liquid having a flashpoint below 100 ^{o}F (37.8 ^{o}C), except any mixture having components with flashpoints of 100 ^{o}F (37.8 ^{o}C) or higher, the total of which make up 99 percent of more of the total volume of the mixture.

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

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

(i) Tagliabue Closed Tester (See American National Standard for Flash Point by Tag Closed Tester, Z11.7-1979 (STM D93-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 ^{o}F (37.8 ^{o}C), than do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))-for liquids with a viscosity equal to or greater than 45SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface fulm under test; or

(iii)Setaflash Closed Tester (see American National standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

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

Appendices A and B of the Hazard Communication Standard (29CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

"Laboratory" means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

"Laboratory scale" means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

"*Laboratory-type hood"* means a device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure with out insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use to that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

"Laboratory use of hazardous chemicals" means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii)Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

"Medical consultation" means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examination or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

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

"Oxidizer" means a chemical other that a blasting agent or explosive as defined in 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

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

"Protective laboratory practices and equipment" means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

"Reproductive toxins" means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis)

"Select carcinogen" means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

(iv) It is listed in either Group 2A or @B 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:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

"Unstable (reactive)" means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

"Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

(c) *Permissible exposure limits.* For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 26 CFR par 1910, subpart Z.

(d)*Employee exposure determination*-(1)*Initial monitoring.* The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL.

(2) *Periodic monitoring.* If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

(3) *Termination of monitoring.* Monitoring may be terminated in accordance with the relevant standard.

(4)*Employee notification of monitoring results.* The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

(e)*Chemical hygiene plan-General.* (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan). (1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

(i) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

(ii) Capable of keeping exposures below the limits specified in paragraph (c) of this section.

(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:

(i) Standard operating procedures relevant to safety and health considerations tob e followed when laboratory work involves the use of hazardous chemicals;

(ii) Criteria that the employer will use to determine and implement control measures to reduce 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 measure for chemicals that are known to be extremely hazardous;

(iii) A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

(iv) Provisions for employee information and training as prescribed in paragraph (f) of this section;

(v) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

(vi) Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

(vii) Designation of personnel responsible for implementation of Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee; and

(viii) Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

(A) Establishment of a designated area;

(B) Use of containment devices such as fume hood or glove boxes;

(C) Procedures for safe removal of contaminated waste; and

(D) Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

(f) *Employee information and training.* (1) 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.

(2) Such information shall be provided at the time of an employees' initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

(3) *Information.* Employees shall be informed of:

(i) The contents of this standard and its appendices which shall be made available to employees;

(ii) The location and availability of the employer's Chemical Hygiene Plan;

(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

(iv)Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

(v) 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 chemical supplier.

(4) *Training.* (I) Employee training shall include:

(A) Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(B) The physical and health hazards of chemicals in the work area; and

(C) 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 personal protective equipment to be used.

(ii) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

(g) *Medical consultation and medical examinations.* (1) The employer shall 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:

(i) 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 shall be provided an opportunity to receive an appropriate medical examination.

(ii) 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.

(iii) 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 and opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

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

(3) *Information provided to the physician.* The employer shall provide the following information to the physician:

(i) The identity of the hazardous chemical(s) to which the employee may have been exposed;

(ii) A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

(iii) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) *Physician's written opinion.* (i) For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

(C) Any medical condition which 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 chemical found in the workplace; and

(D) 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.

(ii) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

(h) *Hazard identification.* (1) With respect to labels and material safety data sheets:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

(2) The following provisions shall apply to chemical substances developed in the laboratory:

(i) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

(ii) If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

(iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (26 CFR 1910.1200) including requirements for preparation of material safety data sheets and labeling.

(i) *Use of respirators.* Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

(j) *Recordkeeping.* (1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including test or written opinions required by this standard.

(2) The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20.

(k) *Dates*-(1) *Effective date.* This section shall become effective May 1, 1990.

(2) *Start-up dates.* (i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

(ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(l) *Appendices.* The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

Appendix A to 1910.1450-National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

Table of Contents

Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. They were extracted from "Prudent Practices for handling Hazardous Chemical in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW., Washington DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deals with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical hazards. Therefore, only those recommendation directed primarily toward control of toxic exposures are cited in this appendix, with the term "chemical hygiene" being substituted for the word "safety". However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given in section F.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs.

Paragraph and topic in laboratory standard	Relevant appendix section
(e)(3)(i) Standard operating procedures for handling toxic chemicals.	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposure.	D
(e)(3)(iii) Fume hood performance	C4b
(e)(3)(iv) Employee information and training (including emergency procedures).	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities.	E2b, E4b
(e)(3)(vi) Medical consultation and medical examinations	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities.	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances.	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A-D. Those recommendations of primary concern to employees who are actually handling laboratory chemical are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B-E, "Prudent Practices" expresses certain general principles, including the following:

1. *It is prudent to minimize all chemical exposures.* Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2, 10). Skin contact with chemicals should be avoided as a cardinal rule (198).

2. *Avoid underestimation of risk.* Even for substances of no known significant hazard, exposure should be minimized; for work with special precautions should be taken 910, 37, 38). One should

assume that any mixture will be more toxic than its most toxic component (30,103) and that all substances of unknown toxicity are toxic (3, 34).

3. *Provide adequate ventilation.* The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).

4. *Institute a chemical hygiene program.* A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6, 11). Its recommendations should be followed in academic teaching laboratories as ell as by full-time laboratory workers (13).

5. *Observe the PELs, TLVs*. The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rest at all levels (6, 11, 21) including the:

1. *Chief executive officer,* who has ultimate responsibility for chemical hygiene within the institution, and must with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. *Supervisor of the department or other administrative unit,* who is responsible for chemical hygiene in that unit (7).

3. *Chemical hygiene officer(s),* whose appointment is essential (7) and who must:

(a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);

(b) Monitor procurement, use, and disposal of chemicals used in the lab (8);

(c) See that appropriate audits are maintained (8);

(d) Help project directors develop precautions and adequate facilities (10);

(e) Know the current legal requirements concerning regulated substances (50); and

(f) Seek ways to improve the chemical hygiene program (8, 11).

4. *Laboratory supervisor,* who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:

(a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);

(b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);

(c) Know the current legal requirements concerning regulated substances (50, 231);

(d) Determine the required levels of protective apparel and equipment (156, 160, 162); and

(e) ensure that facilities and training for use of any material being ordered are adequate (215).

5. *Project director or director of other specific operation,* who has primary responsibility for chemical hygiene procedures for that operation (7).

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

(a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and

(b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. *Design*. The laboratory facility should have:

(a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);

(b) Adequate, well-ventilated stockrooms/storerooms (218, 219);

(c) Laboratory hoods and sinks (12, 162);

(d) Other safety equipment including eyewash fountains and drench showers (162, 169); and

(e) Arrangements for waste disposal (12, 240).

2. *Maintenance.* Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continuing appraisal and be modified if inadequate (11, 12).

3. *Usage*. The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially, to the quality of ventilation (13).

4. *Ventilation.*-(a) *General laboratory ventilation.* This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).

(b) *Hoods.* A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201-206 for a discussion of hood design, construction, and evaluation.

(c) *Other local ventilation devices.* Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate duct (207).

(d) *Special ventilation areas.* Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape in the event of electrical failure (209).

(e) M*odifications.* Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).

(f) *Performance*. Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).

(g) Quality. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194,195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60-100 lfm) (200, 204).

(h) *Evaluation.* Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp. 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

D. Components of the chemical Hygiene Plan

1. Basic Rules and Procedures
(Recommendations for these are given in section E, below)

2. Chemical Procurement, Distribution, and Storage

(a) *Procurement*. Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved (251, 216). No container should be accepted without an adequate identifying label (216).

(b) *Stockrooms/storerooms.* Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218-19).

Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

(c) *Distribution.* When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).

(d) *Laboratory storage.* Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225-6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentration is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devised (12) or when a highly toxic substance is stored or used regularly (e.g., 3 times/week) (13).

4. Housekeeping, Maintenance, and Inspections

(a) Cleaning. Floors should be cleaned regularly (24).

(b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent personnel changes and semiannually for other; informal inspections should be continual (21).

(c) M*aintenance.* Eye wash fountains should be inspected at intervals of not less than 3 months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Safety showers should be tested routinely (169). Other safety equipment should be inspected regularly. (e.g., every 3-6 months) (6, 24,171). Procedures to prevent restarting of out-of-service equipment should be established (25).

(d) *Passageways.* Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) *Compliance with regulations.* Regular medical surveillance should be established to the extent required by regulations (12).

(b) *Routine surveillance.* Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).

(c) *First aid.* Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby (173). See pp. 176-178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory:

(a) Protective apparel compatible with the required degree of protection for substance being handled (158-161);

(b) An easily accessible drench-type safety shower (162, 169);

(c) An eyewash fountain (162);

(d) A fire extinguisher (162-164);

(e) Respiratory protection (164-9), fire alarm and telephone for emergency use (162) should be available nearby; and

(f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).

(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).

(c) Inventory and usage records for high-risk substances should be kept as specified in sections E3e below.

(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

Prominent signs and labels of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);

(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);

(c) Locations signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27) and areas where food and beverage consumption and storage are permitted (24); and

(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents

(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).

(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).

(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).

(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program

(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).

(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169).

Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6).

Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).

(d) Frequency of Training: The training and education program should be a regular, continuing activity-not simply an annual presentation (15).

(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. Waste Disposal Program

(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).

(b) Content (14,232, 233, 240): The waste disposal program should specify how waste is collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).

(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 270.

Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).

(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241).

Indiscriminate disposal by pouring waste chemicals down the drain (14, 231,242) or adding them to mixed refuse for landfill burial is unacceptable (14).

Hoods should not be used as a means of disposal for volatile chemical (40, 200).

Disposal by recycling (233, 243) or chemical decontamination should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1.General Rules

The following should be used for essentially all laboratory work with chemicals:

(a) *Accidents and spills*-eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172).

Ingestion: Encourage the victim to drink large amounts of water (178).

Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33).

Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24, 33). See pp. 233-237 for specific clean-up recommendations.

(b) *Avoidance of "routine" exposure;* Develop and encourage safe habits (230; avoid unnecessary exposure to chemicals by any route (23);

Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199).

Inspect gloves (157) and test glove boxes (208) before use.

Do not allow release of toxic substances in cold rooms and worm rooms, since these have contained recirculated atmospheres (209).

(c) *Choice of chemicals:* Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) *Eating, smoking, etc.:* Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities.

Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

(e)*Equipment and glassware:* handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (250. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) *Exiting:* Wash areas of exposed skin well before leaving the laboratory (23).

(h) *Horseplay:* Avoid practical jokes or other behavior which might confuse, startle or distract another worker (23).

(i) *Personal apparel:* Confine long hair and loose clothing (23, 158). Wear shoes at all time in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) *Personal housekeeping:* Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) *Personal protection:* Assure that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154).

Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159).

Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169).

Use any other protective and emergency apparel and equipment as appropriate (22, 157-162).

Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155).

Remove laboratory coats immediately on significant contamination (161).

(l) *Planning:* Seek information and advice about hazards (7), plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation (22, 23).

(m) *Unattended operations:* Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substance in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).

(n) *Use of hood:* use the hood for operations which might result in release of toxic chemical vapors or dust (198-9).

As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less that 50 ppm (13).

Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200).

Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).

(o) *Vigilance:* Be alert to unsafe conditions and see that they are corrected when detected (22).

(p) *Waste disposal:* Assure that the plan for each laboratory operation includes plans and training for waste disposal (230).

Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24).

Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

(q) *Working alone:* Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Working with Allergens and Embryotoxins

(a) *Allergens* (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).

(b) *Embryotoxins* (34-5) (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.

Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.

Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.

Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisopropylfluorophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).

Supplemental rules to be followed in addition to those mention above (Procedure B of "Prudent Practices"' pp. 39-41):

(a) *Aim:* To minimize exposure to these toxic substances by any route using all reasonable precautions (39).

(b) *Applicability:* These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).

(c) *Location:* use and store these substances only in areas of restricted access with special warning signs (40, 229).

Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to prevent their discharge with the hood exhaust (40).

(d) *Personal protection:* Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate) (39). Always wash hands and arms immediately after working with these materials (40).

(e) *Records:* Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).

(f) *Prevention of spills and accidents:* Be prepared for accidents and spills (41).

Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39).

Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such tray or cover work and storage surfaces with removable, absorbent, plastic backed paper (40).

If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) *Waste*: Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40).

Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with chemicals of High Chronic Toxicity

(Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47). (Procedure A of "Prudent Practices" pp. 47-50).

(a) *Access*: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substance being used and necessary precautions (48).

(b) *Approvals:* Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).

(c) *Non-contamination/Decontamination*: protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50).

Decontaminate the controlled area before normal work is resumed there (50).

(d) *Exiting:* On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).

(e) *Housekeeping*: Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50).

(f) *Medical surveillance:* If using toxicologically significant quantities of such a substance on a regular basis (*e.g.*, 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).

(g) *Records:* Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).

(h) *Signs and labels:* Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled with identity and warning labels (48).

(i) *Spills:* Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233-4).

(j) *Storage:* Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).

(k) G*love boxes*: For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case, trap exit gases of filter them through a HEPA filter and then release them into the hood (49).

(l) *Waste:* Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity

(a) *Access:* For large scale studies, special facilities with restricted access are preferable (56).

(b) *Administration of the toxic substance:* When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).

(c) *Aerosol suppression:* Devise procedures which minimize formation and dispersal of contaminated aerosols, including those form food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).

(d) *Personal protection:* When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).

(e) *Waste disposal:* Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products (238); otherwise package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6)
2. Electrically powered laboratory apparatus: (179-92)
3. Fires, explosions: (26, 57-74, 162-4, 174-5,219-20, 226-7)
4. Low temperature procedures: (26, 88)
5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)

G. Material Safety Data Sheets

Material safety data sheets are presented in "Prudent Practices" for the chemicals listed below. (Asterisks denote that comprehensive material safety data sheets are provided).

*Acetyl peroxide (105)
*Acrolein (106)
*Acrylonilrile (107)
Ammonia (anhydrous) (91)
*Aniline (109)
*Benzene (110)
*Benzo[a]pyrene (112)
*Bis(chloromethyl) ether (113)
Boron trichloride (91)
Boron trifluoride (92)
Bromine (114)
*Tert-butyl hydroperoxide (148)
*Carbon disulfide (116)
Carbon monoxide (92)
*Carbon tetrachloride (118)
*Chlorine (119)
Chlorine trifluoride (94)
*Chloroform (121)
Chloromethane (93)
*Diethyl ether (122)
Diisopropyl fluorophosphate (41)
*Dimehylformamide (123)
*Dimethyl sulfate (125)
*Dioxane (126)
*Ethylene dibromide (128)
*Fluorine (95)
*Formaldehyde (130)
*Hydrazine and salts (132)
Hydrofluoric acid (43)
Hydrogen bromide (98)
Hydrogen chloride (98)
*Hydrogen sulfide (135)
Mercury and compounds (52)
*Methanol (137)
*Morpholine (138)
*Nickel carbonyl (99)
*Nitrobenzene (139)
Nitrogen dioxide (100)
N-nitrosodiethylamine (54)
*Peracetic acid (141)
*Phenol (142)
*Phosgene (143)
*Pyridine (144)
*Sodium azide (145)

*Sodium cyanide (147)
Sulfur dioxide (101)
*Trichloroethylene (149)
*Vinyl chloride (150)

Appendix B to 1910.1450-References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do no imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory. (a) Materials for the development of the Chemical Hygiene Plan:

1. American Chemical Society, Safety in the Academic Chemistry Laboratories, 4th edition, 1985.

2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.

3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL., 1978.

4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing co., NY, 1978.

5. Kaufman, James a., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland MI 48640, 1977.

6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO Washington, DC 20402, 1981.

7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington DC, 1983.

8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington DC, 1981.

9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, *J. Chem. Ed.*, American Chemical Society, Easlon, PA, 1981.

10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA 18042, Vol, I, 1967, Vol. II, 1971, Vol. III 1974.

11. Steere, Norman, V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.

12. Young, Jay A., Ed., Improving safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.

(b) Hazardous Substances Information:

1. American conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, P.O. Box 1937 Cincinnati, OH 45201 (latest edition).

2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington DC (latest edition).

3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.

4. Bretherick, L., Handbook of reactive Chemical Hazards, 2nd editon, Butterworths, London, 1979.

5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, royal Society of Chemistry, London, 1986.

6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washingotn, DC 20402 (latest edition).

7. IARC Monographs on the Evaluation of the carcinogenic Risk of Chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).

8. NIOSH/OSHA pocket Guide to Chemical hazards, NIOSH Pub. No. 85-11, U.s. Government Printing Office, Washington, DC, 1985 (or latest edition).

9. Occupational Health Guidelines, NIOSH/OSHA NIOSH Pub. No. 81-123 U.S. Government Publishing Office, Washington, DC, 1981.

10. Patty, F.F., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (five Volumes).

11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of Documents U.S. Govt. Printing Office, Washington, DC 20402.

12. The Merck Index: An Encyclopedia of Chemicals and Drugs, Merck and Company Inc., Rahway, N.J., 1976 (or latest edition).

13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.

14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications, Park Ridge, NJ, 1981.

(c) Information of Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation, 16th edition Lansing, MI, 1980.

2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y., 1979.

3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.

4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.

Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.

Fire Protection Guide on Hazardous Materials, 7th edition, 1978.

National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF-71980, 1101 16th Street, NW., Washington, C 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.

2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

(Approved by the Office of Management and Budget under control number 1218-0131)
[FR Doc, 90-1717 filed 1-30-90; 8:45 am]
BILLING CODE 4510-26-M

Appendix B
NFPA Chemical Hazard Rankings Table

Fire Protection For Laboratories Using Chemicals

Health Hazard Rating	Materials
4	Materials that, under emergency conditions, can be lethal. The following criteria shall be considered when rating materials: Gases whose LC50 for acute inhalation toxicity is less than or equal to 1000 parts per million (ppm); Any liquid whose saturated vapor concentration at 20 degrees Celsius (68 degrees Fahrenheit) is equal to or greater than 10 times its LC50 for acute inhalation toxicity, if its LC50 is less than or equal to 1000 parts per million (ppm); Dusts and mists whose LC50 for acute inhalation toxicity is less than or equal to 0.5 milligrams per liter (mg/L); Materials whose LD50 for acute dermal toxicity is less than or equal to 40 milligrams per kilogram (mg/Kg); Materials whose LD50 for acute oral toxicity is less than or equal to 5 milligrams per kilogram (mg/Kg).
3	Materials that, under emergency conditions, can cause serious or permanent injury. The following criteria shall be considered when rating materials: Gases whose LC50 for acute inhalation toxicity is greater than 1000 parts per million (ppm), but less than or equal to 3000 parts per million (ppm); Any liquid whose saturated vapor concentration at 20 degrees Celsius (68 degrees Fahrenheit) is equal to or greater than 10 times its LC50 for acute inhalation toxicity, if its LC50 is less than or equal to 3000 parts per million (ppm), and that does

	not meet the criteria for degree of hazard 4; Dusts and mists whose LC50 for acute inhalation toxicity is greater than 0.5 milligrams per liter (mg/L), but less than or equal to 2 milligrams per liter (mg/L); Materials whose LD50 for acute dermal toxicity is greater than 40 milligrams per kilogram (mg/Kg), but less than or equal to 200 milligrams per kilogram (mg/Kg); Materials that are corrosive to the respiratory tract; Materials that are corrosive to the eye or cause irreversible corneal opacity; Materials that are severely irritating and/ or corrosive to skin; Materials whose LD50 for acute oral toxicity is greater than 5 milligrams per kilogram (mg/Kg), but less than or equal to 50 milligrams per kilogram (mg/Kg).
2	Materials that, under emergency conditions, can cause temporary incapacitation or residual injury. The following criteria shall be considered when rating materials: Gases whose LC50 for acute inhalation toxicity is greater than 3000 parts per million (ppm), but less than or equal to 5000 parts per million (ppm); Any liquid whose saturated vapor concentration at 20 degrees Celsius (68 degrees Fahrenheit) is equal to or greater than one fifth (1/5) times its LC50 for acute inhalation toxicity, if its LC50 is less than or equal to 5000 parts per million (ppm), and that does not meet the criteria for either degree of hazard 3 or degree of hazard 4; Dusts and mists whose LC50 for acute

	inhalation toxicity is greater than 2 milligrams per liter (mg/L), but less than or equal to 10 milligrams per liter (mg/L); Materials whose LD50 for acute dermal toxicity is greater than 200 milligrams per kilogram (mg/Kg), but less than or equal to 1000 milligrams per kilogram (mg/Kg); Materials that are respiratory irritants; Materials that cause irritating but irreversible injury to the eyes; Materials that are primary skin irritants or sensitizers; Materials whose LD50 for acute oral toxicity is greater than 50 milligrams per kilogram (mg/Kg), but less than or equal to 500 milligrams per kilogram (mg/Kg).
1	Materials that, under emergency conditions, can cause significant irritation. The following criteria shall be considered when rating materials: Gases whose LC50 for acute inhalation toxicity is greater than 5000 parts per million (ppm), but less than or equal to 10,000 parts per million (ppm); Dusts and mists whose LC50 for acute inhalation toxicity is greater than 10 milligrams per liter (mg/L), but less than or equal to 200 milligrams per liter (mg/L); Materials whose LD50 for acute dermal toxicity is greater than 1000 milligrams per kilogram (mg/Kg), but less than or equal to 2000 milligrams per kilogram (mg/Kg); Materials that are slightly irritating to the respiratory tract, eyes and skin; Materials whose LD50 for acute oral toxicity is greater than 500 milligrams per kilogram

	(mg/Kg), but less than or equal to 2000 milligrams per kilogram (mg/Kg).
0	Materials that, under emergency conditions, can cause significant irritation. The following criteria shall be considered when rating materials: Gases whose LC50 for acute inhalation toxicity is greater than 10,000 parts per million (ppm); Dusts and mists whose LC50 for acute inhalation toxicity is greater than 200 milligrams per liter (mg/L); Materials whose LD50 for acute dermal toxicity is greater than 2000 milligrams per kilogram (mg/Kg); Materials whose LD50 for acute oral toxicity is greater than 2000 milligrams per kilogram (mg/Kg). Essentially nonirritating to the respiratory tract, eyes and skin.

Flammability Hazard Rating	Materials
4	Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air, and which will burn readily. This includes: Flammable gases; Flammable cryogenic materials; Any liquid or gaseous material that is liquid while under pressure and has a flash point below 22.8 degrees Celsius (73 degree Fahrenheit) and a boiling point of 37.8 degree Celsius (100

	degrees Fahrenheit) (i.e., class IA liquids); Materials that ignite spontaneously when exposed to air.
3	Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions. This includes: Liquids having a flash point below 22.8 degrees Celsius (73 degree Fahrenheit) and a boiling point of 37.8 degree Celsius (100 degrees Fahrenheit) and those liquids having a flash point at or above 22.8 degrees Celsius (73 degree Fahrenheit) and below 37.8 degree Celsius (100 degrees Fahrenheit) (i.e., class IB and class IC liquids); Materials that on account of their physical form or environmental conditions can form explosive mixtures with air and that are readily dispersed in air; Materials that burn with extreme rapidity, usually by reason of self-contained oxygen (e.g., dry nitrocellulose and many organic peroxides).
2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating might release

	vapor in sufficient quantities to produce hazardous atmospheres with air. This includes: Liquids having a flash point at or above 37.8 degrees Celsius (100 degree Fahrenheit) and below 93.4 degree Celsius (200 degrees Fahrenheit) (i.e., class II and class IIIA liquids); Solid materials in the form of coarse dusts that burn rapidly burn that generally do not form explosive atmospheres with air; Solid materials in a fibrous or shredded form that burn rapidly and create flash fire hazards, such as cotton, sisal, and hemp; Solids and semisolids that readily give off flammable vapors.
1	Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur. This includes: Materials that will burn in air when exposed to a temperature of 815.5 degrees Celsius (1500 degree Fahrenheit) for a period of 5 minutes or less; Liquids, solids, and semisolids having a flash point at or above 93.4 degree Celsius (200 degrees Fahrenheit) (i.e., class IIIB Liquids); Liquids with a flash point of greater than 35 degree Celsius (95 degrees Fahrenheit) that do not sustain combustion when tested using the *“Method of Testing for combustibility”*, per 49 CFR 173, Appendix H, or the UN

	“Recommendations on the transport of dangerous goods”, 8th Revised edition. Liquids with a flash point of greater than 35 degree Celsius (95 degrees Fahrenheit) in a water-miscible solution or dispersion with a water noncombustible liquid/solid content of more than 85 percent by weight. Liquids that have no fire point when tested by ASTM D 92, *“Standard Test Method for Flash Point and Fire Point by Cleveland Open Cup”*, up to the boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change. Most ordinary combustible materials.
0	Materials that will not burn. This includes any material that will not burn in air when exposed to a temperature of 815.5 degrees Celsius (1500 degree Fahrenheit) for a period of 5 minutes.

Reactivity Rating	**Materials**
4	Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This includes materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures. Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 250 degrees Celsius (482 degrees Fahrenheit) of 1000 W/mL or greater.
3	Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction, but that require a strong initiating source or that must be heated under

	containment before initiation. This includes: **Materials that have an instantaneous power density (product of heat reaction and reaction rate) at 250 degrees Celsius (482 degrees Fahrenheit) at or above 100 W/mL and below 1000W/mL;** **Materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures;** **Materials that react explosively with water without requiring heat or containment.**
2	**Materials that readily undergo violent chemical change at elevated temperatures and pressures. This includes:** **Materials that have an instantaneous power density (product of heat reaction and reaction rate) at 250 degrees Celsius (482 degrees Fahrenheit) at or above 10 W/mL and below 100 W/mL;** **Materials that react violently with water or form potentially explosive mixtures with water.**
1	**Materials that in themselves are normally stable, but can become unstable at elevated temperatures and pressures. This includes:** **Materials that have an instantaneous power density (product of heat reaction and reaction rate) at 250 degrees Celsius (482 degrees Fahrenheit) at or above 0.01 W/mL and below 10 W/mL;** **Materials that react vigorously with water, but not violently;** **Materials that change or decompose on exposure to air, light, or moisture.**
0	**Materials that in themselves are normally**

	stable, even under fire conditions. This includes: **Materials that have an instantaneous power density (product of heat reaction and reaction rate) at 250 degrees Celsius (482 degrees Fahrenheit) below 0.01 W/mL;** **Materials that do not react with water;** **Materials that do not exhibit an exotherm at temperatures less than or equal to 500 degrees Celsius (932 degrees Fahrenheit) when tested by differential scanning calorimetry.**

GUIDE TO HAZARD INFORMATION – (A)

Compound	H	F	R	S/N
Acetal	2	3	0	
Acetaldehyde	3	4	2	
Acetanilide	3	1	0	
Acetic Acid (glacial)	3	2	0	
Acetic Anhydride	3	2	1	W
Acetoacetanilide	2	1	0	
Acetoacet-ortho-toluidide	2	1	1	
Acetoacet-para-phenetide	2	1	1	
Acetone	1	3	0	
Acetone cyanohydrin	4	2	2	
Acetonitrile	2	3	0	
Acetonyl acetone	1	1	0	
Acetophenone	1	2	0	
Acetyl Chloride	3	3	2	W
Acetylene	0	4	3	
Acetyl Peroxide.	1	2	4	
Acrolein	4	3	3	
Acrolein Dimer	1	2	1	
Acrylamide	2	2	2	

Acrylic Acid (glacial)	3	2	2	
Acrylonitrile	4	3	2	
Adipic Acid	-	1	0	
Adiponitrile	2	2	1	
Adipoyl chloride	2	2	0	
Adipyldinitrile	4	2	-	
Aldol	3	2	2	
Allyl Acetate	1	3	0	
Allyl Alcohol	4	3	1	
Allylamine	4	3	1	
Allyl Bromide	3	3	1	
Allyl caproate	1	2	0	
Allyl Chloride	3	3	1	
Allyl Chloroformate	3	3	1	
Allyl ether	3	3	2	
Allylidene diacetate	2	2	1	
Allyl trichlorosilane	3	3	2	W
Alpha, beta-dichlorostyrene	2	1	2	
Alpha, beta-glycerin dichlorohydrin	2	1	0	
Alpha-butylene glycol	0	2	-	
Alpha-chloropropionic acid	-	1	0	
Alpha-methylbenzyl dimethyl amine	2	2	0	
Alpha-methylbenzyl ether	2	1	0	
Alpha-methylbenzylamine	2	2	0	
Alpha-methylstyrene	1	2	1	
Alpha-pinene	1	3	0	
Aluminum (dust or powder)	0	1	1	
Aluminum alkyls	3	4	3	W
Aluminum chloride (anhydrous)	3	0	2	W
Aluminum phosphide	4	4	2	W
Aluminum (uncoated)	0	3	1	
2-Amino-1-butanol	2	2	0	
(2-Aminoethyl) ethanolamine	2	1	0	
4-(2-Aminoethyl)-morpholine	2	2	0	
2-Amino-2-methyl-1-propanol	2	2	0	
1-Amino-2-propanol	2	2	0	
3-Aminopropanol	3	2	0	
Ammonia, Anhydrous	3	1	0	
Ammonium Bromide	2	0	0	
Ammonium Chloride	2	0	0	

Ammonium dichromate	2	1	1	OX
Ammonium Fluoride	3	0	0	
Ammonium Nitrate	0	0	3	OX
Ammonium Perchlorate	1	0	4	OX
Ammonium Permanganate	0	0	3	OX
Ammonium Sulfate	3	0	0	
Amyl Acetate	1	3	0	
Amyl Alcohol	1	3	0	
Amylamine	2	3	0	
Amyl bromide	1	3	0	
Amylbenzene	1	2	0	
Amyl butyrate	1	2	0	
Amyl Chloride	1	3	0	
Amyl cyclohexane	1	-	0	
Amyl Ether	1	2	0	
Amyl formate	1	3	0	
Amyl lactate	1	2	0	
Amyl laurate	0	1	0	
Amyl Maleate	0	1	0	
Amyl mercaptan	2	3	-	
Amyl napthalene	0	1	0	
Amyl nitrate	2	2	0	OX
Amyl nitrite	1	-	2	
Amyl oleate	0	1	0	
Amyl oxalate	0	1	0	
o-Amyl Phenol	2	1	0	
Amyl phenyl ether	0	2	0	
Amyl Propionate	0	2	0	
Amyl salicylate	0	1	0	
Amyl Stearate	0	1	0	
Amyl sulfides (mixed)	2	2	0	
Amyl Toluene.	2	2	0	
Amyl tricholorosilane	3	2	2	W
Amyl xylyl ether	2	1	0	
Aniline	3	2	0	
Aniline Hydrochloride	3	1	-	
2-Anilinoethanol	2	1	0	
o-Anisidine	2	1	0	
Anisole	1	2	0	
Anthracene	0	1	-	

Anthraquinone	0	1	-	
Antimony Pentachloride, liquid	3	0	1	
Antimony Pentafluoride	4	0	1	
Antimony Pentasulfide	3	1	1	
Antimony sulfide	1	1	1	
Arsenic Chloride	3	0	0	
Arsenic pentafluoride	4	0	1	
Arsenic pentoxide	3	0	0	
Arsenic trichloride	3	0	0	
Arsenic trioxide	3	0	0	
Arsenic Trisulfide	3	0	0	
Arsine	4	4	2	
Asphalt (cutback)	0	3	0	
Asphalt (typical)	0	1	0	
Asphalt, liquid-medium curing	0	2	0	
Asphalt, liquid-rapid curing	0	3	0	
Asphalt, liquid-slow curing (grade sc-250)	0	2	0	
Azobisisobutyronitrile	3	-	2	

GUIDE TO HAZARD INFORMATION – (B)

Compound	H	F	R	S/N
Barium Chlorate	2	0	1	OX
Barium Nitrate	1	0	0	OX
Barium Peroxide	1	0	0	OX
Benzaldehyde	2	2	0	
Benzedrine	0	1	-	
Benzene	2	3	0	
Benzoic Acid	2	1	-	
Benzol (diluent)	2	3	0	
Benzotrichloride	3	1	0	
Benzotrifluoride	3	3	1	
Benzoyl Chloride	3	2	2	W
Benzyl Acetate	1	1	0	
Benzyl Alcohol	2	1	0	
Benzile benzoate	1	1	0	
Benzyl butylphthalate	1	1	0	
Benzyl chloride	3	2	1	

Benzyl Cyanide	2	1	0	
Benzyl mercaptan	2	2	-	
Benzyl Salicilate	1	1	0	
Beryllium (dust or powder)	3	1	0	
Beta-amylene-cis	0	4	-	
Beta-amylene-trans	0	4	-	
2, Beta-butoxyethoxyethyl chloride	2	2	0	
Beta-butoxyethoxyethyl salicylate	2	2	0	
Beta-butylene glycol	1	1	0	
Beta-chlorophenetole	-	1	0	
Beta-methyl mercaptopropionaldehyde	-	2	0	
Beta-napthol	-	1	0	
Beta-phelandrene	0	2	0	
Beta-propiolactone	0	2	0	
Beta-(p-tert-butyl phenoxy) ethanol	0	1	0	
Beta-(p-tert-butylphenoxy) ethyl acetate	0	1	0	
Bicyclohexyl	1	2	0	
Biphenyl	2	1	0	
2-Biphenylamine	2	1	0	
Bis [2-(2-chloroethoxy)ethyl] ether	2	1	0	
Bis (2-chloroethyl) ether	3	2	1	
Bis (2-chloroethyl) formal	2	1	0	
Bis-diethylene glycol monethyl ether phthalate	1	1	0	
Bis (2,4-dimethylbutyl) maleate	1	1	0	
Bis (2-ethylhexyl) amine	3	1	0	
Bis (2-ethylhexyl)-ethanolamine	1	1	0	
Bis (2-ethylhexyl) maleate	0	1	0	
Bis (2-ethylhexyl) succinate	0	1	0	
Bis (p-tert-butylphenyl) phenyl phosphate	-	1	0	
Bis (2,2,4-trimethyl-pentanediolisobutyrate) diglycolate	0	1	0	
Borneol	2	2	0	
Boron oleate	0	1	1	
Boron phenyl ether	1	2	0	
Boron tribromide	3	0	2	W
Boron Trifluoride	4	0	1	
Boron Trifluoride etherate	3	2	1	W
Bromine	3	0	0	OX

Bromine pentafluoride	4	0	3	W, OX
Bromine Trifluoride	4	0	3	W, OX
Bromobenzene	2	2	0	
4-Bromodiphenyl	2	1	0	
o-Bromotoluene	2	2	0	
1,3-Butadiene	2	4	2	
Butadiene Monoxide	2	3	2	
Butane	1	4	0	
1,3-Butanediamine	3	2	0	
1,2-Butanediol	1	2	0	
1,4-Butanediol	1	1	0	
2,3-Butanediol	1	1	0	
2,3-Butanedione	1	3	0	
1-Butanethiol	2	3	0	
2-Butanethiol	2	3	0	
1-Butene	1	4	0	
2-Butene-cis.	1	4	0	
2-Butene-trans	1	4	0	
Butenediol	1	1	0	
Butyl Acetate	1	3	0	
Butyl Acetoacetate	1	2	0	
Butyl acetyl ricinoleate	2	1	0	
Butyl Acrylate	2	2	2	W
Butyl Alcohol	1	3	0	
Butylamine	3	3	0	
Butylamine Oleate	3	2	0	
Butylbenzene	2	2	0	
Butyl Benzoate	1	1	0	
2-Butylbiphenyl	0	1	-	
Butyl Bromide	2	3	0	
Butyl butyrate	2	2	0	
Butyl Chloride	2	3	0	
Butylcyclohexane	0	-	0	
Butylcyclopentane	0	-	0	
Butyldecalin	1	1	0	
Butylene glycol (pseudo)	0	2	-	
Butyl formate	2	3	0	
Butyl glycolate	0	2	-	
Butyl isovalerate	0	-	-	
2-Butyloctanol	1	1	0	

1,2-Butylene oxide	2	3	2	
2,3-Butylene oxide	2	3	2	
Butyl Formate	2	3	0	
N-Butyl Isocyanate	3	2	2	
Butyl Isovalerate	0	-	-	
Butyl Lactate	1	2	0	
Butyllithium	3	4	2	W
Butyl Methacrylate	2	2	0	
Butyl Naphthalene	1	1	0	
Butyl Nitrate	1	3	3	
Butyl Oxalate	0	1	0	
Butyl phosphate	3	1	-	
Boron phthalyl butyl glycolate	1	1	0	
Butyl Propionate	2	3	0	
Butyl ricinoleate	1	1	0	
Butyl sebacate	1	1	0	
Butyl Stearate	1	1	0	
Butyl Trichlorosilane	2	2	0	
2-Butyne	-	4	-	
Butyraldehyde	3	3	2	
Butyraldol	2	2	0	
Butyraldoxime	2	2	0	
Butyric Acid	3	2	0	
Butyric anhydride	1	2	1	W
Butyrolactone	0	1	0	
Butyronitrile	3	3	0	

GUIDE TO HAZARD INFORMATION – (C)

Compound	H	F	R	S/N
Calcium	3	1	2	W
Calcium Carbide	3	3	2	W
Calcium Chlorate	2	0	2	OX
Calcium Cyanide	3	0	1	
Calcium Hypochlorite	3	0	1	OX
Calcium Oxide	3	0	1	
Camphor	0	2	0	
Camphor oil (light)	2	2	0	

Caproic Acid	2	1	0	
Caprylaldehyde	2	2	0	
Caprylyl Chloride	3	2	1	
Carbon Disulfide	3	4	0	
Carbon Monoxide	3	4	0	
Carbon oxysulfide	3	4	1	
Carnauba wax	0	1	0	
Caron Tetrachloride	3	0	0	
Castor Oil	0	1	0	
Cellulose nitrate wet with alcohol	2	3	3	
Chlorine	4	0	0	OX
Chlorine Monoxide	3	4	3	
Chlorine trifluoride	4	0	3	W, OX
Chloroacetic Acid	3	1	0	
Chloroacetonitrile	3	2	0	
Chloroaceto Phenone	2	1	0	
Chloroacetyle chloride	3	0	1	
Chlorobenzene	2	3	0	
Chlorobenzotrifluoride	-	2	0	
2-Chloro-1,3-butadiene	2	3	0	
2-Chlorobutene-2	2	3	0	
Chlorodiethyl silane	3	3	1	
Chlorodinitro benzenes	3	1	4	
2-Chloro-4,6-di-tert-amylphenol	2	1	0	
2-Chloroethanol	4	2	0	
Chloroethyl acetate	2	2	0	
2-Chloroethyl acetate	2	2	0	
Chloro-4-ethylbenzene	1	2	0	
2-Chloroethyl-2-xenyl ether	-	1	0	
Chloroform	2	0	0	
1-Chlorohexane	-	3	0	
1-Chloronapthalene	1	1	0	
2-Chloro-5-nitrobenzotrifluoride	-	1	3	
1-Chloro-1-nitroethane	-	2	3	
1-Chloro-1-nitropropane	-	2	3	
2-Chloro-2-nitropropane	-	2	3	
2-Chloro-4-phenylphenol	2	1	0	
1-Chloro-2-propanol	2	2	0	
2-Chloro-1-propanol	2	2	0	
1-Chloropropylene	2	4	2	

Chloropicrin	4	0	3	
Chlorosilanes, n.o.s.	3	3	2	W
Chlorosulfonic acid	4	0	2	W, OX
2-Chloro propylene	2	4	0	
Chloro-4-tert-amylphenol	2	1	0	
2-Chloro-4-tert-amylphenyl methyl ether	1	1	0	
Chlorotoluene	2	2	0	
Chromic Acid	3	0	1	OX
Chromic chloride	3	3	0	
Chromyl chloride	3	0	2	W
Citral	0	2	0	
Citronellel	0	2	0	
Citronellol	0	1	0	
Cleaning solvent, stoddard solvent	0	2	0	
Cleaning solvents, 140(60) class	0	2	0	
Coal tar light oil	2	3	0	
Coal tar pitch	0	1	0	
Cobalt Naphtha	1	2	0	
Coconut Oil	0	1	0	
Cod Liver Oil	0	1	0	
Collodion	1	4	0	
Corn Oil	0	1	0	
Cottonseed oil refined	0	1	0	
Creosote Oil	2	2	0	
o-Cresol	3	2	0	
Cresyl diphenyl phosphate	0	1	0	
Crotonaldehyde	4	3	2	
Crotonic Acid	3	2	0	
Crotononitrile	-	1	0	
Crotonyl alcohol	-	3	2	
1-Crotyl bromide	2	3	2	
1-Crotyl chloride	2	3	2	
Cumene	2	3	1	
Cumene hydroperoxide	1	2	4	OX
Cupric Nitrate	1	0	0	OX
Cyanamide	4	1	3	
Cyanoacetic acid	3	1	0	
2-Cyanoethyl acrylate	2	1	1	
Cyanogen	4	4	2	
Cyanogen Bromide	4	0	1	

Cyclamen aldehyde	-	2	0	
Cyclobutane	1	4	0	
1,5,9-Cyclododecatriene	-	2	0	
Cycloheptane	0	3	0	
Cyclohexane	1	3	0	
1,4-Cyclohexane dimethanol	-	1	0	
Cyclohexanethiol	-	2	0	
Cyclohexanol	1	2	0	
Cyclohexanone	1	2	0	
Cyclohexene	1	3	0	
Cyclohexenone	1	3	0	
Cyclohexyl acetate	1	2	0	
Cyclohexylamine	3	3	0	
Cyclohexylbenzene	2	1	0	
Cyclohexyl Chloride	2	3	0	
Cyclohexylcyclohexanol	0	1	0	
Cyclohexyl formate	-	2	0	
Cyclohexyltrichlorosilane	2	2	1	
1,5-Cyclooctadiene	-	3	0	
Cyclopentane	1	3	0	
Cyclopentanol	0	2	0	
Cyclopentanone	2	3	0	
Cyclopentene	1	3	1	
Cyclopentanone	2	3	0	
Cyclopropane	1	4	0	

GUIDE TO HAZARD INFORMATION – (Decaborane – Diethylene glycol phthalate)

Compound	H	F	R	S/N
Decaborane	3	2	1	
Decahydronapthalene	2	2	0	
Decahydronapthalene-trans	0	2	0	
Decane	0	2	0	
Decanol	0	2	0	
1-Decene	0	2	0	
Decyl acrylate	2	1	0	
Decylamine	2	1	0	

Decylbenzene	2	1	0	
Decylnapthalene	1	1	0	
Decyl nitrate	-	1	0	
Dehydroacetic Acid	1	1	0	
Denatured Alcohol	0	3	0	
Deuterium	0	4	0	
Diacetone Alcohol	1	2	0	
Diallyl phthalate	2	1	0	
1,3-Diamino-2-propanol	2	1	0	
Diamylamine	3	2	0	
Diamylbenzene	0	1	0	
Diamylbiphenyl	0	1	0	
Diamylene	0	2	0	
Diamyl maleate	0	1	0	
Diamyl napthalene	0	1	0	
2,4-Diamylphenol	2	1	0	
Diamyl phthalate	0	1	0	
Diamyl Sulfide	2	2	0	
Dibenzoyl Peroxide	1	4	4	OX
Dibenzyl ether	0	1	0	
Diborane	4	4	3	W
Dibutoxy ethyl phthalate	0	1	0	
Dibutoxymethane	0	2	0	
Dibutoxy tetraglycol	2	1	0	
Dibutylamine	3	2	0	
Dibutylaminoethanol	3	2	0	
Dibutyl Ether	2	3	1	
Dibutyl isophthalate	0	1	0	
Dibutylisopropanolamine	2	1	0	
Dibutyl maleate	1	1	0	
Dibutyl Oxalate	0	1	0	
Dibutyl Phosphite	3	2	0	
Dibutyl Phthalate	0	1	0	
Dibutyl Sebacate	0	1	0	
Dicapryl phthalate	0	1	0	
Dichloroacetyl chloride	3	2	2	W
3,4-Dichloroaniline	3	1	0	
o-Dichlorobenzene	2	2	0	
2,3-Dichlorobutadiene-1,3	3	3	2	
1,2-Dichlorobutane	2	2	0	

2,3-Dichlorobutane	2	2	0	
1,4-Dichlorobutane	3	2	0	
1,3-Dichlorobutene-2	2	3	0	
1,3-Dicholoro-2-butene	3	3	2	
3,4-Dichlorobutene-1	3	2	1	
Dichlorodimethylether, symmetrical	4	3	1	
1,1-Dichloroethene	2	4	2	
1,2-Dicholoroethyl ether	3	2	1	
1,2-Dichloroethylene	2	3	2	
2,2-Dichloroethyl ether	3	2	1	
1,3-Dicholoro-2,4-hexadiene	-	2	0	
Dichloroisopropyl ether	2	2	0	
2,2-Dichloro isopropyl ether	2	2	0	
1,1-Dichloro-1-nitro ethane	2	2	3	
1,1-Dichloro-1-nitro propane	2	2	3	
1,5-Dicholoropentane	2	3	0	
Dichloropentanes	2	2	0	
1,3-Dicholoro-2-propanol	2	2	0	
1,3-Dichloropropene	2	3	0	
2,3-Dichloropropene	3	3	0	
2,4-Dichlorophenol	-	1	0	
Dichlorosilane	3	4	2	W
Dicyclohexylamine	3	1	0	
Dicyclopentadiene	1	3	1	
Didecyl Ether	0	1	0	
Diesel Fuel Oil No. 1	0	2	0	
Diethanolamine	1	1	0	
Diethyl acetoacetate	2	2	0	
Diethylaluminum chloride	3	4	3	W
Diethylaluminum hydride	-	3	3	W
Diethylamine	3	3	0	
2-(Diethylamino) ethanol	2	2	0	
3-(Diethylamino)-prpylamine	2	2	0	
Di-2-ethylbutylphthalate	0	1	0	
Diethyl carbamyl chloride	2	1	2	W
Diethyl carbonate	2	3	1	
Diethylcyclohexane	2	2	0	
1,3-Diethyl-1,3-diphenyl urea	1	1	0	
Diethyl fumarate	1	1	0	
Diethylene glycol	1	1	0	

Diethylene glycol bis (allylcarbonate)	1	1	0	
Diethylene glycol bis(2-butyoxyethyl carbonate)	1	1	1	
Diethylene glycol bis (butyl carbonate)	1	1	1	
Diethylene glycol bis (phenylcarbonate)	0	1	1	
Diethylene glycol butyl ether acetate	-	1	0	
Diethylene glycol diacetate	1	1	0	
Diethylene glycol dibenzoate	0	1	0	
Diethylene glycol dibutyl ether	1	1	0	
Diethylene glycol diethyl ether	1	2	0	
Diethylene glycol diethyl levulinate	0	1	0	
Diethylene glycol dimethyl ether	1	2	1	
Diethylene glycol dipropionate	1	1	0	
Diethylene glycol ethyl ether	1	1	0	
Diethylene glycol ethyl ether phthalate	0	1	0	
Diethylene glycol methyl ether	2	2	0	
Diethylene glycol methyl ether acetate	0	2	0	
Diethylene glycol monobutyl ether	1	2	0	
Diethylene glycol monobutyl ether acetate	1	1	0	
Diethylene glycol monoethyl ether	1	1	0	
Diethylene glycol monoethyl ether acetate	1	1	0	
Diethylene glycol monoisobutyl ether	1	1	0	
Diethylene glycol monomethyl ether	1	1	0	
Diethylene glycol monomethyl ether formal	1	1	0	
Diethylene glycol n-butyl ether	1	1	0	
Diethylene glycol phthalate	0	1	0	

GUIDE TO HAZARD INFORMATION – (Diethyl triamine – Dypnone)

Compound	H	F	R	S/N
Diethylene Triamine	3	1	0	
Di-2-ethylhexyl adipate	0	1	0	
Diethyl Ketone	1	3	0	
Diethyl maleate	1	1	0	
Diethyl malonate	0	1	0	
3,3-Diethylpentane	0	3	0	
Diethyl peroxide	-	4	4	

Diethyl phthalate	0	1	0	
2,2-Diethyl-1,3-propanediol	2	1	0	
Diethyl selenide	2	-	0	
Diethylsulfate	3	1	0	
Diethyl Succinate	1	1	0	
Diethyl Sulfate	3	1	1	
Diethyl tartrate	0	1	0	
Diethyl telluride	1	4	3	W
Diethyl terephthalate	0	1	0	
Diethylzinc	3	4	3	W
Dihexylamine	2	1	0	
Diisobutylaluminum hydride	-	3	3	W
Diisobutylamine	3	3	0	
Diisobutyl Carbinol	1	2	0	
Diisobutylene	1	3	0	
Diisobutyl Ketone	1	2	0	
Diisodecyl adipate	0	1	0	
Diisodecyl phthalate	0	1	0	
Diisooctyl Phthalate	0	1	0	
Diisopropanolamine	2	1	0	
Diisopropylamine	3	3	0	
Diisopropyl Benzene	0	2	0	
Diisopropylmaleate	1	1	0	
Diisopropyl peroxydicarbonate	0	4	4	OX
Diketene	4	2	2	
2,5-Dimethoxyaniline	2	1	0	
2,5-Dimethoxychlorobenzene	2	1	0	
Dimethoxyethyl phthalate	0	1	0	
Dimethoxy tetraglycol	1	1	0	
Dimethylacetamide	2	2	0	
Dimethylamine	3	4	0	
Dimethyl anthranilate	1	2	0	
2-(Dimethylamino) ethyl methacrylate	2	2	0	
3-(Dimethylamino)-propionitrile	-	2	1	
3-(Dimethylamino)-propylamine	3	2	0	
N, N-Dimethylaniline	3	2	0	
Dimethylbenzylcarbinyl acetate	1	1	0	
2,2-Dimethylbutane	1	3	0	
2,3-Dimethylbutane	1	3	0	
2,3-Dimethyl-1-butene	0	3	0	

2,3-Dimethyl-2-butene	0	3	0
1,3-Dimethylbutyl acetate	1	2	0
1,3-Dimethylbutylamine	2	3	0
Dimethyl chloracetal	2	2	0
Dimethylcyanamide	4	2	1
1,2-Dimethylcyclohexane	0	-	0
1,3-Dimethylcyclohexane	0	3	0
1,4-Dimethylcyclohexane	1	3	0
1,3-Dimethylcyclohexane-cis	0	3	0
1,3-Dimethylcyclohexane-trans	0	3	0
Dimethyl decalin	0	2	0
Dimethyldichlorosiliane	3	3	1
Dimethyldioxane	2	3	0
1,3-Dimethyl-1,3-diphenylcyclobutane	0	1	0
2,4-Dimethyl-3-ethylpentane	0	3	0
N, N-Dimethylformamide	1	2	0
2,5-Dimethylfuran	2	3	0
Dimethyl glycol phthalate	0	1	0
3,3-Dimethylheptane	0	3	0
2,3-Dimethylhexane	0	3	0
2,4-Dimethylhexane	0	3	0
Dimethyl hexynol	0	2	0
1,1-Dimethylhydrazine	4	3	1
Dimethylisophthalate	0	1	0
Dimethyl Maleate	1	1	0
2,6-Dimethylmorpholine	2	2	0
2,3-Dimethyloctane	0	2	0
3,4-Dimethyloctane	0	2	0
Dimethyl-o,o-dichlorovinyl-2,2-phosphate (technical)	3	1	-
2,3-Dimethylpentane	0	3	0
2,4-Dimethylpentane	0	3	0
2,4-Dimethyl-3-pentanol	0	2	0
2,3-Dimethylpentaldehyde	1	3	0
Dimethyl Phthalate	0	1	0
Dimethylpiperazine-cis	2	2	0
2,2-Dimethylpropane	0	4	0
2,5-Dimethylpyrazine	-	2	0
Dimethyl sebacate	0	1	0
Dimethyl Sulfate	4	2	0

Dimethyl Sulfide	1	4	0	
Dimethyl Sulfoxide	1	1	0	
Dimethyl terephthalate	1	1	0	
2,4-Dinitroanaline	3	1	3	
Dinitrobenzene (ortho)	3	1	4	
1,2-Dinitrobenzene	3	1	4	
1,2-Dinitrobenzol	3	1	4	
Dinitrochlorobenzene	3	1	4	
2,4-Dinitrotoluene	3	1	3	
2,5-Dinitrotoluene	3	1	3	
2,6-Dinitrotoluene	3	1	3	
Dioctyle adipate	0	1	0	
Dioctyle azelate	0	1	0	
Dioctyl Ether	0	1	0	
Dioctyl phthalate	0	1	0	
p-Dioxane	2	3	1	
Di(oxenyl) phenyl phosphate	0	1	0	
Dioxolane	2	3	2	
Dipentene	0	2	0	
Diphenylamine	3	1	0	
1,1-Diphenylbutane	0	1	0	
Diphenyldichlorosilane	3	1	0	
Diphenyldodecyl phosphite	0	1	0	
1,1-Diphenylethane	0	1	0	
1,2-Diphenylethane	0	1	0	
Diphenylmethane	1	1	0	
Diphenyl (o-xenyl) phosphate	0	1	0	
Diphenyl oxide	1	1	0	
1,1-Diphenylpentane	0	1	0	
Diphenyl Phthalate	0	1	0	
1,1-Diphenypropane	0	1	0	
Dipropylaluminum hydride	-	3	3	W
Dipropylamine	3	3	0	
Dipropylene glycol	0	1	0	
Dipropylene glycol methyl ether	0	2	0	
Di-sec-butylamine	3	3	0	
Di-tert-amylcyclohexanol	0	1	0	
Di-tert-amylphenoxy ethanol	0	1	0	
2,5-Di-tert-butylhydroquinone	1	1	0	
Di-tert-butyl-p-cresol	0	1	0	

Di-tert-butyl peroxide	3	2	4	OX
Ditridecyl phthalate	0	1	0	
Divinyl acetylene	-	3	3	
Divinylbenzene	1	2	2	
Divinyl Ether	2	4	2	
Dodecane	0	2	0	
1-Dodecanethiol	2	1	0	
1-Dodecanol	0	1	0	
4-Dodecycloxy-2-hydroxy-benzophenone	-	1	0	
Dodecyl benzene (crude)	1	1	0	
Dodecylene	0	1	0	
Dodecyl phenol	0	1	0	
Dypnone	1	1	0	

GUIDE TO HAZARD INFORMATION – (E – G)

Compound	H	F	R	S/N
Eicosane	-	1	0	
Endo-tetrahydrodicyclopentadiene	-	-	0	
Endrin (dry)	2	0	0	
Epichlorohydrin	3	2	2	
Ethane	1	4	0	
Ethanediol diformate	1	2	0	
Ethanolamine	3	2	0	
Ethoxyacetylene	2	3	1	
Ethoxybenzene	0	2	0	
2-Ethoxy-3,4-dihydro-2-pyran	2	2	1	
2-Ethoxyethyl acetate	2	2	0	
3-Ethoxypropanal	2	2	0	
3-Ethoxypropionaldehyde	2	3	0	
3-Ethoxypropionic acid	2	1	0	
Ethoxytriglycol	0	1	0	
Ethyl abietate	0	1	0	
Ethyl Acetate	1	3	0	
Ethyl acetoacetate	2	2	0	
Ethyl acetyl glycolate	0	2	0	
Ethyl Acrylate	2	3	2	
Ethyl Alcohol	0	3	0	

Ethylaluminum dichloride	3	3	3	W
Ethylaluminum sesquichloride	-	3	3	W
Ethylamine	3	4	0	
Ethyl amino ethanol	-	2	0	
Ethylaniline	3	2	0	
Ethylaneline	3	2	0	
Ethylbenzene	2	3	0	
Ethyl Benzoate	1	1	0	
Ethyl benzoylacetate	0	1	0	
Ethylbenzylaniline	2	1	0	
Ethyl borate	2	3	0	
Ethyl Bromide	2	1	0	
Ethyl Bromoacetate	-	2	0	
Ethylbutylamine	3	3	0	
2-Ethyl-1-butene	0	3	0	
3-(2-Ethylbutoxy) propionic acid	2	1	0	
Ethylbutylamine	3	3	0	
Ethyl Butyl Carbonate	2	2	1	
Ethyl Butyl Ether	2	3	0	
2-Ethyl butyl glycol	0	2	0	
Ethyl Butyl Ketone	1	2	0	
2-Ethyl-2-butyl-1,3-propanediol	2	1	0	
Ethyl Butyrate	0	3	0	
2-Ethylbutyl acetate	1	2	0	
2-Ethylbutyl acrylate	2	2	0	
2-Ethylbutyl alcohol	1	2	0	
2-Ethylbutyraldehyde	2	3	1	
2-Ethylbutyric acid	2	1	0	
Ethyl Caproate	2	2	0	
Ethyl Caprylate.	2	2	0	
Ethyl Chloride	1	4	0	
Ethyl chloroacetate	-	3	0	
Ethyl cholorformate	4	3	1	
Ethyl Crotonate	2	3	0	
Ethyl cyanoacetate	2	1	0	
Ethylcyclobutane	1	3	0	
Ethylcyclohexane	1	3	0	
Ethylcyclopentane	1	3	0	
Ethyl decanoate	0	1	0	
Ethyl dichlorosilane	3	3	0	

Ethylene	1	4	2
Ethylene carbonate	2	1	1
Ethylene cyanohydrin	1	2	2
Ethylenediamine	3	2	0
Ethylene dibromide	3	0	0
Ethylene Dichloride	2	3	0
Ethyl ether	1	4	1
Ethyl Formate	2	3	0
Ethyl Formate (ortho)	0	3	0
Ethyl fluoride	-	4	0
Ethylene Glycol	1	1	0
Ethylene Glycol Dibutyl Ether	1	2	0
Ethylene glycol diethyl ether	1	3	0
Ethylene glycol dimethyl ether	2	2	0
Ethylene Glycol Ethylbutyl Ether	1	2	0
Ethylene glycol ethylhexyl ether	0	1	0
Ethylene glycol isopropyl ether	1	3	0
Ethylene glycol monoacetate	0	1	0
Ethylene glycol monoacrylate	2	1	1
Ethylene glycol monobenzyl ether	2	1	0
Ethylene Glycol Monobutyl Ether	2	2	0
Ethylene Glycol Monobutyl Ether Acetate	1	2	0
Ethylene Glycol Monoethyl ether	2	2	0
Ethylene Glycol Monoethyl ether acetate	1	2	-
Ethylene Glycol Monoisobutyl ether	2	2	-
Ethylene Glycol Monomethyl ether	2	2	0
Ethylene Glycol Monomethyl ether acetal	1	2	-
Ethylene Glycol Monomethyl ether acetate	1	2	-
Ethylene Glycol Monomethyl ether formal	1	2	-
Ethylene Glycol n-butyl ether	1	2	0
Ethylene Glycol phenyl ether	0	1	0
Ethylenediamine	3	2	0
Ethylene Oxide	3	4	3
Ethylenimine	4	3	3
2-Ethylhexanal	2	2	1
2-Ethylhexanol	2	2	0
2-Ethylhexanoic acid	1	1	0
2-Ethylhexyl acetate	2	2	0
2-Ethylhexyl acrylate	2	2	0
2-Ethylhexylamine	2	2	0

2-Ethylhexyl chloride	2	2	0	
2-Ethylhexyl ether	1	1	0	
2-Ethyl-1,3-hexanediol	1	1	0	
2-Ethylhexyl acrylate	2	2	2	
1,1-Ethylidene dichloride	2	3	0	
1,2-Ethylidene dichloride	2	3	0	
Ethyl Isobutyrate	0	3	0	
2-Ethylisohexanol	1	2	-	
Ethylene Oxide	3	4	3	
Ethyl lactate	2	2	0	
Ethyl Mercaptan	2	4	0	
Ethylene Oxide	3	4	3	
Ethyl methacrylate	2	3	0	
7-Ethyl-2-methyl-4-hendecanol	0	1	0	
4-Ethylmorpholine	2	3	0	
1-Ehtylnapthalene	0	1	0	
Ethyl Nitrate	2	3	4	
Ethyl Nitrite	3	4	4	
3-Ethyloctane	0	2	0	
4-Ethyloctane	0	2	0	
Ethyl Oxalate	0	2	0	
Ethyl phenylacetate	0	1	-	
Ethyl phenyl ketone	-	1	0	
Ethyl phthalyl ethyl glycolate	0	1	0	
Ethyl propenyl ether	2	3	1	
Ethyl propyl ether	1	3	0	
Ethyl Propionate	-	3	0	
2-Ethyl-3-propylacrolein	2	2	1	
2-Ethyl-3-propylacrylic acid	2	1	1	
Ethyl p-toluene sulfonamide	-	1	0	
Ethyl p-toluene sulfonate	-	1	0	
Ethyl Silicate	2	2	0	
Ethyltrichloro silane	3	3	2	W
Fish oil	0	1	0	
Fluoboric acid	3	0	0	
Fluorine	4	0	3	W, OX
Fluorine, compressed	4	0	4	W
Fluorobenzene	-	3	0	
Formaldehyde	3	4	0	
Formaldehyde 37%, 15% menthanol	3	2	0	

Formaldehyde 37% menthanol-free	3	2	0	
Formaldehyde (water solution)	2	2	0	
Formamide	2	1	0	
Formic Acid	3	2	0	
Fuel oil no. 1	0	2	0	
Fuel oil no. 2	0	2	0	
Fuel oil no. 4	0	2	0	
Fuel oil no. 5	0	2	0	
Fuel oil no. 6	0	2	0	
Furan	1	4	1	
Furfural	3	2	0	
Furfuryl acetate	1	2	1	
Furfuryl Alcohol	1	2	1	
Furfurylamine	-	3	0	
Gallium arsenide	3	1	2	W
Gallium phosphide	3	0	1	W
Gallium Tricholoride	3	0	1	
Gas, blast furnace	2	4	0	
Gas, coal gas	2	4	0	
Gas, coke-oven	2	4	0	
Gas, Natural	1	4	0	
Gas oil	0	2	0	
Gas, oil gas	2	4	0	
Gasoline	1	3	0	
Gasoline (100-130 aviation grade)	1	3	0	
Gasoline (115-145 aviation grade)	1	3	0	
Gasoline (casinghead)	1	4	0	
Gasoline 56-100 Octane	1	3	0	
Gas, producer	2	4	0	
Gas, water	2	4	0	
Gas, water (carbureted)	2	4	0	
Geraniol	0	1	0	
Geranyl acetate	0	1	0	
Geranyl butyrate	0	1	0	
Geranyl formate	0	2	0	
Geranyl propionate	0	1	0	
Germane	4	4	3	W
Glucose pentapropionate	1	1	0	
Glycerine	1	1	0	
Glyceryl triacetate	1	1	0	

Glyceryl tributyrate	0	1	0	
Glyceryl tripropionate	0	1	0	
Glycidyl Acrylate	0	2	0	
Glycol benzyl ether	0	1	0	
Glycol diacetate	1	1	0	
Glycol dimercaptoacetate	2	1	0	

GUIDE TO HAZARD INFORMATION – (H – L)

Compound	H	F	R	S/N
Hendecane	0	2	0	
Heptadecanol	0	1	0	
Heptane	1	3	0	
2-Heptanol	0	2	0	
3-Heptanol	0	2	0	
4-Heptanone	2	2	0	
3-Heptene (mixed cis and trans)	0	3	0	
Heptylamine	2	2	0	
Heptylene	0	3	0	
Heptylene-2-trans	0	3	0	
Hexachlorobutadiene	2	1	1	
Hexachloro diphenyl oxide	2	1	1	
Hexadecane	0	1	0	
Hexadecylene-1	0	1	0	
Hexadecyltrichlorosilane	3	1	0	
2,4-Hexadienal	2	2	0	
1,4-Hexadiene	0	3	0	
Hexamethyldisilazane	1	3	1	
Hexanal	2	3	1	
Hexane	1	3	0	
2,5-Hexanediol	2	1	0	
1,2,6-Hexanetriol	1	1	0	
3-Hexanone	1	3	0	
1-Hexene	1	3	0	
2-Hexene (mixed cis-and-trans-isomers)	1	3	0	

2-Hexene-cis	0	3	0	
3-Hexenol-cis	1	2	0	
Hexyl acetate	1	2	0	
Hexyl Alcohol	1	2	0	
Hexylamine	2	3	0	
Hexyl cinnamic aldehyde	-	1	0	
Hexylene glycol	1	1	0	
Hexyl ether	2	2	0	
Hexyl Methacrylate	0	2	0	
Hydrazine (Anhydrous)	3	3	3	
Hydrindane	-	-	0	
Hydriodic acid	3	0	0	
Hydrobromic acid solution	3	0	0	
Hydrocyanic Acid-96%	4	4	2	
Hydrogen	0	4	0	
Hydrogen chloride, anhydrous & refrigerated liquid	3	0	1	
Hydrogen fluoride, anhydrous	4	0	1	
Hydrogen peroxide, aqueous solutions	2	0	1	OX
Hydrogen sulfide	4	4	0	
Hydrogen, refrigerated liquid	3	4	0	
Hydrochloric Acid	3	0	0	
Hydrobromic Acid	3	0	0	
Hydrofluoric Acid	4	0	0	
Hydroquinone	2	1	0	
Hydroquinone di-(beta-hydroxyethyl) ether	-	1	0	
Hydroquinone monomethyl ether	-	1	0	
Hydroxycitronellal	-	1	0	
2-Hydroxyethyl acrylate	2	1	2	
(2-Hydroxyethyl)-ethylenediamine	1	1	0	
4-(2-Hydroxyethyl) morpholine	2	1	0	
1-(2-Hydroxyethyl) piperazine	0	1	0	
Hydroxylamine	2	0	3	
Ionone alpha (Alpha-ionone)	-	1	0	
Ionone beta (Beta-ionone)	-	1	0	
Iron carbonyl	2	3	1	W
Isano oil	-	1	3	
Isoamyl Acetate	1	3	0	
Isoamyl Alcohol	1	2	0	
Isoamyl butyrate	-	2	-	

Isoamyl chloride	-	3	-	
Isobornyl acetate	1	2	0	
Isobutane	1	4	0	
Isobutyl Acetate	1	3	0	
Isobutyl Acrylate	1	3	1	
Isobutyl Alcohol	1	3	0	
Isobutylamine	2	3	0	
Isobutylbenzene	2	2	0	
Isobutyl butyrate	0	2	-	
Isobutyl Chloride	2	3	0	
Isobutylcyclohexane	0	-	0	
Isobutyl formate	-	3	-	
Isobutyl heptyl ketone	2	2	0	
Isobutyl isobutyrate	0	2	0	
Isobutyl Methyl Ketone	2	3	0	
Isobutyl phenylacetate	0	1	0	
Isobutyl phosphate	-	1	-	
Isobutyraldehyde	2	3	1	
Isobutyric Acid	1	2	0	
Isobutyric Anhydride	1	2	1	W
Isobutyronitrile	3	3	0	
Isodecaldehyde	0	2	0	
Isodecane	0	2	0	
Isodecanoic Acid	0	1	0	
Isodecanol, mixed isomers	0	1	0	
Isoevgenol	0	1	0	
Isoheptane	0	3	0	
Isoheptane, mixed isomers	1	3	0	
Isohexane	1	3	0	
Isooctane	0	3	0	
Isooctanoic Acid	0	1	0	
Isooctenes	0	3	0	
Isooctyl Alcohol	0	2	0	
Isooctyl nitrate	-	1	-	
Isopentaldehyde	2	3	0	
Isopentane	1	4	0	
Isopentanoic acid	1	-	0	
Isophorone	2	2	0	
Isophorone diisocyanate	2	1	1	W
Isophthaloyl chloride	-	1	0	

Isoprene	1	4	2	
Isopropenyl acetate	2	3	0	
3-Isopropoxypropionitrile	1	2	1	
Isopropyl Acetate	1	3	0	
Isopropyl acetylene	2	4	2	
Isopropyl alcohol	1	3	0	
Isopropylamine	3	4	0	
Isopropyl benzoate	1	1	-	
Isopropyl bicyclohexyl	0	1	0	
2-Isopropylbiphenyl	0	1	0	
Isopropyl chloride	2	4	0	
Isopropylcyclohexane	1	-	0	
Ispropylcyclohexylamine	3	3	0	
Isopropyl Ether	1	3	1	
Isopropyl Formate	2	3	0	
4-Isopropylheptane	0	2	0	
Isopropyl lactate	2	2	0	
Jet Fuels (Jet A and Jet A-1)	0	2	0	
Jet Fuels (Jet B)	1	3	0	
Jet Fuels (JP-4)	1	3	0	
Jet Fuels (JP-5)	0	2	0	
Lactonitrile	4	2	1	
Lanolin	0	1	0	
Lard oil (commercial or animal)	0	1	0	
Lard oil (pure)	0	1	0	
Lauryl bromide	1	1	0	
Lead Arsenates	2	0	0	
Lead Nitrate	1	0	0	OX
Lead Thiocyanate	1	1	1	
Linalool (ex bios de rose; synthetic)	-	2	0	
Linseed oil, raw	0	1	0	
Lithium	1	1	2	W
Lithium aluminum hydride	3	2	2	W
Lithium Hydride	3	2	2	W
Lithium Metal	3	2	2	W
Lubricating Oil, Mineral	0	1	0	
Lubricating oil, spindle	0	2	0	
Lubricating oil, turbine	0	1	0	
Lynalyl acetate (ex bois de rose; synthetic)	-	2	0	

GUIDE TO HAZARD INFORMATION – (M)

Compound	H	F	R	S/N
M-acetoacet xylidide	2	1	0	
M- or p-cresol	3	2	0	
M-chloronitrobenzene	3	1	0	
M-diethyl benzene	2	2	0	
M-ethyltoluene	-	2	0	
M-nitrotoluene	3	1	1	
M-terphenyl	0	1	0	
M-tolydiethyanolamine	2	1	0	
M-xylene	2	3	0	
Magnesium (including all alloys)	0	1	1	W
Magnesium Nitrate	1	0	0	OX
Magnesium Perchlorate	1	0	0	OX
Maleic Anhydride	3	1	1	
2-Mercaptoethanol	2	2	-	
Menhaden oil	0	1	0	
Mercuric Cyanide	3	0	0	
Mesityl Oxide	2	3	1	
Metaldehyde	1	3	1	
Methacrylic Acid	3	2	2	
Methacrylonitrile	2	3	2	
Methallyl alcohol	2	3	0	
Methallyl chloride	2	3	1	
Methane	1	4	0	
Methoxy ethyl phthalate	0	1	0	
Methoxy triglycol	0	1	0	
Methoxy triglycol acetate	0	1	0	
2-Methoxybutanol	1	2	0	
2-Methoxybutyl acetate	1	2	0	
2-Methoxybutyraldehyde	0	2	0	
2-Methoxyethyl acrylate	0	2	0	
3-Methoxypropionitrile	4	2	1	
3-Methoxypropylamine	2	3	0	
Methyl abietate	0	1	0	
Methyl acetate	1	3	0	
Methyl acetoacetate	2	2	0	

Methyl acrylate	3	3	2	
Methylal	2	3	2	
Methyl Alcohol	1	3	0	
Methylaluminum sesquibromide	-	3	3	W
Methylaluminum sesquichloride	-	3	3	W
Methyl amyl ketone	1	2	0	
Methyl anthranilite	0	1	0	
Methyl benzoate	0	2	0	
Methyl borate	2	3	1	
Methyl bromide	3	1	0	
3-Methyl-1-butene	2	4	0	
Methyl butyl ketone	2	3	0	
2-Methyl butynol	2	3	0	
Methyl butyrate	2	3	0	
Methyl carbonate	3	3	0	
Methyl cellosolve acetate	0	2	0	
Methyl chloride	1	4	0	
Methyl chloroacetate	1	3	0	
Methyl cyclopentadiene	1	2	1	
Methyl dihydroabietate	1	1	0	
Methyl ether	1	4	1	
2-Methyl-2-ethyl-1,3-dioxolane	2	3	0	
Methyl ethyl ether	1	4	1	
Methyl ethyl ketone	1	3	0	
Methyl formate	2	4	0	
Methyl glycol acetate	1	2	0	
Methylamine	3	4	0	
Methyl Amyl Ketone	1	2	0	
Methyl Benzoate	0	2	0	
2-Methylbiphenyl	2	-	0	
2-Methylbutyraldeyde	2	3	0	
Methyl Borate	2	3	1	
Methyl Bromide	3	1	0	
3-Methyl-2-butanethiol	2	3	0	
2-Methyl-1-butanol	2	2	0	
2-Methyl-2-butanol	1	3	0	
2-Methyl-1-butene	2	4	0	
2-Methyl-2-butene	2	3	0	
Methyl Butyl Ketone	2	3	0	
Methyl Carbonate	3	3	0	

Methyl Cellosolve Acetate	0	2	0	
Methyl Chloride	2	4	0	
Methyl Chloroacetate	2	2	1	
Methyl chloromethyl ether, anhydrous	3	3	2	
Methylcyclohexane	2	3	0	
2-Methylcyclohexanol	-	2	0	
3-Methylcyclohexanol	0	2	0	
4-Methylcyclohexanol	-	2	0	
Methylcyclohexanone	-	2	0	
4-Methylcyclohexane	1	3	0	
Methylcyclohexyl acetate	1	2	0	
Methylcyclopentane	2	3	0	
2-Methyldecane	0	2	0	
Methyldichlorosilane	3	3	2	W
1-Methyl-3,5-diethyl-benzene	0	2	0	
Methylene Chloride	2	1	0	
Methylenedianiline	3	1	0	
Methylene Diisocyanate	1	2	1	W
Methyl Ether	1	4	1	
Methyl Ethyl Ether	1	4	1	
2-Methyl-4-ethylhexane	0	3	0	
3-Methyl-4-ethylhexane	0	3	0	
Methyl Ethyl Ketone	1	3	0	
Methyl ethyl ketoxime	-	2	0	
2-Methyl-3-ethylpentane	0	3	0	
2-Methyl-5-ethyl-piperidine	2	2	0	
2-Methyl-5-ethylpyridine	3	2	0	
Methyl Formate	2	4	0	
2-Methylfuran	2	3	1	
Methyl Glycol Acetate	1	2	0	
Methylheptenone	1	2	0	
Methyl heptadecyl ketone	0	1	0	
Methyl heptine carbonate	-	2	0	
Methyl heptyl ketone	0	2	0	
Methyl hexyl ketone	0	2	0	
2-Methylhexane	0	3	0	
3-Methylhexane	0	3	0	
Methyl Hexyl Ketone	0	2	0	
Methylhydrazine	4	3	2	
Methyl-3-hydroxybutyrate	1	2	0	

Methyl ionone	0	1	0	
Methyl Isoamyl Ketone	1	2	0	
Methyl Isobutyl Carbinol	2	2	0	
Methyl Isobutyl Ketone	2	3	1	
Methyl Isocyanate	4	3	2	W
Methyl iso eugenol	0	1	0	
Methyl isoamyl ketone	1	2	0	
Methyl isobutyl carbinol	2	2	0	
Methyl isobutyl ketone	2	3	1	
Methyl isocyanate	4	3	2	W
Methyl isopropenyl ketone	2	-	0	
Methyl Lactate	1	2	0	
Methyl Mercaptan	4	4	0	
Methyl Methacrylate	2	3	2	
4-Methylmorpholine	2	3	0	
1-Methylnapthalene	2	2	0	
Methyl nonyl ketone	0	2	0	
Methyl n-propyl ether	0	3	0	
Methyl para cresol	-	2	0	
Methyl Parathion (solid)	4	1	2	
Methyl pentadecyle ketone	0	1	0	
Methylpentaldehyde	2	3	1	
2-Methylpentane	1	3	0	
3-Methylpentane	1	3	0	
2-Methyl-2,4-pentanediol	0	1	0	
2-Methylpentanoic acid	0	1	0	
2-Methyl-1-pentanol	0	2	0	
2-Methyl-1-pentene	1	3	0	
2-Methyl-2-pentene	1	3	0	
3-Methyl-1-pentynol	1	2	0	
2-Methyl-1,3-pentadiene	0	3	0	
2-Methyl-1,3-pentadiene	0	3	0	
4-Methyl-1,3-pentadiene	0	3	1	
4-Methyl-2-pentanol acetate	1	2	0	
2-Methyl-1-Pentene	1	3	0	
4-Methyl-2-Pentene	1	3	0	
4-Methyl-1-Pentene	1	3	0	
Methyl phenylacetate	0	2	0	
Methylphenyl carbinol	0	2	0	
Methyl phenyl carbinyl acetate	0	2	0	

Methyl phthaly ethyl glycolate	2	1	0	
2-Methyl-2-propanethiol	2	3	0	
2-Methylpropenal	3	3	2	
2-Methylpropene	1	4	0	
Methyl propionate	1	3	0	
Methyl propyl acetylene	-	3	-	
Methyl Phenylacetate	0	2	0	
1-Methyl Piperazine	2	2	0	
Methyl Propionate	1	3	0	
Methyl propyl carbinol	0	2	0	
Methyl Propyl Ketone	2	3	0	
2-Methylpyrazine	2	2	0	
Methylpyrrole	2	3	1	
Methylpyrrolidine	2	3	1	
1-Methyl-2-pyrrolidine	2	1	0	
Methyl Salicylate	1	1	0	
Methyl Stearate	0	1	0	
2-Methyltetrahydrofuran	2	3	0	
Methyl Toluene Sulfonate	2	1	0	
Methyltrichlorosilane	3	3	2	W
Methyl undecyl ketone	1	1	0	
2-Methylvalderaldehyde	1	3	0	
Methyl Vinyl Ketone	4	3	2	
Mineral Oil	0	1	0	
Mineral seal oil typical	0	2	0	
Mineral Spirits	0	2	0	
Mono-(trichloro)tetra-(monopotassium dichloro)-penta-s-triazinetrione acid	3	0	2	W, OX
Monochloro-s-triazinetrione acid	3	0	2	W, OX
Morpholine	3	3	0	
Mustard Oil	3	2	0	

GUIDE TO HAZARD INFORMATION – (N – O)

Compound	H	F	R	S/N
N,n-bis-(1,4-dimethylpentyl)p-phenylenediamine	2	1	0	
N,n-bis (1-methylheptyl) ethylenediamine	0	1	0	
N,n-di-sec-butyl-p-phenylenediamine	2	1	0	
N,n-dibutylacetamide	0	1	0	
N,n-dibutylaniline	3	1	0	
N,n-dibutyl stearamide	0	1	0	
N,n-dibutyltoluenesulfonamide	0	1	0	
N,n-diethylacetoacetamide	0	1	0	
N,n-diethylaniline	3	2	0	
N,n-diethyl-1,3-butanediamine	2	2	0	
N,n-diethylethanolamine	3	2	0	
N,n-diethylethylenediamine	3	2	0	
N,n-diethyllauramide	-	2	0	
N,n-diethylstearamide	0	1	0	
N,n-diisopropylethanolamine	1	2	0	
N,n-dimethylaniline	3	2	0	
N,n-dimethylformamide	1	2	0	
N,n-dimethylisopropanolamine	2	3	0	
N-(2-cyanoethyl) cyclohexylamine	2	1	0	
N-(2-ethylhexyl)-cyclohexylamine	2	1	0	
N-(2-hydroxyethyl) cyclohexylamine	3	1	0	
N-(2-hydroxyethyl) propylenediamine	2	1	0	
N-(2-phenoxyethyl) aniline	1	1	0	
N-(3-aminopropyl) cyclohexylamine	2	2	0	
N-(3-aminopropyl) morpholine	2	1	0	
N-2-(ethylhexyl) aniline	3	1	0	
N-acetyl ethanolamine	1	1	1	
N-acetyl morpholine	2	1	1	
N-benzyldiethylamine	2	2	0	
N-butyl acetamide	2	1	0	
N-butyl ethanolamine	1	2	0	
N-butyl isocyanate	3	2	2	
N-butyl monoethanolamine	1	2	0	

N-butylacetanilide	2	1	0	
N-butylaniline	3	1	0	
N-butylcyclohexylamine	2	1	0	
N-butyldiethanolamine	2	1	0	
N-butylurethane	-	2	0	
N-dibutyl tartrate	0	2	0	
N-ethyl acetanilide	0	2	0	
N-ethylacetamide	1	1	0	
N-ethylcyclohexylamine	3	3	0	
N-ethyldiethanolamine	2	1	0	
N-ethylethanolamine	1	2	0	
N-methylbutylamine	3	3	0	
N-methyldiethanolamine	1	1	0	
N-methylethanolamine	2	2	0	
N-phenyl-n-ethylethanolamine	2	1	0	
N-phenyldiethanolamine	1	1	0	
N-phenylethanolamine	1	1	0	
N-propyl bromide	2	3	0	
N-propyl butyrate	0	3	0	
N-propyl ether	-	3	0	
Naphtha	1	3	0	
Naphtha 49 be-coal tar type	2	2	0	
Naphtha v.m. & p., 50 flash (10)	1	3	0	
Naphtha v.m. & p., High flash	1	3	0	
Naphtha v.m. & p., Regular	1	3	0	
Naphthalene	2	2	0	
Naphthylamine	2	1	0	
Natural gas, liquefied	3	4	0	
Neatsfoot oil	0	1	0	
Neopentyl glycol	1	1	0	
Nickel Carbonyl	4	3	3	
Nickel catalyst, dry	2	4	1	
Nicotine	4	1	0	
Nitric Acid	3	0	0	OX
Nitric oxide	3	0	0	OX
p-Nitroaniline	3	1	3	
Nitrobenzene	3	2	1	
1,3-Nitrobenzotrifluoride	-	1	-	
Nitrobiphenyl	2	1	0	
Nitrochlorobenzene	3	1	1	

Nitrocyclohexane	2	2	3	
Nitroethane	1	3	3	
Nitrogen (liquefied)	3	0	0	
Nitrogen dioxide, liquefied	3	0	0	OX
Nitrogen oxides	3	0	0	OX
Nitrogen pentoxide	3	0	0	OX
Nitrogen Peroxide	3	0	0	OX
Nitrogen, refrigerated liquid	3	0	0	
Nitrogen Trioxide	3	0	0	OX
Nitroglycerine	2	2	4	
Nitromethane	1	3	4	
1-Nitronapthalene	1	1	0	
1-Nitropropane	1	3	2	
2-Nitro-p-toluidine	2	1	4	
2-Nitropropane	1	3	2	
o-Nitrotoluene	2	1	4	
Nonadecane	0	1	0	
Nonane	0	3	0	
Nonene	0	3	0	
Nonyl acetate	1	2	0	
Nonylbenzene	0	1	0	
Nonylnapthalene	0	2	0	
Nonylphenol	2	1	0	
2,5-Norbornadiene	-	3	1	
O-acetoacet anisidide	2	1	0	
O-amyl phenol	2	1	0	
O-anisidine	2	1	0	
O-bromotoluene	2	2	0	
O-chlorobenzotrifluoride	2	2	1	
O-chloronitrobenzene	3	1	0	
O-chlorophenol	3	2	0	
O-cresol	3	2	0	
O-cyclohexylphenol	2	1	0	
O-dianisidine	-	1	0	
O-dichlorobenzene	2	2	0	
O-diethyl benzene	2	2	0	
O-dihydroxybenzene	-	1	0	
O-ethyltoluene	-	2	0	
O-methoxybenzaldehyde	2	1	0	
O-nitrotoluene	3	1	1	

O-phenetidine	2	1	0	
O-phenylendiamine	-	1	0	
O-phenylphenol	1	1	0	
O-terphenyl	0	1	0	
O-toluidine	3	2	0	
O-tolyl p-toluene sulfonate	1	1	0	
O-xylene	2	3	0	
O-xylidine	3	1	0	
Octadecane	0	1	0	
Octadecylene alpha	0	1	0	
Octadecyltrichlorosilane	3	2	2	
Octane	0	3	0	
1-Octanethiol	2	2	0	
2-Octanol	1	2	0	
1-Octene	1	3	0	
2-Octene	1	3	0	
Octyl alcohol	1	2	0	
Octylamine	2	2	0	
Octyl chloride	1	2	0	
Octylene glycol	1	1	0	
Oleic Acid	0	1	0	
Oleo oil	0	1	0	
Olive Oil	0	1	0	
Oxalic Acid	3	1	0	
Oxygen (liquid)	3	0	0	OX

GUIDE TO HAZARD INFORMATION – (P – R)

Compound	H	F	R	S/N
P-acetotoluidide	2	1	-	
P-benzoquinone	1	2	1	
P-bromotoluene	2	2	0	
P-chlorobenzaldehyde	2	2	0	
P-cresyl acetate	1	2	0	
P-chlorophenol	3	1	0	
P-cymene	2	2	0	
P-dichlorobenzene	2	2	0	

P-diethyl benzene	2	2	0
P-dihydroxybenzene	-	1	0
P-dioxane	2	3	1
P-ethylphenol	2	1	0
P-ethyltoluene	-	2	0
P-methylacetophenone	0	1	0
P-nitroaniline	3	1	2
P-nitrochlorobenzene	2	1	3
P-nitrophenol	3	1	2
P-nitrotoluene	3	1	1
P-octylphenyl salicylate	1	1	0
P-phenetidine	2	1	0
P-sec-amylphenol	1	1	0
P-tert-amylaniline	3	1	0
Naphtha v.m. & p., Regular	1	3	0
2-(P-tert-amylphenoxy) ethanol	1	1	0
2-(P-tert-amylphenoxy) ethyl laurate	0	1	0
P-tert-amylphenyl butyl ether	0	1	0
P-tert-amylphenyl methyl ether	0	1	0
P-tert-butyl-o-cresol	2	1	0
P-toluenesulfonic acid	3	1	1
P-toluidine	3	2	0
P-xylene	2	3	0
Palm kernel oil	0	1	0
Palm oil	0	1	0
Paraffin Oil	0	1	0
Paraformaldehyde	3	1	0
Paraldehyde	2	3	1
Parathion	4	1	2
Peanut oil	0	1	0
Pentaborane	4	4	2
Pent acetate	2	3	0
Pentachlorophenol (dry)	3	0	0
1,3-Pentadiene (cis and trans mix)	0	4	2
1,2,3,4,5-Pentamethyl benzene 95%	-	2	0
Pentamethylene oxide	2	3	1
Pentane	1	4	0
1,5-Pentanediol	1	1	0
2,4-Pentanedione	2	2	0
Pentanoic Acid	2	1	0

3-Pentanol	1	2	0	
Pentaphen	2	1	0	
1-Pentene	1	4	0	
1-Pentyne	-	3	3	
Peracetic acid diluted with 60% of acetic acid	3	2	4	OX
Perchloric Acid	3	0	3	OX
Perchloroethylene	2	0	0	
Perchloroethylene, tetrachloroethylene	2	0	0	
Perhydrophenanthrene	-	-	0	
Perilla oil	0	1	0	
Petroleum, Crude	1	3	0	
Petroleum Ether	1	4	0	
Petroleum sulfonate	0	1	0	
Phenanthrene	-	1	0	
Phenethyl alcohol	1	1	0	
Phenol	4	2	0	
Phenoxy ethyl alcohol	0	1	0	
Phenylacetaldehyde	1	2	0	
Phenyl Acetate	1	2	0	
Phenyl acetate (beta)	0	1	0	
Phenylacetic Acid	1	1	0	
1-Phenyl-2-butene	-	2	0	
Phenyl didecyl phosphite	0	1	0	
Phenyl di-o-xenyl phosphate	0	1	0	
o-Phenylenediamine	-	1	0	
Phenylhydrazine	3	2	0	
Phenylmercuric acetate (dry)	3	1	0	
Phenylmercuric acetate (organic solution)	3	2	0	
Phenylmethyl ethanol amine	2	1	0	
4-Phenylmorpholine	2	1	0	
Phenylpropyl Alcohol	0	1	0	
Phenyl propyl aldehyde	-	1	0	
Phenyl toluene o	-	1	0	
Phenyl trichloro silane	3	2	0	
Phorone	2	2	0	
Phosgene	4	0	1	
Phosphine	4	4	2	
Phosphoric Acid	3	0	0	
Phosphorous oxychloride	4	0	2	W
Phosphorus Pentachloride	3	0	2	W

Phosphorus Pentasulfide	2	1	2	W
Phosphorus, Red	1	1	1	
Phosphorus, White or Yellow	4	4	2	
Phosphorus Tribromide	3	0	2	W
Phosphorus Trichloride	4	0	2	W
Phosphorus, White or Yellow	3	3	1	
Phosphoryl Chloride	3	0	2	W
Phthalic Acid	0	1	1	
Phthalic Anhydride	3	1	0	
4-Picoline	2	2	0	
Pinane	0	1	0	
Pine oil	0	2	0	
Pine pitch	0	1	0	
Pine tar	0	2	0	
Pine tar oil	0	2	0	
Picric Acid	3	4	4	
2-Picoline	2	2	0	
Pine Oil	0	2	0	
Pine Tar	0	2	0	
Piperazine	2	2	0	
Piperidine	3	3	0	
Polyamyl napthalene mixture of polymers	0	1	0	
Polychlorinated biphenyls	2	1	0	
Polyethylene glycols	0	1	0	
Polyoxyethylene lauryl ether	0	1	0	
Polypropylene glycols	0	1	0	
Polyvinyl alcohol mixture of polymers	0	2	0	
Poppy seed oil	0	1	0	
Potassium	3	1	2	W
Potassium, metal	3	3	2	W
Potassium Bromate	1	0	0	OX
Potassim Chlorate	2	0	0	OX
Potassium Cyanide	3	0	0	
Potassium dichloro-s-triazinetrione	3	0	2	OX
Potassium Hydroxide (lye)	3	0	1	
Potassium Nitrate	1	0	0	OX
Potassium Permanganate	1	0	0	OX
Potassium Peroxide	3	0	1	W
Potassium Persulfate	1	0	0	OX
Potassium Sulfide	2	1	0	

Potassium sulfide, anhydrous	3	1	0	
Potassium xanthanate	2	1	0	
Propanal	2	3	2	
Propane	1	4	0	
1,3-Propanediamine	2	3	0	
Propargyl alcohol	4	3	3	
Propargyl bromide	3	3	4	
P-dioxane	2	3	1	
Propenyl ethyl ether	2	3	0	
Propionic anhydride	3	2	1	
Propionic nitrile	4	3	1	
Propionyl Chloride	3	3	1	
Propyl Acetate	1	3	0	
Propyl Alcohol	1	3	0	
2-Propybiphenyl	0	1	0	
Propylamine	3	3	0	
Propylbenzene	2	3	0	
Propyl Chloride	2	3	0	
Propyl chlorothiolformate	2	2	0	
Propylcyclohexane	0	-	0	
Propylcyclopentane	0	-	0	
Propylene	1	4	1	
Propylene carbonate	1	1	0	
Propylenediamine	2	3	0	
Propylene Dichloride	2	3	0	
Propylene Glycol	0	1	0	
Propylene Glycol methyl ether	0	3	0	
Propylene Glycol methyl ether acetate	0	2	0	
Propylene Glycol monacrylate	3	1	2	
Propylene Oxide	3	4	2	
n-Propyl Ether	-	3	0	
Propyl formate	2	3	3	
Propyl Nitrate	2	4	3	OX
Propyl propionate	1	3	0	
Propyltrichlorosilane	3	3	1	
Propyne	2	4	2	
Pyridine	3	3	0	
Pyroxylin solution	1	3	0	
Pyrrole	2	2	0	
Pyrrolidine	2	3	1	

2-Pyrrolidone	2	1	0	
Quenching oil	0	1	0	
Quinoline	2	1	0	
Rape seed oil	0	1	0	
Resorcinol	-	1	0	
Rhodinol	0	1	0	
Rosin oil	0	1	0	

GUIDE TO HAZARD INFORMATION – (S)

Compound	H	F	R	S/N
Safrole	-	1	0	
Salicyaldehyde	0	2	0	
Salicylic Acid	0	1	0	
Santalol	-	1	0	
Sec-amyl acetate	1	3	0	
Sec-amyl alcohol	1	3	0	
Sec-amylamine	2	3	0	
Sec-butyl acetate	1	3	0	
Sec-butyl alcohol	1	3	0	
Sec-butylamine	3	3	-	
Sec-butylbenzene	2	2	0	
Sec-butyl chloride	2	3	0	
Sec-butylcyclohexane	0	-	0	
Sec-hexyl alcohol	0	2	0	
Sesame oil	0	1	0	
Silane	1	4	3	
Silane, (4-aminobutyl)-diethoxymethyl	3	2	1	
Silicon tetrachloride	3	0	2	W
Silicon tetrafluoride	3	0	2	W
Silver Nitrate	1	0	0	OX
Sodium	3	3	2	W
Sodium Chlorate	1	0	2	OX
Sodium Chlorite	1	0	1	OX

Sodium Cyanide	3	0	0	
Sodium dichloro-s-triazinetrione dihydrate	2	0	1	OX
Sodium dichloro-s-triazinetrione dihydrate, anhydrous	2	0	2	OX
Sodium Fluoride	3	0	0	
Sodium Hydride	3	3	2	W
Sodium Hydroxide (lye)	3	0	1	
Sodium hydrosulfite	2	1	2	
Sodium Nitrate	1	0	0	OX
Sodium Perchlorate	2	0	2	OX
Sodium Peroxide	3	0	1	OX
Sodium-Potassium Alloys	3	3	2	W
Sodium Sulfide	3	1	1	
Soybean oil	0	1	0	
Sperm oil no. 1 & no. 2	0	1	0	
Stannic Chloride	3	0	1	
Stearic Acid	1	1	0	
Stearyl Alcohol	0	-	0	
Stibine	4	4	2	
Stoddard Solvent	0	2	0	
Straw oil	0	1	0	
Styrene	2	3	2	
Styrene oxide	2	2	0	
Succinonitrile	-	1	0	
Sulfur	2	1	0	
Sulfolane	2	1	0	
Sulfur	2	1	0	
Sulfur Chloride	3	1	1	
Sulfur Dioxide	3	0	0	
Sulfuric Acid	3	0	2	W
Sulfuryl chloride	3	0	2	

GUIDE TO HAZARD INFORMATION – (T)

Compound	H	F	R	S/N
Tallow	0	1	0	
Tallow Oil	0	1	0	
Tannic Acid	0	1	0	
Tartaric acid(d,l)	0	1	0	
Terephthalic acid	0	1	0	
Terephthaloyl Chloride	3	1	0	
Terpineol	0	2	0	
Terpinyl acetate	0	2	0	
Tert-amyl chloride	1	3	0	
Tert-butyl alcohol	1	3	0	
Tert-butylamine	2	4	0	
Tert-butylaminoethyl methacrylate	2	1	0	
Tert-butylbenzene	2	2	0	
Tert-butyl carbinol	2	3	0	
4-Tert-butyl-catechol	2	1	0	
Tert-butyl chloride	2	3	-	
4-Tert-butyl-2-chlorophenol	2	1	0	
Tert-butylcyclohexane	0	-	0	
Tert-butyldecalin	1	1	0	
Tert-butyldiethanolamine	2	1	0	
Tert-butyl hydroperoxide	1	4	4	OX
Tert-butyl-m-cresol	2	2	0	
Tert-butyl peracetate	2	3	4	
Tert-butyl perbenzoate	0	3	4	OX
Tert-butyl peroxypivalate	0	3	4	OX
4-Tert-butyl-2-phenylphenol	1	1	0	
Tert-butylstyrene	2	2	2	
Tert-butyl tetralin	2	1	0	
Tert-decylmercaptan	2	2	0	
Tert-dodecyl mercaptan	2	1	0	
Tert-hexadecanethiol	0	1	0	
Tert-isohexyl alcohol	-	2	0	
Tert-nonyl mercaptan	2	2	0	
Tert-octylamine	-	3	0	
Tert-octyl-mercaptan	2	2	0	
Tert-tetradecyl mercaptan	2	1	0	

Tetraamylbenzene	0	1	0	
1,1,2,2 Tetrabromoethane	3	0	1	
Tetrachlorobenzene	0	1	0	
1,2,4,5-Tetracholorbenzene	1	1	0	
Tetrachloroethylene	2	0	0	
Tetradecane	0	1	0	
Tetradecanol	0	1	0	
1-Tetradecene	0	1	0	
Tetraethoxypropane	0	2	0	
Tetraethylene Glycol	1	1	0	
Tetraethylene pentamine	2	1	0	
Tetraethyl Lead, Compounds	3	2	3	
Tetrafluoroethylene	2	4	3	
1,2,3,6-Tetrahydrobenzaldehyde	2	2	0	
Tetrahydrofuran	2	3	1	
Tetrahydrofurfuryl alcohol	2	2	0	
Tetrahydrofurfuryl oleate	1	1	0	
Tetrahydronapthalene	1	2	0	
Tetrahydropyran-2-methanol	1	2	0	
1,1,3,3-Tetramethoxypropane	0	2	0	
Tetramethoxysilane	3	3	1	
1,2,3,4-Tetramethylbenzene 95%	0	2	0	
1,2,3,5-Tetramethylbenzene 85.5%	0	2	0	
1,2,4,5-Tetramethylbenzene 95%	0	2	0	
Tetramethyleneglycol	0	1	0	
Tetramethyl Lead, Compounds	3	3	3	
2,2,3,3-Tetramethyl pentane	0	3	0	
2,2,3,4-Tetramethyl pentane	0	3	0	
Tetramethyl tin	2	-	0	
Tetraphenyl tin	3	1	0	
Tetra (2-ethylbutyl) silicate	1	1	0	
Tetra (2-ethylhexyl) silicate	1	1	0	
Thialdine	2	2	1	
2,2-Thiodethanol	1	1	0	
Thiodiglycol	2	1	0	
Thionyl Chloride	4	0	2	W
Thiophene	2	3	0	
1,4-Thioxane	2	2	0	
Tin tetrachloride, anhydrous	3	0	1	
Titanium Tetrachloride	3	0	2	

Tin tetrachloride, anhydrous	3	0	1	
Toluene	2	3	0	
Toluene-2,4-Diisocyanate	3	1	3	W
Toluhydroquinone	-	1	0	
o-Toluidine	3	2	0	
Transformer oil	0	1	0	
Triamylamine	2	1	0	
Triamylbenzene	0	1	0	
Triamylborate	1	2	0	
Tributylamine	3	2	0	
Tributyl citrate	0	1	0	
Tributyl Phosphate	2	1	0	
Tributylphosphine	0	1	0	
Tributyl Phosphite	2	1	1	
1,2,4-Trichlorobenzene	2	1	0	
1,1,1-Trichloroethane	2	1	0	
1,1,2-Trichloroethane	2	1	0	
Trichloroethylene	2	1	0	
Trichloroethylsilane	3	3	0	
Trichloroisocyanuric acid, dry	2	0	2	OX
1,2,3-Trichloropropane	3	2	0	
Trichlorosilane	3	4	2	W
Tridecanol	0	1	0	
Tridecyl acrylate	1	1	0	
Tridecyl alcohol	0	2	0	
Tridecyl phosphite	0	1	0	
Triethanolamine	2	1	1	
1,1,3-Triethoxyhexane	1	1	0	
Triethylaluminum	3	4	3	W
Triethylamine	3	3	0	
1,2,4-Triethylbenzene	-	2	0	
Triethylborane	1	3	3	W
Triethyl citrate	0	1	0	
Triethylene glycol	0	1	0	
Triethylene glycol diacetate	0	1	0	
Triethylene glycol, dimethyl ether	1	1	0	
Triethyleneglycol monobutyl ether	0	1	0	
Triethylenetetramine	3	1	0	
Triethyl Phosphate	0	1	1	
Trifluorochloroethylene	-	4	0	

Triglycol dichloride	2	1	0	
Trihexyl phosphite	-	1	0	
Triisobutylaluminum	3	4	3	W
Triisobutyl Borate	3	2	1	
Triisopropanolamine	2	1	0	
Trifluorochloroethylene	-	4	0	
Triisopropyl benzene	0	1	0	
Trilauryl trithiophosphite	0	1	0	
Trimethoxysilane	4	3	2	
Trimethylaluminum	-	3	3	W
Trimethylamine	3	4	0	
1,2,3-Trimethylbenzene	0	2	0	
1,2,3-Trimethylbenzene 90.5%	0	2	0	
1,2,4-Trimethylbenzene	0	2	0	
1,3,5-Trimethylbenzene	0	2	0	
2,2,3-Trimethylbutane	0	3	0	
2,3,3-Trimethyl-1-butene	0	3	0	
Trimethylchlorosilane	3	3	2	W
1,3,5-Trimethylcyclohexane	0	-	0	
Trimethylcyclohexanol	2	2	0	
3,3,5-Trimethyl-1-cyclohexanol	2	2	0	
Trimethylene glycol	1	-	0	
2,5,5-Trimethylheptane	0	2	0	
2,2,5-Trimethylhexane	2	3	0	
3,5,5-Trimethylhexanol	2	2	0	
2,4,8-Trimethyl-6-nonanol	0	2	0	
2,6,8-Trimethyl-4-nonanol	2	2	0	
2,6,8-Trimethyl-4-nonanone	2	2	0	
Trimethylolpropane triacrylate	0	1	0	
2,2,3-Trimethylpentane	0	3	0	
2,2,4-Trimethylpentane	-	3	0	
2,3,3-Trimethylpentane	0	3	0	
2,2,4-Trimethyl-1,3-pentanediol	0	1	0	
2,2,4-Trimethylpentanediol diisobutyrate	0	1	0	
2,2,4-Trimethyl-1,3-pentanediol isobutyrate	0	1	0	
2,2,4-Trimethylpentanediol isobutyrate benzoate	0	1	0	
2,3,4-Trimethyl-1-pentene	0	3	0	
2,4,4-Trimethyl-1-pentene	2	3	0	
2,4,4-Trimethyl-2-pentene	2	3	0	
3,4,4-Trimethyl-2-pentene	0	3	0	

Trimethyl phosphite	0	2	0	
Tri-n-butyl borate	3	2	1	
Trinitrobenzene	2	4	4	
Trinitrotoluene (tnt)	2	4	4	
Tri-o-cresyl-phosphate	2	1	0	
Trioctyl phosphite	0	1	0	
Trioxane	2	2	0	
Triphenylmethane	0	1	0	
Triphenyl phosphate	2	1	0	
Triphenyl phosphite	0	1	0	
Triphenylphosphorous	0	1	0	
Tripropyl aluminum	-	3	3	W
Tripropylamine	2	2	0	
Tripropylene	0	3	0	
Tripropylene Glycol	0	1	0	
Tripropylene Glycol methyl ether	0	1	0	
Tung Oil	0	1	0	
Turkey red oil	0	1	0	
Turpentine	1	3	0	

GUIDE TO HAZARD INFORMATION – (U – Z)

Compound	H	F	R	S/N
Ultrasene	1	2	0	
2-Undecanol	1	1	0	
Valeraldehyde	1	3	0	
Vanadium Tetrachloride	3	0	2	W
Vinyl Acetate	2	3	2	
Vinyl Acetylene	2	4	3	
Vinyl allyl ether	2	3	2	
Vinylbenzylchloride	2	1	-	
Vinyl Bromide	2	0	1	
Vinyl Butyl Ether	2	3	2	
Vinyl butyrate	2	3	2	
Vinyl Chloride	2	4	2	
Vinyl 2-chloroethyl ether	2	3	2	
Vinyl Crotonate	2	3	2	
4-Vinyl cyclohexene	0	3	2	

Vinyl Ethyl Alcohol	0	2	0	
Vinyl Ethyl Ether	2	4	2	
Vinyl 2-ethylhexoate	2	2	2	
Vinyl 2-ethylhexyl ether	2	2	2	
2-Vinyl-5-ethylpyridine	2	2	2	
Vinyl Fluoride	1	4	2	
Vinylidene Chloride	2	4	2	
Vinylidene Fluoride	1	4	2	
Vinylisobutyl ether	2	3	2	
Vinyl isooctyle ether	1	2	0	
Vinyl isopropyl ether	2	4	2	
Vinyl 2-methoxyethyl ether	0	3	0	
Vinyl Methyl Ether	2	4	2	
Vinyl octadecyl ether	0	1	0	
1-Vinylpyrrolidone	0	1	0	
Vinyl Propionate	2	3	2	
Vinyl Toluene	2	2	2	
Vinyl trichlorosilane	3	3	2	W
Vinylidene chloride	4	4	2	
Wax, microcrystalline	0	1	0	
Wax, ozocerite	0	1	0	
Wax, paraffin	0	1	0	
Whale oil	0	1	0	
Xylenes, mixed	2	3	0	
o-Xylene	2	3	0	
o-Xylidine	3	1	0	
Zinc (powder or dust)	0	1	1	
Zinc Chlorate	2	0	2	OX
Zinc cyanide	3	0	0	
Zinc phosphide	3	3	1	
Zinc, stearate	0	1	0	
Zirconium Tetrachloride	3	0	2	W

APPENDIX C
Standard Operating Procedure Template

STANDARD OPERATING PROCEDURE

Location	
Chemicals	
Specific Hazards	

1. **Purchasing**: All purchases of this material must have written approval from the Principal Investigator (P.I.) or ______________________________ before ordering. The user is responsible to ensure that Environmental Health & Safety is notified upon receipt of a new chemical so a current material safety data sheet (MSDS) is on file. Quantities of this material will be limited to _____________________, or the smallest amount necessary to complete the experiment.

2. **Storage**: Material will be stored according to compatibility and label recommendations in a designated area: _________________________________. Storage areas will be regularly inspected by the Laboratory Coordinator to ensure safety. Periodic inventory reduction will be scheduled.

3. **Authorized personnel**: Use of this material requires prior written approval from the PI or ___________________________, Title: _______________________. Use will be limited to the following personnel (check all that apply):

   Principal Investigator ________________ Graduate students ____________________
   Technical staff _____________________ Undergraduates ______________________
   Others (describe) _______________________________

4. **Training**: The user must demonstrate competency and familiarity regarding the safe handling and use of this material prior to purchase. Training should include the following:

   - Review of current MSDS
   - Review of the OSHA Lab Standard
   - Special training provide by the Department/supervisor
   - Review of the department safety procedures
   - Review of the Chemical Hygiene Plan
   - Review of emergency procedures
   - Review of necessary personal protective equipment
   - Review of proper waste disposal practices

5. **Use location**: Material shall be used only in the following designated areas in Room ____. Check all that apply:

Demarcated area in lab (describe) ____

Fume hood _____ glove box _______ other (describe) ______________________

6. **Personal protective equipment**: All personal are required to wear the following personal protective equipment (PPE) whenever handling this material (check all that apply). Refer to MSDS for appropriate PPE.

   Safety goggles ______ Chemical safety/splash goggles _____ Face shield _____ Gloves

   (type/use):

   Incidental contact: ____

   Extended contact: ____

   Lab coat ____ Rubber gloves ____ Tyvek clothing _____

   Respirator (type) ________________ Other (describe) __________________

7. **Waste disposal**: The authorized person using this material is responsible for the safe collection, preparation and ensuring the proper disposal of waste unless otherwise stated below. Waste shall be disposed of as soon as possible and in accordance with all laboratory and Ithaca College procedures.

   Specific Instructions: ____

   ____

8. **Decontamination**: Specific instructions:_______________________________________

   ____

   1) Place waste in designated Satellite containers
   2) Follow all storage procedures on the posted "Hazardous Waste Satellite Accumulation Guide"
   3) Contact EH&S (274-1613) for pick-up of all full hazardous waste containers

9. **Exposures**: Emergency procedures to be followed (from MSDS)

   Skin/eye contact – symptoms:
   First aid:

   Ingestion – symptoms:

First aid:

Inhalation – symptoms:
First aid:

10. **Spills**: Spill cleanup materials to be used, location of material, PPE to be used, disposal of cleanup materials, etc. (Refer to chemical MSDS) please be as complete as possible:

11. **Phone numbers**:

Immediate Medical Attention: Campus Safety 911 or 274-3333
EH&S @ 274-3353
Hammond Health Center 274-3177

12. **Other**: Special precautions, incompatible/reactive materials, usable shelf life, etc.

Please be as specific as possible: ____
____
____
____

____

Prepared by: ____
Date: ______________________________
Reviewed/Revised: ____

Note: A copy of the completed SOP must be filed with the Chemical Hygiene Officer at Environmental Health & Safety.

APPENDIX D
Particularly Hazardous Chemicals

Carcinogens

The following chemicals have been identified by ==================== as being known cancer-causing agents.

Chemical	CAS Number
A-alpha-C (2-Amino-9H-pyrido[2,3-b]indole)	26148-68-5
Acetaldehyde	75-07-0
Acetamide	60-35-5
Acetochlor	34256-82-1
2-Acetylaminofluorene	53-96-3
Acifluorfen	62476-59-9
Acrylamide	79-06-1
Acrylonitrile	107-13-1
Actinomycin D	50-7-60
Adriamycin (Doxorubicin hydrochloride)	23214-92-8
AF-2;[2-(2-furyl)-3-(5-nitro-2-furyl)]acrylamide	3688-53-7
Aflatoxins	1402-68-2
Alachlor	15972-60-8
Alcoholic beverages, when associated with alcohol abuse	n/a
Aldrin	309-00-2
Allyl chloride	107-05-1
Aluminum products	n/a
2-Aminoanthraquinone	117-79-3
p-Aminoazobenzene	60-09-3
ortho-Aminoazotoluene	97-56-3
4-Aminobiphenyl (4-aminodiphenyl)	92-67-1
3-Amino-9-ethylcarbazole hydrochloride	6109-97-3
1-Amino-2-methylanthraquinone	82-28-0
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole	712-68-5
Amitrole	61-82-5
Analgesic mixtures containing phenacetin	n/a
Androgenic (anabolic) steroids	n/a
Aniline	62-53-3
ortho-Anisidine	90-04-0
ortho-Anisidine hydrochloride	134-29-2
Antimony oxide (antimony trioxide)	1309-64-4
Aramite	140-57-8
Arsenic (inorganic arsenic compounds)	various
Asbestos	1332-21-4
Auramine	492-80-8
Azaserine	115-02-6
Azathioprine	446-86-6
Azacitidine	320-67-2
Azobenzene	103-33-3

Benz[a]anthracene	56-55-3
Benzene	71-43-2
Benzidine [and its salts]	92-87-5
Benzidine-based dyes	various
Benzo[b]fluoranthene	205-99-2
Benzo[j]fluoranthene	205-82-3
Benzo[k]fluoranthene	207-08-9
Benzofuran	271-89-6
Benzo[a]pyrene	50-32-8
Benzotrichloride	98-07-7
Benzyl chloride	100-44-7
Benzyl violet 4B	1694-09-3
Beryllium and beryllium compounds	various
Betel quid with tobacco	n/a
Bis(2-chloroethyl)ether	111-44-4
N,N-Bis(2-chloroethyl)-2- naphthylamine (Chlornapazine)	494-03-1
Bischloroethyl nitrosourea (BCNU) (Carmustine)	154-93-8
Bis(chloromethyl)ether	542-88-1
Bitumens, extracts of steam-refined and air refined	various
Bleomycins	various
Bracken fern	n/a
Bromodichloromethane	75-27-4
Bromoform	75-25-2
1,3-Butadiene	106-99-0
1,4-Butanediol dimethanesulfonate (Busulfan)	55-98-1
Butylated hydroxyanisole (BHA)	25013-16-5
beta-Butyrolactone	3068-88-0

Cadmium and cadmium compounds	various
Caffeic acid	331-39-5
Captafol	2425-06-1
Captan	133-06-2
Carbon tetrachloride	56-23-5
Carbon-black extracts	n/a
Carrageenan, degraded	n/a
Ceramic fibers (airborne particles of respirable size)	n/a
Certain combined chemotherapy drugs for lymphomas	n/a
Chlorambucil	305-03-3
Chloramphenicol	56-75-7
Chlordane	57-74-9
Chlordecone (Kepone)	143-50-0
Chlordimeform	6164-98-3
Chlorendic acid (approximately 60 percent chlorine by weight)	115-28-6
Chlorinated Parrafins (C12, 60% chlorine)	108171-26-2
alpha-Chlorinated toluenes	various
p-Chloroaniline	106-47-8

Chlorodibromomethane	124-48-1
Chloroethane (ethyl chloride)	75-00-3
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU) (Lomustine)	13010-47-4
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)	13909-09-6
Chloroform	67-66-3
Chloromethyl methyl ether (technical grade)	107-30-2
3-Chloro-2-methylpropene	563-47-3
4-Chloro-ortho-phenylenediamine	95-83-0
p-Chloro-o-toluidine	95-69-2
Chlorophenols	various
Chlorophenoxy herbicides	various
Chlorothalonil	1897-45-6
Chlorozotocin	54749-90-5
Chromium (hexavalent compounds)	various
Chrysene	218-01-9
C. I. Acid Red 114	6459-94-5
C. I. Basic Red 9 monohydrochloride	569-61-9
Ciclosporin (Cyclosporin A; Cyclosporine)	59865-13-3
Cinnamyl anthranilate	87-29-6
Cisplatin	15663-27-1
Citrus Red No. 2	6358-53-8
Coal gasification	n/a
Coal-tar pitches	n/a
Coal-tars	n/a
Cobalt metal powder	7440-48-4
Cobalt [II] oxide	1307-96-6
Coke Production oven emissions	n/a
Conjugated estrogens	n/a
Creosotes	n/a
para-Cresidine	120-71-8
Cupferron	135-20-6
Cycasin	14901-08-7
Cyclophosphamide (anhydrous)	50-18-0
Cyclophosphamide (hydrated)	6055-19-2

D&C Orange No. 17	3468-63-1
D&C Red No. 8	2092-56-0
D&C Red No. 9	5160-02-1
D&C Red No. 19	81-88-9
Dacarbazine	4342-03-4
Daminozide	1596-84-5
Dantron (Chrysazin; 1,8-Dihydroxyanthraquinone)	117-10-2
Daunomycin	20830-8-13
DDD (Dichlorodiphenyldichloroethane)	72-5-48
DDE (Dichlorodiphenyldichloroethylene)	72-55-9
DDT (Dichlorodiphenyltrichloroethane)	50-29-3

DDVP (Dichlorvos)	62-73-7
N,N'-Diacetylbenzidine	613-35-4
2,4-Diaminoanisole	615-05-4
2,4-Diaminoanisole sulfate	39156-41-7
4,4'-Diaminodiphenyl ether (4,4'-Oxydianiline)	101-80-4
2,4-Diaminotoluene	95-80-7
Diaminotoluene (mixed)	n/a
Dibenz[a,h]acridine	226-36-8
Dibenz[a,j]acridine	224-42-0
Dibenz[a,h]anthracene	53-70-3
7H-Dibenzo[c,g]carbazole	194-59-2
Dibenzo[a,e]pyrene	192-65-4
Dibenzo[a,h]pyrene	189-64-0
Dibenzo[a,i]pyrene	189-55-9
Dibenzo[a,l]pyrene	191-30-0
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8
1,2-Dibromoethane	106-93-4
2,3-Dibromo-1-propanol	96-13-9
p-Dichlorobenzene	106-46-7
3,3'-Dichlorobenzidine	91-9-41
3,3'-Dichlorobenzidine 2HCl	612-83-9
1,4-Dichloro-2-butene	764-41-0
3,3'-Dichloro-4,4'-diaminodiphenyl ether	28434-86-8
1,1-Dichloroethane	75-34-3
1,2-Dichloroethane	107-06-2
Dichloromethane (Methylene chloride)	75-09-2
1,2-Dichloropropane	78-87-5
1,3-Dichloropropene (technical grade)	542-75-6
Dieldrin	60-57-1
Dienestrol	84-17-3
Diepoxybutane	1464-53-5
Diesel engine exhaust	n/a
Di(2-ethylhexyl)phthalate	117-81-7
1,2-Diethylhydrazine	1615-80-1
Diethyl sulfate	64-67-5
Diethylstilbestrol	56-53-1
Diglycidyl resorcinol ether (DGRE)	101-90-6
Dihydrosafrole	94-58-6
Diisopropyl sulfate	2973-10-6
3,3'-Dimethoxybenzidine (ortho-Dianisidine)	119-90-4
3,3'-Dimethoxybenzidine dihydrochloride (ortho-dianisidine dihydrochloride)	20325-40-0
para-Dimethylaminoazobenzene	60-11-7
4-Dimethylaminoazobenzene	60-11-7
trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole	55738-54-0
7,12-Dimethylbenz(a)anthracene	57-97-6

3,3'-Dimethylbenzidine (ortho-Tolidine)	119-93-7
3,3'-Dimethylbenzidine dihydrochloride	612-82-8
Dimethylcarbamoyl chloride	79-44-7
1,1-Dimethylhydrazine (UDMH)	57-14-7
1,2-Dimethylhydrazine	540-73-8
Dimethyl sulfate	77-78-1
Dimethylvinyl Chloride	513-37-1
1,6-Dinitropyrene	42397-64-8
1,8-Dinitropyrene	42397-65-9
2,4-Dinitrotoluene	121-14-2
2,6-Dinitrotoluene	606-20-2
1,4-Dioxane	123-91-1
Diphenylhydantoin (Phenytoin)	57-41-0
Diphenylhydantoin (Phenytoin), sodium salt	630-93-3
Direct Black 38 (technical grade)	1937-37-7
Direct Blue 6 (technical grade)	2602-46-2
Direct Brown 95 (technical grade)	16071-86-6
Disperse Blue 1	2475-45-8
Epichlorohydrin	106-89-8
Erionite	12510-42-8
Estradiol 17B	50-28-2
Estrone	53-16-7
Ethinylestradiol	57-63-6
Ethyl acrylate	140-88-5
Ethyl methanesulfonate	62-50-0
Ethyl-4,4'-dichlorobenzilate	510-15-6
Ethylene dibromide	106-93-4
Ethylene dichloride (1,2-Dichloroethane)	107-06-2
N-Ethyl-N-nitrosourea	759-73-9
Ethylene oxide	75-21-8
Ethylene thiourea	96-45-7
Ethyleneimine	151-56-4
Folpet	133-07-3
Formaldehyde (gas or aqueous solution)	50-00-0
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl) thiazole	3570-75-0
Furan	110-00-9
Furazolidone	67-45-8
Furmecyclox	60568-05-0
Fusarin C	79748815
Gasoline engine exhaust (condensates/extracts)	n/a
Glasswool fibers (airborne particles of respirable size)	n/a
Glu-P-1 (2-Amino-6-methyldipyrido[1,2- a:3', 2'-d]imidazole)	67730-11-4
Glu-P-2 (2-Aminodipyrido[1,2-a:3',2'-d]imidazole)	67730-10-3

Glycidaldehyde	765-34-4
Glycidol	556-52-5
Griseofulvin	126-07-8
Gyromitrin (Acetaldehyde methylformylhydrazone)	16568-02-8
HC Blue 1	2784-94-3
Heptachlor	76-44-8
Heptachlor epoxide	1024-57-3
Hexachlorobenzene	118-74-1
Hexachlorocyclohexanes (technical grade)	various
Hexachlorodibenzodioxin	34465-46-8
Hexachloroethane	67-72-1
Hexamethylphosphoramide	680-31-9
Hydrazine	302-01-2
Hydrazine sulfate	10034-93-2
Hydrazobenzene (1,2-Diphenylhydrazine)	122-66-7
Indeno [1,2,3-cd]pyrene	193-39-5
IQ (2-Amino-3-methylimidazo[4,5-f]quinoline)	76180-96-6
Iron dextran complex	9004-66-4
Isosafrole	120-58-1
Kepone (Chlordecone)	143-50-0
Lactofen	77501-63-4
Lasiocarpine	303-34-4
Lead acetate	301-04-2
Lead and lead compounds	various
Lead phosphate	7446-27-7
Lindane and other hexachlorocyclohexane isomers	various
Mancozeb	8018-01-7
Maneb	12427-38-2
Me-A-alpha-C (2-Amino-3-methyl-9H-pyrido[2, 3-b]indole)	68006-83-7
Medroxyprogesterone acetate	71-58-9
MeIQ(2-Amino-3,4-dimethylimidazo[4,5-f]quinoline)	7094112
MeIQx(2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline)	7500-04-0
Melphalan	148-82-3
Merphalan	531-76-0
Mestranol	72-33-3
Methoxsalen with ultraviolet A therapy	n/a
8-Methoxypsoralen with ultraviolet A therapy	298-81-7
5-Methoxypsoralen with ultraviolet A therapy	484-20-8
2-Methylaziridine (Propyleneimine)	75-55-8
Methylazoxymethanol	590-96-5
Methylazoxymethanol acetate	592-62-1

3-Methylcholanthrene	56-49-5
5-Methylchrysene	3697-24-3
4,4'-Methylene bis(2-chloroaniline) (MOCA)	101-14-4
4,4'-Methylene bis(N,N-dimethyl)benzenamine	101-61-1
4,4'-Methylene bis(2-methylaniline)	838-88-0
4,4'-Methylenedianiline	101-77-9
4,4'-Methylenedianiline dihydrochloride	13552-44-8
Methylhydrazine and its salts	13552-44-8
Methyl chloromethyl ether	107-30-2
Methyl-CCNU	13909-09-6
Methyl iodide	74-88-4
Methyl methanesulfonate	66-27-3
2-Methyl-1-nitroanthraquinone (of uncertain purity)	129-15-7
N-Methyl-N'-nitro-N-nitrosoguanidine (MNNG)	70-25-7
N-Methyl-N-nitrosourea	
N-Methylolacrylamide	924-42-5
Methylthiouracil	56-04-2
Metiram	9006-4222
Metronidazole	443-48-1
Michler's ketone	90-94-8
Mineral Oils, untreated and mildly treated	n/a
Mirex	2385-85-5
Mitomycin C	50-07-7
MOPP	
Monocrotaline	135-22-0
5-(Morpholinomethyl)-3-[(5-nitro-fufurylidene)-amino]-2-oxazolidinone	139-91-3
Mustard gas	505-60-2

Nafenopin	3771-19-5
1-Naphthylamine	134-32-7
2-Naphthylamine	91-59-8
3-Naphthylamine	
Nickel and certain nickel compounds	various
Nickel carbonyl	13463-3933
Nickel refinery dust, from the pyrometallurgical process	7440-02-0
Nickel subsulfide	12035-72-2
Niridazole	61-57-4
Nitrilotriacetic acid	139-13-9
Nitrilotriacetic acid, trisodium salt monohydrate	18662-53-8
5-Nitroacenaphthene	602-87-9
5-Nitro-o-anisidine	99-59-2
o-Nitroanisole	91-23-6
4-Nitrobiphenyl	92-93-3
6-Nitrochrysene	7496-02-8
Nitrofen (technical grade)	1836-755
2-Nitrofluorene	607-57-8

Nitrofurazone	59-87-0
1-[(5-Nitrofurfurylidene)amino]-2-imidazollidinone	555-84-0
1-[(5-Nitrofurfurylidene)-N-[4-(5-Nitro-2-furyl)-2 thiazolyl]acetamide	531-82-8
Nitrogen mustard (Mechlorethamine)	51-75-2
Nitrogen mustard hydrochloride (Mechlorethamine hydrochloride)	55-86-7
Nitrogen mustard N-oxide	126-85-2
Nitrogen mustard N-oxide hydrochloride	302-70-5
2-Nitropropane	79-46-9
4-Nitropyrene	57835-92-4
N-Nitrosodi-n-butylamine	924-16-3
N-Nitrosodiethanolamine	1116-54-7
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
p-Nitrosodiphenylamine	156-10-5
N-Nitrosodiphenylamine	86-30-6
N-Nitrosodi-n-propylamine	621647
N-Nitroso-N-ethylurea	759-73-9
3-(N-Nitrosomethylamino)propionitrile	60153-49-3
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone (NNK)	64091-91-4
N-Nitrosomethylethylamine	10595-95-6
N-Nitroso-N-methylurea	684-93-5
N-Nitroso-N-methylurethane	615--532
N-Nitrosomethylvinylamine	4549-40-0
N-Nitrosomorpholine	59-89-2
N-Nitrosonornicotine	16543-55-8
N-Nitrosopiperidine	100-75-4
N-Nitrosopyrrolidine	930-55-2
N-Nitrososarcosine	13256-22-9
Norethisterone (Norethindrone)	68-22-4

Ochratoxin A	303-47-9
Oestrogen replacement therapy	n/a
Oestrogen, nonstreoidal	
Oestrogen, steroidal	
Oil Orange SS	2646-17-5
Oral contraceptives, combined	n/a
Oral contraceptives, sequential	n/a
4,4'-Oxydianiline	101-80-4
Oxadiazon	19666-30-9
Oxymetholone	434-07-1
Oxazepam	604-75-1

Panfuran S	794-93-4
Pentachlorophenol	87-86-5
Phenacetin	62-44-2
Phenazopyridine hydrochloride	136-40-3

Phenesterin	3546-10-9
Phenobarbital	50-06-6
Phenoxybenzamine	59961
Phenoxybenzamine hydrochloride	63-92-3
Phenyl glycidyl ether	122-60-1
Phenylhydrazine and its salts	various
o-Phenylphenate, sodium	132-27-4
Phenytoin	57-41-0
PhiP(2-Amino-1-methyl-6-phenylimidazol[4,5-b]pyridine)	105650-23-5
Polybrominated biphenyls	various
Polychlorinated biphenyls	various
Polychlorinated biphenyls (containing 60 or more percent chlorine by molecular weight)	various
Polychlorinated dibenzo-p-dioxins	various
Polychlorinated dibenzofurans	various
Polycyclic aromatic hydrocarbons	various
Polygeenan	53973-98-1
Ponceau MX	3761-53-3
Ponceau 3R	3564-09-8
Potassium bromate	7758-01-2
Procarbazine	671-16-9
Procarbazine hydrochloride	366-70-1
Procymidone	32809-16-8
Progesterone	57-83-0
Progestins	various
1,3-Propane sultone	1120-71-4
Progargite	2312-35-8
beta-Propiolactone	57-57-8
Propylene oxide	75-56-9
Propylthiouracil	51-52-5
Radionuclides	various
Radon	10043-92-2
Reserpine	50-55-5
Residual (heavy) fuel oils	n/a
Saccharin	81-07-2
Saccharin, sodium	128-44-9
Safrole	94-59-7
Selenium sulfide	7446-34-6
Shale-oils	68308-34-9
Silica, crystalline (airborne particles of respirable size)	n/a
Sodium ortho-phenylphenate	
Soots, tars, and mineral oils (untreated and mildly treated oils and used engine oils)	n/a
Sterigmatocystin	10048-13-2
Streptozotocin	18883-66-4

Styrene	100-42-5
Styrene oxide	96-09-3
Sulfallate	95-06-7
Talc containing asbestiform fibers	n/a
Terrazole	2593-15-9
Testosterone and its esters	58-22-0
2,3,7,8-Tetrachlorodibenzo-para-dioxin (TCDD)	1746-01-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene (Perchloroethylene)	127-18-4
p-a,a,a-Tetrachlorotoluene	5216-25-1
Tetranitromethane	509-14-8
Thioacetamide	62-55-5
4,4'-Thiodianiline	139-65-1
Thiourea	62-56-6
Thorium dioxide	1314-20-1
Tobacco, oral use of smokeless products	n/a
Tobacco smoke	n/a
Toluene diisocyanate	26471-62-5
ortho-Toluidine	95-53-4
ortho-Toluidine hydrochloride	636-21-5
para-Toluidine	106-49-0
Toxaphene (Polychorinated camphenes)	8001-35-2
Treosulfan (Tresoluphan)	299-75-2
Trichlormethine (Trimustine hydrochloride)	817-09-4
2,4,6-Trichlorophenol	88-06-2
1,2,3-Trichloropropane	96-18-4
Triphenyltin hydroxide	76-87-9
Trichloroethylene	79-01-6
Tris(aziridinyl)-para-benzoquinone (Triaziquone)	68-76-8
Tris(1-aziridinyl)phosphine sulfide (Thiotepa)	52-24-4
Tris(2-chloroethyl) phosphate	115-96-8
Tris(2,3-dibromopropyl)phosphate	126-72-7
Trp-P-1 (Tryptophan-P-1) (3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole)	62450-06-0
Trp-P-2 (Tryptophan-P-2) (3-Amino-1-methyl-5H-pyrido[4,3-b]indole)	62450-07-1
Trypan blue (commercial grade)	72-57-1
Unleaded gasoline (wholly vaporized)	n/a
Uracil mustard	66-75-1
Urethane (Ethyl carbamate)	51-79-6
Vinyl bromide	593-60-2
Vinyl chloride	75-01-4
4-Vinyl-1-cyclohexene diepoxide (Vinyl cyclohexene dioxide)	106-87-6
Vinyl trichloride (1,1,2-Trichloroethane)	79-00-5

2,6-Xylidine (2,6-Dimethylaniline)	87-62-7
Zineb	12122-67-7

Chemicals Known To Cause Reproductive Toxicity

Developmental Toxicity

Chemical	CAS Number
Acetohydroxamic acid	546-88-3
Actinomycin D	50-76-0
All-trans retinoic acid	302-79-4
Alprazolam	28981-97-7
Amikacin sulfate	39831-55-5
Aminoglutethimide	125-84-8
Aminoglycosides	various
Aminopterin	54-62-6
Angiotensin converting enzyme (ACE) inhibitors	various
Anisindione	117-37-3
Aspirin (NOTE: It is especially important not to use aspirin during the last three months of pregnancy, unless specifically directed to do so by a because it may cause problems in the unborn child or complications during delivery.)	50-78-2
Barbiturates	various
Benomyl	17804-35-2
Benzphetamine hydrochloride	5411-22-3
Benzodiazepines	various
Bischloroethyl nitrosourea (BCNU) (Carmustine)	1540-93-8
Bromoxynil	1689-84-5
Butabarbital sodium	143-81-7
1,4-Butanediol dimethylsulfonate (Busulfan)	55-98-1
Carbon disulfide	75-15-0
Carbon monoxide	630-08-0
Carboplatin	41575-94-4
Chenodiol	474-25-9
Chlorcyclizine hydrochloride	1620-21-9
Chlorambucil	305-03-3
Chlordecone (Kepone)	143-50-0
Chlordiazepoxide	58-25-3
Chlordiazepoxide hydrochloride	438-41-5
1-(2-Chloroethyl)-3-cyclohexyl-l-nitrosourea (CCNU) (Lomustine)	13010-47-4

Clomiphene citrate	50-41-9
Clorazepate dipotassium	57109-90-7
Cocaine	50-36-2
Colchicine	64-86-8
Conjugated estrogens	n/a
Cyanazine	21725-46-2
Cycloheximide	66-81-9
Cyclophosphamide (anhydrous)	50-18-0
Cyclophosphamide (hydrated)	6055-19-2
Cyhexatin	13121-70-5
Cytarabine	147-94-4
Danazol	17230-88-5
Daunorubicin hydrochloride	23541-50-6
Demeclocycline hydrochloride (internal use)	64-73-3
Diazepam	439-14-5
Dicumarol	66-76-2
Diethylstilbestrol (DES)	56-53-1
Dinocap	39300-45-3
Dinoseb	88-85-7
Diphenylhydantoin (Phenytoin)	57-41-0
Doxycycline (internal use)	564-25-0
Doxycycline calcium (internal use)	94088-85-4
Doxycycline hyclate (internal use)	24390-14-5
Doxycycline monohydrate (internal use)	17086-28-1
Ergotamine tartrate	379-79-3
Ethyl alcohol in alcoholic beverages	n/a
Ethylene glycol monoethyl ether	110-80-5
Ethylene glycol monomethyl ether	109-86-4
Ethylene glycol monoethyl ether acetate	111-15-9
Ethylene glycol monomethyl ether acetate	110-49-6
Ethylene thiourea	96-45-7
Etoposide	33419-42-0
Etretinate	54350-48-0
Fluorouracil	51-21-8
Fluoxymesterone	76-43-7
Flurazepam hydrochloride	1172-18-5
Flutamide	13311-84-7
Halazepam	23092-17-3
Hexachlorobenzene	118-74-1
Ifosfamide	3778-73-2
Iodine-131	10043-66-0

Isotretinoin	4759-48-2
Lead	7439-92-1
Lithium carbonate	554-13-2
Lithium citrate	919-16-4
Lorazepam	846-49-1
Lovastatin	75330-75-5
Medroxyprogesterone acetate	71-58-9
Megestrol acetate	595-33-5
Melphalan	148-82-3
Menotropins	9002-68-0
Meprobamate	57-53-4
Mercaptopurine	6112-76-1
Mercury and mercury compounds	various
Methacycline hydrochloride	3963-95-9
Methimazole	60-56-0
Methotrexate	59-05-2
Methotrexate sodium	15475-56-6
Methyl bromide as a structural fumigant	74-83-9
Methyl mercury (dimethyl mercury)	593-74-8
Methyltestosterone	58-18-4
Midazolam hydrochloride	59467-96-8
Minocycline hydrochloride (internal use)	13614-98-7
Misoprostol	59122-46-2
Mitoxantrone hydrochloride	70476-82-3
Nafarelin acetate	86220-42-0
Neomycin sulfate (internal use)	1405-10-3
Netilmicin sulfate	56391-57-2
Nicotine	54-11-5
Nitrogen mustard (Mechlorethamine)	51-75-2
Nitrogen mustard hydrochloride (Mechlorethamine hydrochloride)	55-86-7
Norethisterone (Norethindrone)	68-22-4
Norethisterone acetate (Norethindrone acetate)	51-98-9
Norethisterone (Norethindrone)/Ethinyl estradiol	68-22-4/57-63-6
Norethisterone (Norethindrone)/Mestranol	68-22-4/72-33-3
Norgestrel	6533-00-2
Oxazepam	604-75-1
Oxytetracycline (internal use)	79-57-2
Oxytetracycline hydrochloride(internal use)	2058-46-0
Paramethadione	115-67-3
Penicillamine	52-67-5
Pentobarbital sodium	63-98-9

Phenprocoumon	435-97-2
Pipobroman	54-91-1
Plicamycin	18378-89-7
Polybrominated biphenyls	922-66-0
Polychlorinated biphenyls	various
Procarbazine hydrochloride	366-70-1
Propylthiouracil	51-52-5

Retinol/retinyl esters, when in daily dosages in excess of 10,000 IU, or 3,000 retinol equivalents. (NOTE: Retinol/retinyl esters are required and essential for maintenance of normal reproductive function. The recommended daily level during pregnancy is 8,000 IU.)	
Ribavirin	36791045

Secobarbital sodium	309-43-3
Streptomycin sulfate	3810-74-0

Tamoxifen citrate	54965-24-1
Temazepam	846-50-4
Testosterone cypionate	58-20-8
Testosterone enanthate	315-37-7
2,3,7,8-Tetrachlorodibenzo-para-dioxin (TCDD)	1746-01-6
Tetracyclines (internal use)	various
Tetracycline (internal use)	60-54-8
Tetracycline hydrochloride (internal use)	64-75-5
Thalidomide	50-35-1
Thioguanine	154-42-7
Tobacco smoke (primary)	n/a
Tobramycin sulfate	108-88-3
Triazolam	28911-01-5
Trilostane	13647-35-3
Trimethadione	127-48-0

Uracil mustard	66-75-1
Urethane	51-79-6
Urofollitropin	26995-91-5

Valproate (Valproic acid)	99-66-1
Vinblastine sulfate	143-67-9
Vincristine sulfate	2068-78-2

Warfarin	81-81-2

Female Reproductive Toxicity

Aminopterin	54-62-6

Anabolic steroids	n/a
Aspirin(NOTE: It is especially important not to use aspirin during the last three months of pregnancy, unless specifically directed to do so by a physician because it may cause problems in the unborn child or complications during delivery.)	50-78-2
Carbon disulfide	75-15-0
Cocaine	50-36-2
Cyclophosphamide (anhydrous)	50-18-0
Cyclophosphamide (hydrated)	6055-19-2
Ethylene oxide	75-21-8
Lead	
Tobacco smoke (primary)	n/a
Uracil mustard	66-75-1

Male Reproductive Toxicity

Anabolic steroids	n/a
Benomyl	17804-35-2
Carbon disulfide	75-15-0
Colchicine	64-86-8
Cyclophosphamide (anhydrous)	50-18-0
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8
m-Dinitrobenzene	99-65-0
o-Dinitrobenzene	528-29-0
p-Dinitrobenzene	100-25-4
Dinoseb	88-85-7
Ethylene glycol monoethyl ether	110-80-5
Ethylene glycol monomethyl ether	109-86-4
Ethylene glycol monoethyl ether acetate	111-15-9
Ethylene glycol monomethyl ether acetate	110-49-6
Hexamethylphosphoramide	680-31-9
Lead	7439-92-1
Nitrofurantoin	67-20-9
Tobacco smoke (primary)	n/a
Uracil mustard	66-75-1

Acutely Toxic Chemicals

Based on OSHA Standard 29 CFR 1910.119 App A

CHEMICAL NAME	**CAS NUMBER**
Acetaldehyde	75-07-0
Acrolein (2-Propenal)	107-02-8
Acrylyl Chloride	814-68-6
Allyl Chloride	107-05-1
Allylamine	107-11-9
Alkylaluminums	Varies
Ammonia, Anhydrous	7664-41-7
Ammonia solutions (greater than 44% ammonia by weight)	7664-41-7
Ammonium Perchlorate	7790-98-9
Ammonium Permanganate	7787-36-2
Arsine (also called Arsenic Hydride)	7784-42-1
Bis(Chloromethyl) Ether	542-88-1
Boron Trichloride	10294-34-5
Boron Trifluoride	7637-07-2
Bromine	7726-95-6
Bromine Chloride	13863-41-7
Bromine Pentafluoride	7789-30-2
Bromine Trifluoride	7787-71-5
3-Bromopropyne (also called Propargyl Bromide)	106-96-7
Butyl Hydroperoxide (Tertiary)	75-91-2
Butyl Perbenzoate (Tertiary)	614-45-9
Carbonyl Chloride (see Phosgene)	75-44-5
Carbonyl Fluoride	353-50-4
Cellulose Nitrate (concentration greater than 12.6% nitrogen)	9004-70-0
Chlorine	7782-50-5
Chlorine Dioxide	10049-04-4
Chlorine Pentafluoride	13637-63-3
Chlorine Trifluoride	7790-91-2
Chlorodiethylaluminum (also called Diethylaluminum Choride)	91-10-6
1-Chloro-2, 4-Dinitrobenzene	97-00-7
Chloromethyl Methyl Ether	107-30-2
Chloropicrin	76-06-2
Chloropicrin and Methyl Bromide mixture	None
Chloropicrin and Methyl Chloride mixture	None
Commune Hydroperoxide	80-15-9
Cyanogen	460-19-5
Cyanogen Chloride	506-77-4
Cyanuric Fluoride	675-14-9

Diacetyl Peroxide (concentration greater than 70%)	110-22-5
Diazomethane	334-88-3
Dibenzoyl Peroxide	94-36-0
Diborane	19287-45-7
Dibutyl Peroxide (Tertiary)	110-05-4
Dichloro Acetylene	7572-29-4
Dichlorosilane	4109-96-0
Diethylzinc	557-20-0
Diisopropyl Peroxydicarbonate	105-64-6
Dilauroyl Peroxide	105-74-8
Dimethyldichlorosilane	75-78-5
Dimethylhydrazine, 1,1-	57-14-7
Dimethylamine, Anhydrous	124-40-3
2, 4-Dinitroaniline	97-02-9
Ethyl Methyl Ketone Peroxide (also Methyl Ethyl Ketone Peroxide; concentration greater than 60%)	1338-23-4
Ethyl Nitrite	109-95-5
Ethylamine	75-04-7
Ethylene Fluorohydrin	371-62-0
Ethylene Oxide	75-21-8
Ethyleneimine	151-56-4
Fluorine	7782-41-4
Formaldehyde (Formalin)	50-00-0
Furan	110-00-9
Hexafluoroacetone	684-16-2
Hydrochloric Acid, Anhydrous	7647-01-0
Hydrofluoric Acid, Anhydrous	7664-39-3
Hydrogen Bromide	10035-10-6
Hydrogen Chloride	7647-01-0
Hydrogen Cyanide, Anhydrous	74-90-8
Hydrogen Fluoride	7664-39-3
Hydrogen Peroxide (52% by weight or greater)	7722-84-1
Hydrogen Selenide	7783-07-5
Hydrogen Sulfide	7783-06-4
Hydroxylamine	7803-49-8
Iron, Pentacarbonyl	13463-40-6
Isopropylamine	75-31-0
Ketene	463-51-4
Methacrylaldehyde	78-85-3
Methacryloyl Chloride	920-46-7
Methacryloyloxyethyl Isocyanate	30674-80-7
Methyl Acrylonitrile	126-98-7
Methylamine, Anhydrous	74-89-5
Methyl Bromide	74-83-9
Methyl Chloride	74-87-3
Methyl Chloroformate	79-22-1

Methyl Ethyl Ketone Peroxide (concentration greater than 60%)	1338-23-4
Methyl Fluoroacetate	453-18-9
Methyl Fluorosulfate	421-20-5
Methyl Hydrazine	60-34-4
Methyl Iodide	74-88-4
Methyl Isocyanate	624-83-9
Methyl Mercaptan	74-93-1
Methyl Vinyl Ketone	79-84-4
Methyltrichlorosilane	75-79-6
Nickel Carbonyl (Nickel Tetracarbonyl)	13463-39-3
Nitric Acid (94.5% or greater by weight)	7697-37-2
Nitric Oxide	10102-44-0
Nitroaniline (para-Nitroaniline)	100-01-6
Nitromethane	75-52-5
Nitrogen Dioxide	10102-44-0
Nitrogen Oxides (NO; NO(2); N2O4; N2O3)	10102-44-0
Nitrogen Tetroxide (also called Nitrogen Peroxide)	10544-72-6
Nitrogen Trifluoride	7783-54-2
Nitrogen Trioxide	10544-73-7
Oleum (65% to 80% by weight; also called Fuming Sulfuric Acid)	8014-94-7
Osmium Tetroxide	20816-12-0
Oxygen Difluoride (Fluorine Monoxide)	7783-41-7
Ozone	10028-15-6
Pentaborane	19624-22-7
Peracetic Acid (concentration greater than 60% Acetic Acid; also called Peroxyacetic Acid)	79-21-0
Perchloric Acid (concentration greater than 60% by weight)	7601-90-3
Perchloromethyl Mercaptan	594-42-3
Perchloryl Fluoride	7616-94-6
Peroxyacetic Acid (concentration greater than 60% Acetic Acid; also called Peracetic Acid)	79-21-0
Phosgene (also called Carbonyl Chloride)	75-44-5
Phosphine (Hydrogen Phosphide)	7803-51-2
Sulfur Dioxide (liquid)	7446-09-5
Sulfur Pentafluoride	5714-22-7
Sulfur Tetrafluoride	7783-60-0
Sulfur Trioxide (also called Sulfuric Anhydride)	7446-11-9
Sulfuric Anhydride (also called Sulfur Trioxide)	7446-11-9
Tellurium Hexafluoride	7783-80-4
Tetrafluoroethylene	116-14-3
Tetrafluorohydrazine	10036-47-2
Tetramethyl Lead	75-74-1
Thionyl Chloride	7719-09-7

Trichloro (chloromethyl) Silane	1558-25-4
Trichloro (dichlorophenyl) Silane	27137-85-5
Trichlorosilane	10025-78-2
Trifluorochloroethylene	79-38-9
Trimethyoxysilane	2487-90-3

Poison Inhalation List

arsenic pentafluoride
arsine
boron trichloride
boron trifluoride
bromine pentafluoride
bromine trifluoride
bromotrifluoroethylene
carbonyl fluoride
carbonyl sulfide
chlorine
chlorine pentachloride
chlorine trifluoride
chloropicrin (in mixes)
cyanogen chloride
diborane
dichlorosilane
digermane
dimethylamine
dinitrogen tetroxide
disilane
ethylene oxide
fluorine
germane
hexamethyltetraphosphate
hydrogen bromide
hydrogen chloride
hydrogen cyanide
hydrogen fluoride
hydrogen iodide
hydrogen selenide
hydrogen sulfide
methyl chloride
methyl mercaptan
methyl silane
nitric oxide
nitrogen dioxide
nitrogen trifluoride
nitrogen trioxide
oxygen difluoride
phosgene
phosphine
phosphorous pentafluoride
selenium hexafluoride
silane
silicon tetrachloride
silicon tetrafluoride
stibine
sulfur dioxide
sulfur tetrafluoride
tellurium hexafluoride
tetraethyldithiopyrophosphate
tetraethylpyrophosphate
triethylaluminum
triethylborane
triethylgallium
trimethylaluminum
trimethylamine
trimethylgallium
vinyl bromide
vinyl chloride
vinyl fluoride

APPENDIX E
Peroxide Forming Compounds List

Control and Safe Use of Peroxide Formers

Peroxide formation may be controlled by the following methods:

- Date all incoming containers of peroxide formers when received and again when opened.
- Many chemical companies now routinely print an expiration date on containers of the worst peroxide formers. Highlight this date upon receipt.
- Purchase the smallest possible container size for your needs.
- Store peroxide formers in sealed, air tight containers such as dark amber glass with a tight-fitting cap.
- Iron inhibits the formation of peroxides in some materials, which is why diethyl ether and some other materials are purchased in metal cans. Ground glass stoppered bottles and plastic containers are not advisable, however, plastic squeeze bottles may be used for small quantities of some materials, such as 2-propanol, for immediate use.
- Store peroxide formers in the dark.
- Inhibitors are added to some chemicals and the purchase of peroxide formers with added inhibitors is encouraged.
- Store peroxide formers, especially those in Table A below, under nitrogen or other inert gas, or keep and use them in an inert atmosphere chamber. <u>Note</u>: Some inhibitors actually need small amounts of oxygen to prevent peroxide formation and it is recommended that inhibited chemicals are not stored under an inert atmosphere.
- Avoid the distillation of peroxide formers without first testing for the existence of peroxides in the material. Most explosions with the use of peroxide formers occur when a material is distilled to dryness. Leave at least 10-20% bottoms. Stir such distillations with a mechanical stirrer or an inert gas. Air or an oxygen-containing mixture should never be used for this purpose.

Generally Safe Storage Periods for Peroxide Formers

Unopened chemicals from manufacturer	18 months
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 month

Table A. Chemicals that form explosive levels of peroxides without concentration.

- Butadiene[a]
- Chloroprene[a]
- Divinylacetylene
- Isopropyl ether
- Potassium metal
- Potassium amide
- Sodium amide (sodamide)
- Tetrafluoroethylene[a]
- Vinylidene chloride

Table B. Chemicals that form explosive levels of peroxides on concentration

- Acetal
- Acetaldehyde
- Benzyl alcohol
- 2-Butanol
- Cumene
- Cyclohexanol
- 2-Cyclohexen-1-ol
- Cyclohexene
- Decahydronaphthalene
- Diacetylene
- Dicyclopentadiene
- Diethyl ether
- Diethylene glycol dimenthyl ether (diglyme)
- Dioxanes
- Ethylene glycol dimethyl ether (glyme)
- 4-Heptanol
- 2-Hexanol
- Methylacetylene
- 3-Methyl-1-butanol
- Methylcyclopentane
- Methyl isobutyl ketone
- 4-Methyl-2-pentanol
- 2-Pentanol
- 4-Penten-1-ol
- 1-Phenylethanol
- 2-Phenylethanol
- 2-Propanol
- Tetrahydrofuran
- Tetrahydronaphthalene
- Vinyl ethers
- Other secondary alcohols

Table C. Chemicals that may autopolymerize as a result of peroxide accumulation

- Acrylic acid[b]
- Acrylonitrile[b]
- Butadiene[c]
- Chloroprene[c]
- Chlorotrifluoroethylene
- Methyl methacrylate[b]
- Styrene
- Tetrafluoroethylene[c]
- Vinyl acetate
- Vinylacetylene
- Vinyl chloride
- Vinylpyridine
- Vinyladiene chloride

Table D. Chemicals that may form peroxides but cannot clearly be placed in sections A - C.

- Acrolein
- Allyl ether[d]
- Allyl ethyl ether
- Allyl phenyl ether
- *p*-(*n*-Amyloxy)benzoyl chloride
- *n*-Amyl ether
- Benzyl *n*-butyl ether[d]
- Benxyl ether[d]
- Benzyl ethyl ether[d]
- Benzyl methyl ether
- Benzyl 1-napthyl ether[d]
- 1,2-Bis(2-chloroethoxy)ethane
- Bis(2 ethoxyethyl)ether
- Bis(2-(methoxyethoxy)ethyl) ether
- Bis(2-chloroethyl)ether
- Bis(2-ethoxyethyl)adipate
- Bis(2-ethoxyethyl) phthalate
- Bis(2-methoxyethyl) carbonate
- Bis(2-methoxyethyl) ether
- *tert*-Butyl methyl ether
- *n*-Butyl phenyl ether
- *n*-Butyl vinyl ether
- Chloroacetaldehyde diethylacetal[d]
- 2-Chlorobutadiene
- 1-(2-Chloroethoxy)-2-phenoxyethane
- Chloroethylene
- Chloromethyl methyl ether[e]
- B-Chlorophenetole
- o-Chlorophenetole
- p-Chlorophenetole
- Cyclooctene[d]
- Cyclopropyl methyl ether
- Diallyl ether[d]
- *p*-Di-n-butoxybenzene
- 1,2-Dibenzyloxyethane[d]
- *p*-Dibenzyloxybenzene[d]
- 1,2-Dichloroethyl ethyl ether
- 2,4-Dichlorophenetole
- Di(1-propynyl)ether[f]
- Di(2-propynyl)ether
- Di-*n*-propoxymethane[d]
- 1,2-Epoxy-3-isopropoxypropane[d]
- 1,2-Epoxy-3-phenoxypropane
- *p*-Ethoxyacethophenone
- 1-(2-Ethoxyethoxy)ethyl acetate
- 2-Ethoxyethyl acetate
- (2-Ethoxyethyl)-o-benzoyl benzoate
- 1-Ethoxynaphthalene
- o,p-Ethoxyphenyl isocyanate
- 1-Ethoxy-2-propyne
- 3-Ethoxyopropionitrile
- 2-Ethylacrylaldehyde oxime
- 2-Ethylbutanol
- Ethyl *B*-ethoxypropionate
- 2-Ethylhexanal
- Ethyl vinyl ether
- Furan
- 4-Methyl-2-pentanone
- *n*-Methylphenetole
- 2-Methyltetrahydrofuran
- 3-Methoxy-1-butyl acetate
- 2-Methoxyethanol
- 3-Methoxyethyl acetate
- 2-Methoxyethyl vinyl ether
- Methonxy-1,3,5,7-cyclooctatetraene
- B-Methoxypropionitrile
- m-Nitrophenetole
- 1-Octene
- Oxybis(2-ethyl acetate)
- Oxybis(2-ethyl benzoate)
- *B,B*-oxydipropionitrile
- 1-Pentene
- Phenoxyacetyl chloride
- *a*-Phenoxypropionyl chloride
- Phenyl *o*-propyl ether
- *p*-Phenylphenetone

Bis(2-methoxyethyl) phthalate
Bis(2-methoxymethyl) adipate
Bis(2-n-butoxyethyl) phthalate
Bis(2-phenoxyethyl) ether
Bis(4-chlorobutyl) ether
Bis(chloromethyl) ether[e]
2-Bromomethyl ethyl ether
B-Bromophenetole
o-Bromophenetole
p-Bromophenetole
3-Bromopropyl phenyl ether
1,3-Butadiyne
Buten-3-yne
tert-Butyl ethyl ether

Diethoxymethane[d]
2,2-Diethoxypropane
Diethyl ethoxymethylenemalonate
Diethyl fumarate[d]
Diethyl acetal[d]
Diethyketene[f]
m,o,p-diethoxybenzene
1,2-Diethoxyethane
Dimethoxymethane[d]
1,1-Dimethoxyethane[d]
Dimethylketene[f]
3,3-Dimethoxypropene
2,4-Dinitrophenetole
1,3-Dioxepane[d]

2,5-Hexadiyn-1-ol
4,5-Hexadien-2-yn-1-ol
n-Hexyl ether
o,p-Iodophenetole
Isoamyl benzyl ether[d]
Isoamyl ether[d]
Isobutyl vinyl ether
Isophorone[d]
B-Isopropoxypropionitrile[d]
Isopropyl 2,4,5-trichlorophenoxyacetate
Limonene
1,5-*p*-Methadiene
Methyl *p*-(*n*-amyloxy)benzoate

n-Propyl ether
n-Propyl isopropyl ether
Sodium 8,11,14-eicosatetraenoate
Sodium ethoxyacetylide[f]
Tetrahydropyran
Triethylene glycol diacetate
Triethylene glycol dipropionate
1,3,3-Trimethoxypropene[d]
1,1,2,3-Tetrachloro-1,3-butadiene
4-Vinyl cyclohexene
Vinylene carbonate
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.

"Review of Safety Guidelines for Peroxidizable Organic Chemicals," *Chemical Health and Safety*, September/October 1996.

APPENDIX F
Incompatible Chemical Combinations

INCOMPATIBLE CHEMICAL COMBINATIONS

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 being used can usually be found in the "REACTIVITY" or "INCOMPATIBILITIES" section of the Material Safety Data Sheet.

Chemical	**Do Not Combine or Mix With**
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 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.
Aluminum alkyls	Halogenated hydrocarbons, water.
Ammonia (anhydrous)	Silver, mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrogen fluoride, chlorine dioxide.
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organics or combustibles.
Aniline	Nitric acid, hydrogen peroxide.
Benzoyl peroxide	Chloroform, organic materials.
Bromine	Ammonia, acetylene, butadiene, butane and other petroleum gases, sodium carbide, turpentine, benzene and finely divided metals.
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.
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organics or combustibles.
Chlorine	Ammonium salts, acids, metal powders, sulfur, finely divided organics or combustibles.
Chlorine dioxide	Ammonia, methane, phosphine and hydrogen sulfide.
Chlorosulfonic acid	Organic materials, water, powdered metals.
Chromic acid	Acetic acid, naphthalene, camphor, glycerine, turpentine, alcohol and other flammable liquids, paper or cellulose.
Copper	Acetylene, hydrogen peroxide, ethylene oxide.
Cumene hydroperoxide	Acids, organic or mineral.
Ethylene oxide	Acids, bases, copper, magnesium perchlorate.
Fluorine	Almost all oxidizable substances.
Hydrocyanic acid	Nitric acid, alkalis.
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, any flammable liquid, combustible materials, aniline, nitromethane.
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.
Iodine	Acetylene, ammonia (anhydrous or aqueous).

Maleic anhydride	Sodium hydroxide, pyridine and other tertiary amines.
Mercury	Acetylene, fulminic acid, ammonia, oxalic acid.
Nitrates	Acids, metal powders, flammable liquids, chlorates, sulfur, finely divided organics or combustibles.
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic, acid, hydrogen sulfide, flammable liquids, flammable gases, nitratable substances, organic peroxides, chlorates.
Nitroparaffins	Inorganic bases.
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.
Phosphorus (white)	Air, oxygen.
Phosphorus pentoxide	Propargyl alcohol.
Potassium chlorate	Acids (see also chlorates).
Potassium perchlorate	Acids (see also perchloric acid).
Potassium permanganate	Glycerine, ethylene glycol, benzaldehyde, any free acid.
Silver	Acetylene, oxalic acid, tartaric acid, fulminic acid, ammonium compounds.
Sodium	See alkaline 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.
Sulfuric acid	Chlorates, perchlorates, permanganates, organic peroxides.
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 G
OSHAs PELs & TLVs

Z-1 LIMITS FOR AIR CONTAMINANTS

NOTE: Because of the length of the table, explanatory Footnotes applicable to all substances are given below as well as at the end of the table. Footnotes specific only to a limited number of substances are also shown within the table.

Footnote(1) The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing-zone air samples.

Footnote(a) Parts of vapor or gas per million parts of contaminated air by volume at 25 degrees C and 760 torr.

Footnote(b) Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

Footnote(c) The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound measured as the metal, the CAS number for the metal is given - not CAS numbers for the individual compounds.

Footnote(d) The final benzene standard in 1910.1028 applies to all occupational exposures to benzene except in some circumstances the distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures; for the excepted subsegments, the benzene limits in Table Z-2 apply. See 1910.1028 for specific circumstances.

Footnote(e) This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste recycling (sorting, blending, cleaning and willowing) and garnetting. See also 1910.1043 for cotton dust limits applicable to other sectors.

Footnote(f) All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particulates Not Otherwise Regulated (PNOR) limit which is the same as the inert or nuisance dust limit of Table Z-3.

Footnote(2) See Table Z-2.

Footnote(3) See Table Z-3

Footnote(4) Varies with compound.

TABLE Z-1. - LIMITS FOR AIR CONTAMINANTS

Substance	CAS No. (c)	ppm (a)(1)	mg/m(3) (b)(1)	Skin designation
Acetaldehyde	75-07-0	200	360	
Acetic acid	64-19-7	10	25	
Acetic anhydride	108-24-7	5	20	
Acetone	67-64-1	1000	2400	
Acetonitrile	75-05-8	40	70	
2-Acetylaminofluorene; see 1910.1014	53-96-3			
Acetylene dichloride; see 1,2-Dichloroethylene.				
Acetylene tetrabromide.	79-27-6	1	14	
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-06-1	....	0.3	X
Acrylonitrile; see 1910.1045	107-13-1			
Aldrin	309-00-2	....	0.25	X
Allyl alcohol	107-18-6	2	5	X
Allyl chloride	107-05-1	1	3	
Allyl glycidyl ether (AGE)	106-92-3	(C)10	(C)45	
Allyl propyl disulfide.	2179-59-1	2	12	
alpha-Alumina	1344-28-1			
Total dust		....	15	
Respirable fraction		....	5	
Aluminum Metal (as Al).	7429-90-5			
Total dust		....	15	
Respirable fraction		....	5	
4-Aminodiphenyl; see 1910.1011	92-67-1			
2-Aminoethanol; see Ethanolamine				
2-Aminopyridine	504-29-0	0.5	2	
Ammonia	7664-41-7	50	35	
Ammonium sulfamate	7773-06-0			
Total dust		....	15	
Respirable fraction		....	5	
n-Amyl acetate	628-63-7	100	525	
sec-Amyl acetate	626-38-0	125	650	
Aniline and homologs	62-53-3	5	19	X
Anisidine (o-,p-isomers)	29191-52-4	....	0.5	X
Antimony and compounds (as Sb)	7440-36-0	....	0.5	
ANTU (alpha Naphthylthiourea)	86-88-4	....	0.3	
Arsenic, inorganic compounds (as As); see 1910.1018	7440-38-2			
Arsenic, organic				

compounds (as As)....	7440-38-2	....	0.5	
Arsine................	7784-42-1	0.05	0.2	
Asbestos; see 1910.1001........	(4)			
Azinphos-methyl........	86-50-0	....	0.2	X
Barium, soluble compounds (as Ba)....	7440-39-3	....	0.5	
Barium sulfate.........	7727-43-7			
Total dust...........		....	15	
Respirable fraction..		....	5	
Benomyl................	17804-35-2			
Total dust...........		....	15	
Respirable fraction..		....	5	
Benzene; See 1910.1028. See Table Z-2 for the limits applicable in the operations or sectors excluded in 1910.1028(d)	71-43-2			
Benzidine; See 1910.1010........	92-87-5			
p-Benzoquinone; see Quinone.				
Benzo(a)pyrene; see Coal tar pitch volatiles............				
Benzoyl peroxide.......	94-36-0	....	5	
Benzyl chloride........	100-44-7	1	5	
Beryllium and beryllium compounds (as Be).............	7440-41-7		(2)	
Biphenyl; see Diphenyl.				
Bismuth telluride, Undoped.............	1304-82-1			
Total dust...........		....	15	
Respirable fraction..		....	5	
Boron oxide............	1303-86-2			
Total dust...........		....	15	
Boron trifluoride......	7637-07-2	(C)1	(C)3	
Bromine................	7726-95-6	0.1	0.7	
Bromoform..............	75-25-2	0.5	5	X
Butadiene (1,3-Butadiene); See 29 CFR 1910.1051; 29 CFR 1910.19(l)....	106-99-0	1 ppm/5 ppm STEL		
Butanethiol; see Butyl mercaptan.				
2-Butanone (Methyl ethyl ketone)	78-93-3	200	590	
2-Butoxyethanol........	111-76-2	50	240	X
n-Butyl-acetate........	123-86-4	150	710	
sec-Butyl acetate......	105-46-4	200	950	
tert-Butyl-acetate.....	540-88-5	200	950	
n-Butyl alcohol........	71-36-3	100	300	
sec-Butyl alcohol......	78-92-2	150	450	
tert-Butyl alcohol.....	75-65-0	100	300	

Butylamine............	109-73-9	(C)5	(C)15	X
tert-Butyl chromate (as CrO(3))..........	1189-85-1	....	(C)0.1	X
n-Butyl glycidyl ether (BGE)................	2426-08-6	50	270	
Butyl mercaptan........	109-79-5	10	35	
p-tert-Butyltoluene....	98-51-1	10	60	
Cadmium (as Cd); see 1910.1027........	7440-43-9			
Calcium Carbonate......	1317-65-3			
Total dust...........		....	15	
Respirable fraction..		....	5	
Calcium hydroxide......	1305-62-0			
Total dust...........		....	15	
Respirable fraction..		....	5	
Calcium oxide..........	1305-78-8	....	5	
Calcium silicate.......	1344-95-2			
Total dust...........		....	15	
Respirable fraction..		....	5	
Calcium sulfate........	7778-18-9			
Total dust...........		....	15	
Respirable fraction..		....	5	
Camphor, synthetic.....	76-22-2	....	2	
Carbaryl (Sevin).......	63-25-2	....	5	
Carbon black...........	1333-86-4	....	3.5	
Carbon dioxide.........	124-38-9	5000	9000	
Carbon disulfide.......	75-15-0		(2)	
Carbon monoxide........	630-08-0	50	55	
Carbon tetrachloride...	56-23-5		(2)	
Cellulose..............	9004-34-6			
Total dust...........		....	15	
Respirable fraction..		....	5	
Chlordane..............	57-74-9	....	0.5	X
Chlorinated camphene...	8001-35-2	....	0.5	X
Chlorinated diphenyl oxide...............	55720-99-5	....	0.5	
Chlorine...............	7782-50-5	(C)1	(C)3	
Chlorine dioxide.......	10049-04-4	0.1	0.3	
Chlorine trifluoride...	7790-91-2	(C)0.1	(C)0.4	
Chloroacetaldehyde.....	107-20-0	(C)1	(C)3	
a-Chloroacetophenone (Phenacyl chloride)..	532-27-4	0.05	0.3	
Chlorobenzene..........	108-90-7	75	350	
o-Chlorobenzylidene malononitrile........	2698-41-1	0.05	0.4	
Chlorobromomethane.....	74-97-5	200	1050	
2-Chloro-1,3-butadiene; See beta-Chloroprene.				
Chlorodiphenyl (42% Chlorine)(PCB)..	53469-21-9	....	1	X
Chlorodiphenyl (54% Chlorine)(PCB)..	11097-69-1	....	0.5	X
1-Chloro-2, 3-epoxypropane; See Epichlorohydrin.				
2-Chloroethanol; See Ethylene chlorohydrin				

Chloroethylene; See Vinyl chloride.				
Chloroform (Trichloromethane)	67-66-3	(C)50	(C)240	
bis(Chloromethyl) ether; see 1910.1008.	542-88-1			
Chloromethyl methyl ether; see 1910.1006.	107-30-2			
1-Chloro-1-nitropropane	600-25-9	20	100	
Chloropicrin	76-06-2	0.1	0.7	
beta-Chloroprene	126-99-8	25	90	X
2-Chloro-6 (trichloromethyl) pyridine	1929-82-4			
Total dust		....	15	
Respirable fraction		....	5	
Chromic acid and chromates (as CrO(3))	(4)		(2)	
Chromium (II) compounds (as Cr)	7440-47-3	....	0.5	
Chromium (III) compounds (as Cr)	7440-47-3	....	0.5	
Chromium metal and insol. salts (as Cr)	7440-47-3	....	1	
Chrysene; see Coal tar pitch volatiles				
Clopidol	2971-90-6			
Total dust		....	15	
Respirable fraction		....	5	
Coal dust (less than 5% SiO(2)), respirable fraction			(3)	
Coal dust (greater than or equal to 5% SiO(2)), respirable fraction			(3)	
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65966-93-2	....	0.2	
Cobalt metal, dust, and fume (as Co)	7440-48-4	....	0.1	
Coke oven emissions; see 1910.1029				
Copper	7440-50-8			
Fume (as Cu)		....	0.1	
Dusts and mists (as Cu)		....	1	
Cotton dust (e), see 1910.1043		....	1	
Crag herbicide (Sesone)	136-78-7			
Total dust		....	15	
Respirable fraction		....	5	
Cresol, all isomers	1319-77-3	5	22	X

Crotonaldehyde	123-73-9 4170-30-3	2	6	
Cumene	98-82-8	50	245	X
Cyanides (as CN)	(4)	....	5	X
Cyclohexane	110-82-7	300	1050	
Cyclohexanol	108-93-0	50	200	
Cyclohexanone	108-94-1	50	200	
Cyclohexene	110-83-8	300	1015	
Cyclopentadiene	542-92-7	75	200	
2,4-D (Dichlorophenoxyacetic acid)	94-75-7	....	10	
Decaborane	17702-41-9	0.05	0.3	X
Demeton (Systox)	8065-48-3	....	0.1	X
Diacetone alcohol (4-Hydroxy-4-methyl-2-pentanone)	123-42-2	50	240	
1,2-Diaminoethane; see Ethylenediamine				
Diazomethane	334-88-3	0.2	0.4	
Diborane	19287-45-7	0.1	0.1	
1,2-Dibromo-3-chloropropane (DBCP); see 1910.1044	96-12-8			
1,2-Dibromoethane; see Ethylene dibromide				
Dibutyl phosphate	107-66-4	1	5	
Dibutyl phthalate	84-74-2	....	5	
o-Dichlorobenzene	95-50-1	(C)50	(C)300	
p-Dichlorobenzene	106-46-7	75	450	
3,3'-Dichlorobenzidine; see 1910.1007	91-94-1			
Dichlorodifluoromethane	75-71-8	1000	4950	
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5	....	0.2	
Dichlorodiphenyltrichloroethane (DDT)	50-29-3	....	1	X
1,1-Dichloroethane	75-34-3	100	400	
1,2-Dichloroethane; see Ethylene dichloride				
1,2-Dichloroethylene	540-59-0	200	790	
Dichloroethyl ether	111-44-4	(C)15	(C)90	X
Dichloromethane; see Methylene chloride				
Dichloromonofluoromethane	75-43-4	1000	4200	
1,1-Dichloro-1-nitroethane	594-72-9	(C)10	(C)60	
1,2-Dichloropropane; see Propylene dichloride				
Dichlorotetrafluoroethane	76-14-2	1000	7000	
Dichlorvos (DDVP)	62-73-7	....	1	X
Dicyclopentadienyl iron	102-54-5			
Total dust		....	15	
Respirable fraction		....	5	
Dieldrin	60-57-1	....	0.25	X

Diethylamine	109-89-7	25	75	
2-Diethylaminoethanol	100-37-8	10	50	X
Diethyl ether; see Ethyl ether				
Difluorodibromomethane	75-61-6	100	860	
Diglycidyl ether (DGE)	2238-07-5	(C)0.5	(C)2.8	
Dihydroxybenzene; see Hydroquinone				
Diisobutyl ketone	108-83-8	50	290	
Diisopropylamine	108-18-9	5	20	X
4-Dimethylaminoazobenzene; see 1910.1015	60-11-7			
Dimethoxymethane; see Methylal				
Dimethyl acetamide	127-19-5	10	35	X
Dimethylamine	124-40-3	10	18	
Dimethylaminobenzene; see Xylidine				
Dimethylaniline (N,N-Dimethylaniline)	121-69-7	5	25	X
Dimethylbenzene; see Xylene				
Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate	300-76-5	....	3	
Dimethylformamide	68-12-2	10	30	X
2,6-Dimethyl-4-heptanone; see Diisobutyl ketone				
1,1-Dimethylhydrazine	57-14-7	0.5	1	X
Dimethylphthalate	131-11-3	....	5	
Dimethyl sulfate	77-78-1	1	5	X
Dinitrobenzene (all isomers)			1	X
(ortho)	528-29-0			
(meta)	99-65-0			
(para)	100-25-4			
Dinitro-o-cresol	534-52-1	....	0.2	X
Dinitrotoluene	25321-14-6	....	1.5	X
Dioxane (Diethylene dioxide)	123-91-1	100	360	X
Diphenyl (Biphenyl)	92-52-4	0.2	1	
Diphenylmethane diisocyanate; see Methylene bisphenyl isocyanate				
Dipropylene glycol methyl ether	34590-94-8	100	600	X
Di-sec octyl phthalate (Di-(2-ethylhexyl) phthalate)	117-81-7	....	5	
Emery	12415-34-8			
Total dust		....	15	
Respirable fraction		....	5	
Endrin	72-20-8	....	0.1	X
Epichlorohydrin	106-89-8	5	19	X

EPN....................	2104-64-5	....	0.5	X
1,2-Epoxypropane; see Propylene oxide......				
2,3-Epoxy-1-propanol; see Glycidol.........				
Ethanethiol; see Ethyl mercaptan......				
Ethanolamine...........	141-43-5	3	6	
2-Ethoxyethanol (Cellosolve).........	110-80-5	200	740	X
2-Ethoxyethyl acetate (Cellosolve acetate).	111-15-9	100	540	X
Ethyl acetate..........	141-78-6	400	1400	
Ethyl acrylate.........	140-88-5	25	100	X
Ethyl alcohol (Ethanol)	64-17-5	1000	1900	
Ethylamine.............	75-04-7	10	18	
Ethyl amyl ketone (5-Methyl-3-heptanone)...........	541-85-5	25	130	
Ethyl benzene..........	100-41-4	100	435	
Ethyl bromide..........	74-96-4	200	890	
Ethyl butyl ketone (3-Heptanone)........	106-35-4	50	230	
Ethyl chloride.........	75-00-3	1000	2600	
Ethyl ether............	60-29-7	400	1200	
Ethyl formate..........	109-94-4	100	300	
Ethyl mercaptan........	75-08-1	(C)10	(C)25	
Ethyl silicate.........	78-10-4	100	850	
Ethylene chlorohydrin..	107-07-3	5	16	X
Ethylenediamine........	107-15-3	10	25	
Ethylene dibromide.....	106-93-4		(2)	
Ethylene dichloride (1,2-Dichloroethane).	107-06-2		(2)	
Ethylene glycol dinitrate...........	628-96-6	(C)0.2	(C)1	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate...				
Ethyleneimine; see 1910.1012........	151-56-4			
Ethylene oxide; see 1910.1047........	75-21-8			
Ethylidene chloride; see 1,1-Dichlorethane				
N-Ethylmorpholine......	100-74-3	20	94	X
Ferbam.................	14484-64-1			
Total dust...........		....	15	
Ferrovanadium dust.....	12604-58-9	....	1	
Fluorides (as F).......	(4)	....	2.5	
Fluorine...............	7782-41-4	0.1	0.2	
Fluorotrichloromethane (Trichloro-fluoromethane).......	75-69-4	1000	5600	
Formaldehyde; see 1910.1048........	50-00-0			
Formic acid............	64-18-6	5	9	
Furfural...............	98-01-1	5	20	X

Furfuryl alcohol	98-00-0	50	200	
Grain dust (oat, wheat barley)	....	....	10	
Glycerin (mist)	56-81-5			
Total dust		....	15	
Respirable fraction		....	5	
Glycidol	556-52-5	50	150	
Glycol monoethyl ether; see 2-Ethoxyethanol				
Graphite, natural respirable dust	7782-42-5		(3)	
Graphite, synthetic				
Total dust		....	15	
Respirable Fraction		....	5	
Guthion; see Azinphos methyl				
Gypsum	13397-24-5			
Total dust		....	15	
Respirable fraction		....	5	
Hafnium	7440-58-6	....	0.5	
Heptachlor	76-44-8	....	0.5	X
Heptane (n-Heptane)	142-82-5	500	2000	
Hexachloroethane	67-72-1	1	10	X
Hexachloronaphthalene	1335-87-1	....	0.2	X
n-Hexane	110-54-3	500	1800	
2-Hexanone (Methyl n-butyl ketone)	591-78-6	100	410	
Hexone (Methyl isobutyl ketone)	108-10-1	100	410	
sec-Hexyl acetate	108-84-9	50	300	
Hydrazine	302-01-2	1	1.3	X
Hydrogen bromide	10035-10-6	3	10	
Hydrogen chloride	7647-01-0	(C)5	(C)7	
Hydrogen cyanide	74-90-8	10	11	X
Hydrogen fluoride (as F)	7664-39-3		(2)	
Hydrogen peroxide	7722-84-1	1	1.4	
Hydrogen selenide (as Se)	7783-07-5	0.05	0.2	
Hydrogen sulfide	7783-06-4		(2)	
Hydroquinone	123-31-9	....	2	
Iodine	7553-56-2	(C)0.1	(C)1	
Iron oxide fume	1309-37-1	....	10	
Isomyl acetate	123-92-2	100	525	
Isomyl alcohol (primary and secondary)	123-51-3	100	360	
Isobutyl acetate	110-19-0	150	700	
Isobutyl alcohol	78-83-1	100	300	
Isophorone	78-59-1	25	140	
Isopropyl acetate	108-21-4	250	950	
Isopropyl alcohol	67-63-0	400	980	
Isopropylamine	75-31-0	5	12	
Isopropyl ether	108-20-3	500	2100	
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240	
Kaolin	1332-58-7			

Total dust		....	15	
Respirable fraction		....	5	
Ketene	463-51-4	0.5	0.9	
Lead inorganic (as Pb); see 1910.1025	7439-92-1			
Limestone	1317-65-3			
Total dust		....	15	
Respirable fraction		....	5	
Lindane	58-89-9	....	0.5	X
Lithium hydride	7580-67-8	....	0.025	
L.P.G. (Liquified petroleum gas)	68476-85-7	1000	1800	
Magnesite	546-93-0			
Total dust		....	15	
Respirable fraction		....	5	
Magnesium oxide fume	1309-48-4			
Total Particulate		....	15	
Malathion	121-75-5			
Total dust		....	15	X
Maleic anhydride	108-31-6	0.25	1	
Manganese compounds (as Mn)	7439-96-5	....	(C)5	
Manganese fume (as Mn)	7439-96-5	....	(C)5	
Marble	1317-65-3			
Total dust		....	15	
Respirable fraction		....	5	
Mercury (aryl and inorganic)(as Hg)	7439-97-6		(2)	
Mercury (organo) alkyl compounds (as Hg)	7439-97-6		(2)	
Mercury (vapor) (as Hg)	7439-97-6		(2)	
Mesityl oxide	141-79-7	25	100	
Methanethiol; see Methyl mercaptan.				
Methoxychlor	72-43-5			
Total dust		....	15	
2-Methoxyethanol; (Methyl cellosolve)	109-86-4	25	80	X
2-Methoxyethyl acetate (Methyl cellosolve acetate)	110-49-6	25	120	X
Methyl acetate	79-20-9	200	610	
Methyl acetylene (Propyne)	74-99-7	1000	1650	
Methyl acetylene propadiene mixture (MAPP)		1000	1800	
Methyl acrylate	96-33-3	10	35	X
Methylal (Dimethoxy-methane)	109-87-5	1000	3100	
Methyl alcohol	67-56-1	200	260	
Methylamine	74-89-5	10	12	
Methyl amyl alcohol; see Methyl Isobutyl carbinol.				
Methyl n-amyl ketone	110-43-0	100	465	
Methyl bromide	74-83-9	(C)20	(C)80	X

Methyl butyl ketone; see 2-Hexanone.......				
Methyl cellosolve; see 2-Methoxyethanol.				
Methyl cellosolve acetate; see 2-Methoxyethyl acetate.............				
Methyl chloride........	74-87-3		(2)	
Methyl chloroform (1,1,1-Trichloroethane).............	71-55-6	350	1900	
Methylcyclohexane......	108-87-2	500	2000	
Methylcyclohexanol.....	25639-42-3	100	470	
o-Methylcyclohexanone..	583-60-8	100	460	X
Methylene chloride.....	75-09-2		(2)	
Methyl ethyl ketone (MEK); see 2-Butanone				
Methyl formate.........	107-31-3	100	250	
Methyl hydrazine (Monomethyl hydrazine)...........	60-34-4	(C)0.2	(C)0.35	X
Methyl iodide..........	74-88-4	5	28	X
Methyl isoamyl ketone..	110-12-3	100	475	
Methyl isobutyl carbinol............	108-11-2	25	100	X
Methyl isobutyl ketone; see Hexone...........				
Methyl isocyanate......	624-83-9	0.02	0.05	X
Methyl mercaptan.......	74-93-1	(C)10	(C)20	
Methyl methacrylate....	80-62-6	100	410	
Methyl propyl ketone; see 2-Pentanone......				
alpha-Methyl styrene...	98-83-9	(C)100	(C)480	
Methylene bisphenyl isocyanate (MDI).....	101-68-8	(C)0.02	(C)0.2	
Mica; see Silicates....				
Molybdenum (as Mo).....	7439-98-7			
Soluble compounds....		....	5	
Insoluble Compounds				
Total dust.........		....	15	
Monomethyl aniline.....	100-61-8	2	9	X
Monomethyl hydrazine; see Methyl hydrazine.				
Morpholine............	110-91-8	20	70	X
Naphtha (Coal tar).....	8030-30-6	100	400	
Naphthalene...........	91-20-3	10	50	
alpha-Naphthylamine; see 1910.1004........	134-32-7			
beta-Naphthylamine; see 1910.1009........	91-59-8			
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007	
Nickel, metal and insoluble compounds (as Ni).............	7440-02-0	....	1	
Nickel, soluble compounds (as Ni)....	7440-02-0	....	1	

Nicotine	54-11-5	....	0.5	X
Nitric acid	7697-37-2	2	5	
Nitric oxide	10102-43-9	25	30	
p-Nitroaniline	100-01-6	1	6	X
Nitrobenzene	98-95-3	1	5	X
p-Nitrochlorobenzene	100-00-5	....	1	X
4-Nitrodiphenyl; see 1910.1003	92-93-3			
Nitroethane	79-24-3	100	310	
Nitrogen dioxide	10102-44-0	(C)5	(C)9	
Nitrogen trifluoride	7783-54-2	10	29	
Nitroglycerin	55-63-0	(C)0.2	(C)2	X
Nitromethane	75-52-5	100	250	
1-Nitropropane	108-03-2	25	90	
2-Nitropropane	79-46-9	25	90	
N-Nitrosodimethylamine; see 1910.1016				
Nitrotoluene (all isomers)		5	30	X
o-isomer	88-72-2			
m-isomer	99-08-1			
p-isomer	99-99-0			
Nitrotrichloromethane; see Chloropicrin				
Octachloronaphthalene	2234-13-1	....	0.1	X
Octane	111-65-9	500	2350	
Oil mist, mineral	8012-95-1	....	5	
Osmium tetroxide (as Os)	20816-12-0	....	0.002	
Oxalic acid	144-62-7	....	1	
Oxygen difluoride	7783-41-7	0.05	0.1	
Ozone	10028-15-6	0.1	0.2	
Paraquat, respirable dust	4685-14-7 1910-42-5 2074-50-2	....	0.5	X
Parathion	56-38-2	....	0.1	X
Particulates not otherwise regulated (PNOR)(f)				
Total dust		....	15	
Respirable fraction		....	5	
PCB; see Chlorodiphenyl (42% and 54% chlorine)				
Pentaborane	19624-22-7	0.005	0.01	
Pentachloronaphthalene	1321-64-8	....	0.5	X
Pentachlorophenol	87-86-5	....	0.5	X
Pentaerythritol	115-77-5			
Total dust		....	15	
Respirable fraction		....	5	
Pentane	109-66-0	1000	2950	
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700	
Perchloroethylene (Tetrachloroethylene)	127-18-4		(2)	
Perchloromethyl				

mercaptan	594-42-3	0.1	0.8	
Perchloryl fluoride	7616-94-6	3	13.5	
Petroleum distillates (Naphtha)(Rubber Solvent)		500	2000	
Phenol	108-95-2	5	19	X
p-Phenylene diamine	106-50-3	....	0.1	X
Phenyl ether, vapor	101-84-8	1	7	
Phenyl ether-biphenyl mixture, vapor		1	7	
Phenylethylene; see Styrene				
Phenyl glycidyl ether (PGE)	122-60-1	10	60	
Phenylhydrazine	100-63-0	5	22	X
Phosdrin (Mevinphos)	7786-34-7	....	0.1	X
Phosgene (Carbonyl chloride)	75-44-5	0.1	0.4	
Phosphine	7803-51-2	0.3	0.4	
Phosphoric acid	7664-38-2	....	1	
Phosphorus (yellow)	7723-14-0	....	0.1	
Phosphorus pentachloride	10026-13-8	....	1	
Phosphorus pentasulfide	1314-80-3	....	1	
Phosphorus trichloride	7719-12-2	0.5	3	
Phthalic anhydride	85-44-9	2	12	
Picloram	1918-02-1			
Total dust		....	15	
Respirable fraction		....	5	
Picric acid	88-89-1	....	0.1	X
Pindone (2-Pivalyl-1, 3-indandione)	83-26-1	....	0.1	
Plaster of paris	26499-65-0			
Total dust		....	15	
Respirable fraction		....	5	
Platinum (as Pt)	7440-06-4			
Metal		....	....	
Soluble Salts		....	0.002	
Portland cement	65997-15-1			
Total dust		....	15	
Respirable fraction		....	5	
Propane	74-98-6	1000	1800	
beta-Propriolactone; see 1910.1013	57-57-8			
n-Propyl acetate	109-60-4	200	840	
n-Propyl alcohol	71-23-8	200	500	
n-Propyl nitrate	627-13-4	25	110	
Propylene dichloride	78-87-5	75	350	
Propylene imine	75-55-8	2	5	X
Propylene oxide	75-56-9	100	240	
Propyne; see Methyl acetylene				
Pyrethrum	8003-34-7	....	5	
Pyridine	110-86-1	5	15	
Quinone	106-51-4	0.1	0.4	
RDX: see Cyclonite				
Rhodium (as Rh), metal				

fume and insoluble compounds............	7440-16-6	....	0.1
Rhodium (as Rh), soluble compounds....	7440-16-6	....	0.001
Ronnel.................	299-84-3	....	15
Rotenone..............	83-79-4	....	5
Rouge..................			
Total dust...........		....	15
Respirable fraction..		....	5
Selenium compounds (as Se).............	7782-49-2	....	0.2
Selenium hexafluoride (as Se).............	7783-79-1	0.05	0.4
Silica, amorphous, precipitated and gel.	112926-00-8		(3)
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica	61790-53-2		(3)
Silica, crystalline cristobalite, respirable dust......	14464-46-1		(3)
Silica, crystalline quartz, respirable dust.................	14808-60-7		(3)
Silica, crystalline tripoli (as quartz), respirable dust......	1317-95-9		(3)
Silica, crystalline tridymite, respirable dust......	15468-32-3		(3)
Silica, fused, respirable dust......	60676-86-0		(3)
Silicates (less than 1% crystalline silica)			
Mica (respirable dust)...............	12001-26-2		(3)
Soapstone, total dust	....		(3)
Soapstone, respirable dust................	....		(3)
Talc (containing asbestos): use asbestos limit: see 29 CFR 1910.1001.....			(3)
Talc (containing no asbestos), respirable dust......	14807-96-6		(3)
Tremolite, asbestiform; see 1910.1001...........			
Silicon...............	7440-21-3		
Total dust...........		....	15
Respirable fraction..		....	5
Silicon carbide........	409-21-2		
Total dust...........		....	15
Respirable fraction..		....	5
Silver, metal and			

soluble compounds (as Ag)	7440-22-4	....	0.01	
Soapstone; see Silicates				
Sodium fluoroacetate	62-74-8	....	0.05	X
Sodium hydroxide	1310-73-2	....	2	
Starch	9005-25-8			
Total dust		....	15	
Respirable fraction		....	5	
Stibine	7803-52-3	0.1	0.5	
Stoddard solvent	8052-41-3	500	2900	
Strychnine	57-24-9	....	0.15	
Styrene	100-42-5		(2)	
Sucrose	57-50-1			
Total dust		....	15	
Respirable fraction		....	5	
Sulfur dioxide	7446-09-5	5	13	
Sulfur hexafluoride	2551-62-4	1000	6000	
Sulfuric acid	7664-93-9	....	1	
Sulfur monochloride	10025-67-9	1	6	
Sulfur pentafluoride	5714-22-7	0.025	0.25	
Sulfuryl fluoride	2699-79-8	5	20	
Systox; see Demeton				
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	93-76-5	....	10	
Talc; see Silicates				
Tantalum, metal and oxide dust	7440-25-7	....	5	
TEDP (Sulfotep)	3689-24-5	....	0.2	X
Tellurium and compounds (as Te)	13494-80-9	....	0.1	
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2	
Temephos	3383-96-8			
Total dust		....	15	
Respirable fraction		....	5	
TEPP (Tetraethyl pyrophosphaate)	107-49-3	....	0.05	X
Terphenylis	26140-60-3	(C)1	(C)9	
1,1,1,2-Tetrachloro-2, 2-difluoroethane	76-11-9	500	4170	
1,1,2,2-Tetrachloro-1, 2-difluoroethane	76-12-0	500	4170	
1,1,2,2-Tetrachloroethane	79-34-5	5	35	X
Tetrachoroethylene; see Perchloroethylene				
Tetrachloromethane; see Carbon tetrachloride				
Tetrachloronaphthalene	1335-88-2	....	2	X
Tetraethyl lead (as Pb)	78-00-2	....	0.075	X
Tetrahydrofuran	109-99-9	200	590	
Tetramethyl lead, (as Pb)	75-74-1	....	0.075	X
Tetramethyl succinonitrile	3333-52-6	0.5	3	X

Tetranitromethane	509-14-8	1	8	
Tetryl (2,4,6-Trinitrophenylmethylnitramine)	479-45-8	....	1.5	X
Thallium, soluble compounds (as Tl)	7440-28-0	....	0.1	X
4,4'-Thiobis(6-tert, Butyl-m-cresol)	96-69-5			
Total dust		....	15	
Respirable fraction		....	5	
Thiram	137-26-8	....	5	
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5	....	2	
Tin, organic compounds (as Sn)	7440-31-5	....	0.1	
Titanium dioxide	13463-67-7			
Total dust		....	15	
Toluene	108-88-3		(2)	
Toluene-2, 4-diisocyanate (TDI)	584-84-9	(C)0.02	(C)0.14	
o-Toluidine	95-53-4	5	22	X
Toxaphene; see Chlorinated camphene				
Tremolite; see Silicates				
Tributyl phosphate	126-73-8	....	5	
1,1,1-Trichloroethane; see Methyl chloroform				
1,1,2-Trichloroethane	79-00-5	10	45	X
Trichloroethylene	79-01-6		(2)	
Trichloromethane; see Chloroform				
Trichloronaphthalene	1321-65-9	....	5	X
1,2,3-Trichloropropane	96-18-4	50	300	
1,1,2-Trichloro-1,2, 2-trifluoroethane	76-13-1	1000	7600	
Triethylamine	121-44-8	25	100	
Trifluorobromomethane	75-63-8	1000	6100	
2,4,6-Trinitrophenol; see Picric acid				
2,4,6-Trinitrophenylmethyl nitramine; see Tetryl				
2,4,6-Trinitrotoluene (TNT)	118-96-7	....	1.5	X
Triorthocresyl phosphate	78-30-8	....	0.1	
Triphenyl phosphate	115-86-6	....	3	
Turpentine	8006-64-2	100	560	
Uranium (as U)	7440-61-1			
Soluble compounds		....	0.05	
Insoluble compounds		....	0.25	
Vanadium	1314-62-1			
Respirable dust (as V(2)O(5))		....	(C)0.5	
Fume (as V(2)O(5))		....	(C)0.1	

Vegetable oil mist.....				
Total dust...........		....	15	
Respirable fraction..		....	5	
Vinyl benzene; see Styrene..........				
Vinyl chloride; see 1910.1017........	75-01-4			
Vinyl cyanide; see Acrylonitrile				
Vinyl toluene..........	25013-15-4	100	480	
Warfarin...............	81-81-2	....	0.1	
Xylenes (o-, m-, p-isomers)..	1330-20-7	100	435	
Xylidine...............	1300-73-8	5	25	X
Yttrium................	7440-65-5	....	1	
Zinc chloride fume.....	7646-85-7	....	1	
Zinc oxide fume........	1314-13-2	....	5	
Zinc oxide.............	1314-13-2			
Total dust...........		....	15	
Respirable fraction..		....	5	
Zinc stearate..........	557-05-1			
Total dust...........		....	15	
Respirable fraction..		....	5	
Zirconium compounds (as Zr).............	7440-67-7	....	5	

Footnote(1) The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing-zone air samples.

Footnote(a) Parts of vapor or gas per million parts of contaminated air by volume at 25 degrees C and 760 torr.

Footnote(b) Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

Footnote(c) The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound measured as the metal, the CAS number for the metal is given - not CAS numbers for the individual compounds.

Footnote(d) The final benzene standard in 1910.1028 applies to all occupational exposures to benzene except in some circumstances the distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures; for the excepted subsegments, the benzene limits in Table Z-2 apply. See 1910.1028 for specific circumstances.

Footnote(e) This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste recycling (sorting, blending, cleaning and willowing) and garnetting. See also 1910.1043 for cotton dust limits applicable to other sectors.

Footnote(f) All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particulates Not Otherwise Regulated (PNOR) limit

which is the same as the inert or nuisance dust limit of Table Z-3.
Footnote(2) See Table Z-2.
Footnote(3) See Table Z-3
Footnote(4) Varies with compound.

[54 FR 36767, Sept. 5, 1989; 54 FR 41244, Oct. 6, 1989; 55 FR 3724, Feb. 5, 1990; 55 FR 12819, Apr 6, 1990; 55 FR 19259, May 9, 1990; 55 FR 46950, Nov. 8, 1990; 57 FR 29204, July 1, 1992; 57 FR 42388, Sept. 14, 1992; 58 FR 35340, June 30, 1993; 61 FR 56746, Nov. 4, 1996; 62 FR 42018, August 4, 1997]

TABLE Z-2

Substance	8-hour time weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift	
			Concentration	Maximum duration
Benzene(a) (Z37.40-1969)	10 ppm	25 ppm	50 ppm	10 minutes.
Beryllium and beryllium compounds (Z37.29-1970)	2 ug/m(3)	5 ug/m(3)	25 ug/m(3)	30 minutes.
Cadmium fume(b) (Z37.5-1970)	0.1 mg/m(3)	0.3 mg/m(3)	....	
Cadmium dust(b) (Z37.5-1970)	0.2 mg/m(3)	0.6 mg/m(3)		
Carbon disulfide (Z37.3-1968)	20 ppm	30 ppm	100 ppm	30 minutes.
Carbon tetrachloride (Z37.17-1967)	10 ppm	25 ppm	200 ppm	5 min. in any 4 hrs.
Chromic acid and chromates (Z37-7-1971)	....	1 mg/10 m(3)		
Ethylene dibromide (Z37.31-1970)	20 ppm	30 ppm	50 ppm	5 minutes.
Ethylene dichloride (Z37.21-1969)	50 ppm	100 ppm	200 ppm	5 min. in any 3 hrs.
Fluoride as dust (Z37.28-1969)	2.5 mg/m(3)	....	....	
Formaldehyde: see 1910.1048	....	....	....	
Hydrogen fluoride (Z37.28-1969)	3 ppm	....	....	
Hydrogen sulfide (Z37.2-1966)	....	20 ppm	50 ppm	10 mins.

				once only if no other meas. exp. occurs.
Mercury (Z37.8-1971)........	....	1 mg/10m(3)	....	
Methylene chloride (Z37.18-1969).......	....	....	....	
Methylene Chloride: see 1910.1052.......				
Organo (alkyl) mercury (Z37.30-1969).......	0.01mg/m(3)	0.04 mg/m(3)	....	
Styrene (Z37.15-1969).......	100 ppm....	200 ppm....	600 ppm..	5 mins. in any 3 hrs.
Tetrachloroethylene (Z37.22-1967).......	100 ppm....	200 ppm....	300 ppm..	5 mins. in any 3 hrs.
Toluene (Z37.12-1967).......	200 ppm....	300 ppm....	500 ppm..	10 minutes
Trichloroethylene (Z37.19-1967).......	100 ppm....	200 ppm....	300 ppm..	5 mins. in any 2 hrs.

Footnote(a) This standard applies to the industry segments exempt from the 1 ppm 8-hour TWA and 5 ppm STEL of the benzene standard at 1910.1028.

Footnote(b) This standard applies to any operations or sectors for which the Cadmium standard, 1910.1027, is stayed or otherwise not in effect.

[62 FR 42018, August 4, 1997]

APPENDIX H
Emergency Evacuation Procedures

EMERGENCY EVACUATION PROCEDURES
NEW SCIENCE BUILDING

In an emergency dial 911 or **Campus Safety** at **274-3333**

IN ALL CASES OF FIRE…

1. Know the location of fire extinguishers, fire exits, and alarm systems in your area and know how to use them. Training and information is available through Environmental Health & Safety at extension 3353. See the attached floor plans for emergency evacuation information and the location of fire equipment and exits.

2. If fire emergency exists, activate the building alarm by pulling a pull station. Pull station locations can be found on the floor plans. (The fire system rings automatically to Campus Safety Dispatch 24 hours a day.) Then evacuate all rooms, closing all doors to confine and reduce the fire and oxygen for the fire – DO NOT LOCK DOORS !

3. When the building evacuation alarm is sounding an emergency exists. Walk quickly to the nearest marked exit and alert others to do the same.

4. ASSIST THE HANDICAPPED IN EXITING THE BUILDING ! DO NOT USE THE ELEVATOR DURING A FIRE. Smoke is the greatest danger in a fire, so stay near the floor where the air will be less toxic.

5. Leave the building using the nearest exit. Once you are outside the building, move to the grassy area – east of the building, this is the assembly area for the New Science Building. Keep streets, fire lanes, hydrants and walkways clear for emergency vehicles and crews.

6. A Campus Emergency Command Post may be set up near the emergency site. Keep clear of the command post unless you have official business.

7. DO NOT RETURN TO AN EVACUATED BUILDING unless told to do so by a College official.

NOTE: If you become trapped in a building during a fire and a window is available, place an article of clothing (shirt, coat, etc.) outside the window as a marker for rescue crews. If there is no window stay near the floor where the air will be less toxic. Shout at regular intervals to alert emergency crews to your location. DO NOT PANIC !

IMPORTANT: After an evacuation, report to your designated campus area assembly point, for accountability.

APPENDIX I
Hand Protection and Glove Selection

Introduction

Supervisors are responsible for the selection, availability and use of gloves and other personal protective equipment (PPE) in the workplace. Environmental Health & Safety can assist with the proper selection of PPE.

Glove selection can be difficult for many lab staff. Different references provide conflicting information and the many available styles and types of glove materials add another layer of confusion. The process of glove selection can also be very time consuming. Consequently, many chemical users select a glove that may not be appropriate for the chemicals in use.

Various glove manufacturers use different formulations for their polymers. A glove from one firm may not have the same chemical resistance as a glove that appears to be an identical glove made by another company. Therefore, it is prudent to check the **glove selection charts** provided by the glove manufacturer for the gloves you use to determine their suitability for use with any particular chemical(s).

The glove selection chart for the materials listed below is for anyone using these chemicals at Ithaca College. If a particular manufacturer's glove charts vary from the glove selections below, *follow the manufacturer's glove charts* for the model of glove recommended or contact Environmental Health & Safety at extension 3353 for a second opinion on glove selection for the chemical in use.

Many of the recommendations below are for "**incidental contact**." This means that, as with many chemical procedures, no or very little actual contact with a chemical in use is anticipated. The gloves specified are basically there to prevent chemical contact with the skin when something goes wrong--a spill or splash to the hand, over-spray from a dispensing device, etc. As soon as practical after the chemical makes contact with the gloved hand the gloves are removed and replaced. A glove specified for incidental contact is generally not suitable for **extended contact**, when the gloved hands may come into substantial contact with or actually may become covered with or immersed in the chemical. A more substantial glove is usually required for extended contact than for incidental contact, although there are exceptions.

The practice of **double-gloving** is recommended for many materials listed below. Two pairs of gloves are worn, one over the other. This affords a double layer of protection. If the outer glove starts to degrade or tears, the inner glove continues to offer protection until the gloves are removed and replaced. The best practice is to check the outer glove frequently, watching for signs of degradation (e.g., change of color, texture, etc.). With the first sign of degradation, remove the outer glove and reglove.

Glove Selection Guide

Chemical	Incidental Contact	Extended Contact
Acetic Acid	nitrile	neoprene, butyl rubber
Acetic Anhydride	nitrile (8 mil), double glove	butyl rubber, neoprene
Acetone	natural rubber (latex) (8 mil)	butyl rubber
Acetonitrile	nitrile	butyl rubber, polyvinyl acetate (PVA)
Acrylamide	nitrile	butyl rubber
bis-Acrylamide	nitrile	
Ammonium Hydroxide	nitrile	neoprene, butyl rubber
Arsenic Salts	nitrile	
Benzotriazole, 1,2,3-	nitrile	
Bismuth Salts	nitrile	
Cadmium Salts	nitrile	
Carbon Disulfide	nitrile (8 mil), double glove	viton, polyvinyl acetate (PVA)
Carbon Tetrachloride	nitrile (8 mil), double glove	viton
Catechol	nitrile	
Chloroform	nitrile (8 mil), double glove	viton, polyvinyl acetate (PVA)
Chromium Salts	nitrile	
Cobalt Chloride	nitrile	
Cobalt Salts	nitrile	
Copper (Cupric) Sulfate	nitrile	
3,3’-Diaminobenzidine (DAB)	nitrile	nitrile, double glove
Diazomethane in Ether	nitrile (8 mil), double glove	Norfoil
Dichloromethane	nitrile (8 mil), double glove	polyvinyl acetate (PVA) or viton
Diethyl Pyrocarbonate	nitrile	nitrile, double glove
Dimethyl Sulfoxide (DMSO)	[1]natural rubber (latex)(15-18 mil)	butyl rubber
1,4-Dioxane	nitrile (8 mil), double glove	butyl rubber
Dithiothreitol	nitrile	
Ethanol	nitrile	
Ethidium Bromide (EtBr)	nitrile	nitrile, double glove
Ethyl Ether	nitrile (8 mil), double glove	polyvinyl acetate (PVA)
Formaldehyde	nitrile	
Formamide	nitrile	butyl rubber
Formic Acid	nitrile (8 mil), double glove	butyl rubber, neoprene (30 mils)
Gallic Acid	nitrile	
Heptane	nitrile (8 mil), double glove	nitrile (35 mil or thicker), viton, PVA
Hexamethylenediamine (1,6-Diaminohexane)	nitrile (8mil)	neoprene
Hexane	nitrile (8 mil), double glove	nitrile (35 mil or thicker), viton, PVA

Hydrochloric Acid	nitrile	neoprene, butyl rubber
Hydrofluoric Acid (HF)	nitrile (8 mil), double glove	
Isopropanol	nitrile	
Laser Dyes	nitrile	
Lead Acetate	nitrile, double glove	
Lead Salts	nitrile	
Mercuric Chloride	nitrile, double glove	
Mercury	nitrile	
Mercury Salts	nitrile	
Methanol	nitrile	
Methylene Chloride	nitrile (8 mil), double glove	polyvinyl acetate, viton
Methyl Sulfonic Acid, Ethyl Ester (EMS) (Ethyl Methanesulfonate)	nitrile	nitrile, double glove
Monoethanolamine	nitrile	
Nickel Chloride	nitrile	
Nickel Salts	nitrile	
N-Methylethanolamine	nitrile (8 mil), double glove	viton, neoprene, butyl rubber
Organophosphorous compounds	nitrile (8 mil), double glove	
Osmium Salts	nitrile	
Osmium Tetroxide	nitrile, double glove	
Paraformaldehyde	nitrile	
Phenol	nitrile (8 mil), double glove	neoprene, butyl rubber
Phenol-Chloroform mixtures	nitrile (8 mil), double glove	viton
Phenylmethylsulfonyl Fluoride (PMSF)	nitrile	nitrile, double glove
Polychlorinated Biphenyls (PCB’s)	nitrile (8 mil) glove over a neoprene glove	neoprene (20 mil)
Polyoxyethylenesorbitan Monolaurate (Tween 20)	nitrile	
Psoralen	nitrile	nitrile, double glove
Pump Oil	butyl rubber	
Silane based silanization or derivatization compounds	nitrile (8 mil), double glove	
Silver Nitrate	nitrile	
Silver Salts	nitrile	
Sodium Dodecyl Sulfate (SDS)	nitrile	
Sodium Azide	nitrile	
Sulfuric Acid	nitrile (8 mil)	neoprene, butyl rubber (20 mil or greater)
Tetrahydrofuran (THF)	nitrile (8 mil), double glove	Norfoil
3,3’,5,5’-Tetramethyl-Benzidine (TMB)	nitrile	nitrile, double glove
N,N,N’,N’-Tetramethyl-	nitrile	nitrile, double glove

ethylenediamine (TEMED)		
Toluene	nitrile (8 mil), double glove	viton, polyvinyl acetate (PVA)
Trichloromethyl Chloroformate (diphosgene)	nitrile (8 mil) over butyl rubber glove box gloves	Material must be used in a glove box.
Triton-X 100	nitrile (8 mil), double glove	
Uranium Salts	nitrile	
Xylene	nitrile	polyvinyl acetate (PVA), viton

Electronic Resources

Best Glove Co. has an electronic version of their glove selection chart available on their Web site at:

http://www.bestglove.com

Software can download and installed on your PC. Mac version does not exist.

APPENDIX J
Listed Hazardous Waste

Hazardous waste from nonspecific sources (F-List)

Industry and EPA hazardous waste number	Hazardous Waste	Hazard code
F001	The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	(T)
F002	The following spent halogenated solvents: tetrachloro-ethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, orthodichlorobenzene, trichlorofluoromethane and 1,1,2-trichloroethane;all spent solvent mixtures/blends containing before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004 or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	(T)
F003	The following spent nonhalogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, only the above spent nonhalogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above nonhalogenated solvents, and a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	(I)*
F004	The following spent nonhalogenated solvents: cresols and cresylic acid, and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above nonhalogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	(T)
F005	The following spent nonhalogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol,and pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane; all spent solvent mixtures/blends	(I,T)

	containing, before use, a total of ten percent or more (by volume) of one or more of the above nonhalogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel ;and (6) chemical etching and milling of aluminum.	(T)
F007	Spent cyanide plating bath solutions from electroplating operations.	(R,T)
F008	Plating sludges from the bottom of plating baths from electroplating operations where cyanides are used in the process.	(R,T)
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process.	(R,T)
F010	Quenching bath sludge from oil baths from metal heat treating operations where cyanides are used in the process.	(R,T)
F011	Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations.	(R,T)
F012	Quenching wastewater treatment sludges from metal heat treating operations where cyanides are used in the process.	(T)
F019	Wastewater treatment sludges from the chemical conversion coating of aluminum except from zirconium phosphating in aluminum can washing when such phosphating is an exclusive conversion coating process.	(T)
F020	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri- or tetrachlorophenol, or of intermediates used to produce their pesticide derivatives. (This listing does not include wastes from the production of hexachlorophene from highly purified 2,4,5-trichlorophenol.)	(H)
F021	Waste (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of pentachlorophenol, or of intermediates used to produce its derivatives.	(H)
F022	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta,	(H)

	or hexachlorobenzenes under alkaline conditions.	
F023	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the production or manufacturing use (as a reactant, chemical intermediate, component in a formulating process) of tri-and tetra-chlorophenols. (This listing does not include wastes from equipment used only for the production or use of Hexachlorophene from highly purified 2,4,5-trichlorophenol.)	(H)
F024	Process wastes, including but not limited to, distillation residues, heavy ends, tars, and reactor clean-out wastes, from the production of certain chlorinated aliphatic hydrocarbons by free radical catalyzed processes. These chlorinated aliphatic hydrocarbons are those having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution. (This listing does not include wastewaters, wastewater treatment sludges, spent catalysts, and wastes listed in subdivision (b) or (c) of this section.)	(T)
F025	Condensed light ends, spent filters and filter aids, and spent desiccant wastes from the production of certain chlorinated aliphatic hydrocarbons, by free radical catalyzed processes. These chlorinated aliphatic hydrocarbons are those having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution.	(T)
F026	Waste (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzene under alkaline conditions.	(H)
F027	Discarded unused formulations containing tri,- tetra-, or pentachlorophenol or discarded unused formulation containing compounds derived from these chlorophenols. (This listing does not include formulations containing hexachlorophene synthesized from prepurified 2,4,5-trichlorophenol as the sole component.)	(H)
F028	Residues resulting from the incineration or thermal treatment of soil contaminated with EPA hazardous waste numbers F020, F021, F022, F023, F026 and F027.	(T)
F032	Wastewaters (except those that have not come into contact with process contaminants), process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that currently use or have previously used chlorophenolic formulations (except potentially cross-contaminated wastes that have had the F032 waste code deleted in accordance with subdivision (f) or potentially cross-contaminated wastes that are otherwise currently	(T)

	regulated as hazardous wastes (i.e., F034 or F035), and where the generator does not resume or initiate use of chlorophenolic formulations). This listing does not include K001 bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and/or pentachlorophenol.	
F034	Wastewaters (except those that have not come into contact with process contaminants), process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that use creosote formulations. This listing does not include K001 bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and/or pentachlorophenol.	(T)
F035	Wastewaters (except those that have not come into contact with process contaminants), process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that use inorganic preservatives containing arsenic or chromium. This listing does not include K001 bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and/or pentachlorophenol.	(T)
F037	Petroleum refinery primary oil/water/solids separation sludge; any sludge generated from the gravitational separation of oil/water/solids during the storage or treatment of process wastewaters and oily cooling wastewaters from petroleum refineries. Such sludges include, but are not limited to, those generated in: oil/water/solids separators; tanks and impoundments; ditches and other conveyances; sumps; and stormwater units receiving dry weather flow. Sludge generated in stormwater units that do not receive dry weather flow, sludges generated from non-contact once-through cooling waters segregated for treatment from other process or oily cooling waters, sludges generated in aggressive biological treatment units as defined in subparagraph (2)(ii) of this subdivision (including sludges generated in one or more additional units after wastewaters have been treated in aggressive biological treatment units) and K051 wastes are not included in this listing.	(T)
F038	Petroleum refinery secondary (emulsified) oil/water/solids separation sludge; any sludge and/or float generated from the physical and/or chemical separation of oil/water/solids in process wastewaters and oily cooling wastewaters from petroleum refineries. Such wastes include, but are not limited to, all sludges and floats generated in: induced air flotation (IAF) units, tanks and impoundments, and all sludges generated in DAF units. Sludges generated in stormwater units that do not receive dry weather flow, sludges generated from non-contact once-through cooling waters segregated for treatment from other process or oily cooling waters, sludges and floats	(T)

	generated in aggressive biological treatment units as defined in subparagraph (2)(ii) of this subdivision (including sludges and floats generated in one or more additional units after wastewaters have been treated in aggressive biological treatment units) and F037, K048, and K051 wastes are not included in this listing.	
F039	Leachate (liquids that have percolated through land disposed wastes) resulting from the disposal of more than one restricted waste classified as hazardous under this section. (Leachate resulting from the disposal of one or more of the following EPA hazardous wastes and no other hazardous waste retains its EPA hazardous waste number(s): F020, F021, F022, F026, F027, and/or F028.)	(T)
*(I,T) should be used to specify mixtures containing ignitable and toxic constituents.		

Hazardous Wastes from specific sources (K-List)

Industry and EPA hazardous waste number	Hazardous waste	Hazard code
Wood Preservation:		
K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol.	(T)
Inorganic pigments:		
K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments.	(T)
K003	Wastewater treatment sludge from the production of molybdate orange pigments.	(T)
K004	Wastewater treatment sludge from the production of zinc yellow	(T)

	pigments.	
K005	Wastewater treatment sludge from the production of chrome green pigments.	(T)
K006	Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated).	(T)
K007	Wastewater treatment sludge from the production of iron blue pigments.	(T)
K008	Oven residue from the production of chrome oxide green pigments.	(T)
Organic Chemicals:		
K009	Distillation bottoms from the production of acetaldehyde from ethylene.	(T)
K010	Distillation side cuts from the production of acetaldehyde from ethylene.	(T)
K011	Bottom stream from the wastewater stripper in the production of acrylonitrile.	(R,T)
K013	Bottom stream from the acetonitrile column in the production of acrylonitrile.	(R,T)
K014	Bottoms from the acetonitrile purification column in the production of acrylonitrile.	(T)
K015	Still bottoms from the distillation of benzyl chloride.	(T)
K016	Heavy ends or distillation residues from the production of carbon tetrachloride.	(T)
K017	Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin.	(T)
K018	Heavy ends from the fractionation column in ethyl chloride production.	(T)
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production.	(T)
K020	Heavy ends from the distillation of vinyl chloride chloride monomer production.	(T)
K021	Aqueous spent antimony catalyst waste from fluoromethanes production.	(T)
K022	Distillation bottom tars from the production of phenol/acetone from cumene.	(T)
K023	Distillation light ends from the production of phthalic anhydride from naphthalene.	(T)

K024	Distillation bottoms from the production of phthalic anhydride from naphthalene.	(T)
K025	Distillation bottoms from the production of nitrobenzene by the nitration of benzene.	(T)
K026	Stripping still tails from the production of methyl ethyl pyridines.	(T)
K027	Centrifuge and distillation residues from toluene diisocyanate production.	(R,T)
K028	Spent catalyst from the hydrochlorinator reactor in the production of 1,1,1-trichloroethane.	(T)
K029	Waste from the product stream stripper in the production of 1,1,1-trichloroethane.	(T)
K030	Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene.	(T)
K083	Distillation bottoms from aniline production.	(T)
K085	Distillation or fractionation column bottoms from the production of chlorobenzenes.	(T)
K093	Distillation light ends from the production of phthalic anhydride from ortho-xylene.	(T)
K094	Distillation bottoms from the production of phthalic anhydride from ortho-xylene.	(T)
K095	Distillation bottoms from the production of 1,1,1-trichloroethane.	(T)
K096	Heavy ends from the heavy ends column from the production of 1,1,1-trichloroethane.	(T)
K103	Process residues from aniline extraction from the production of aniline.	(T)
K104	Combined wastewater streams generated from nitrobenzene/aniline production.	(T)
K105	Separated aqueous stream from the reactor product washing step in the production of chlorobenzene.	(T)
K107	Column bottoms from product separation from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides.	(C,T)
K108	Condensed column overheads from product separation and condensed reactor vent gases from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides.	(I,T)
K109	Spent filter cartridges from product purification from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic	(T)

	acid hydrazides.		
K110	Condensed column overheads from intermediate separation from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides.	(T)	
K111	Product washwaters from the production of dinitrotoluene via nitration of toluene.	(C,T)	
K112	Reaction by-product water from the drying column in the production of toluenediamine via hydrogenation of dinitrotoluene.	(T)	
K113	Condensed liquid light ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.	(T)	
K114	Vicinals from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.	(T)	
K115	Heavy ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.	(T)	
K116	Organic condensate from the solvent recovery column in the production of toluene diisocyanate via phosgenation of toluenediamine.	<	(T)
K117	Wastewater from the reactor vent gas scrubber in the production of ethylene dibromide via bromination of ethene.	(T)	
K118	Spent adsorbent solids from purification of ethylene dibromide in the production of ethylene dibromide via bromination of ethene.	(T)	
K136	Still bottoms from the purification of ethylene dibromide in the production of ethylene dibromide via bromination of ethene.	(T)	
K149	Distillation bottoms from the production of alpha- (or methyl-) chlorinated toluenes, ring-chlorinated toluenes, benzoyl chlorides, and compounds with mixtures of these functional groups. (This waste does not include still bottoms from the distillation of benzyl chloride.)	(T)	
K150	Organic residuals, excluding spent carbon adsorbent, from the spent chlorine gas and hydrochloric acid recovery processes associated with the production of alpha- (or methyl-) chlorinated toluenes, ring-chlorinated toluenes, benzoyl chlorides, and compounds with mixtures of these functional groups.	(T)	
K151	Wastewater treatment sludges, excluding neutralization and biological sludges, generated during the treatment of	(T)	

	wastewaters from the production of alpha-(or methyl-) chlorinated toluenes, ring-chlorinated toluenes, benzoyl chlorides, and compounds with mixtures of these functional groups.	
K156	Organic waste (including heavy ends, still bottoms, light ends, spent solvents, filtrates, and decantates) from the production of carbamates and carbamoyl oximes. (This listing does not apply to wastes generated from the manufacture of 3-iodo-2-propynyl n-butylcarbamate.)	(T)
K157	Wastewaters (including scrubber waters, condenser waters, washwaters, and separation waters) from the production of carbamates and carbamoyl oximes. (This listing does not apply to wastes generated from the manufacture of 3-iodo-2-propynyl n-butylcarbamate.)	(T)
K158	Bag house dusts and filter/separation solids from the production of carbamates and carbamoyl oximes. (This listing does not apply to wastes generated from the manufacture of 3-iodo-2-propynyl n-butylcarbamate.)	(T)
K159	Organics from the treatment of thiocarbamate wastes.	(T)
K161	Purification solids (including filtration, evaporation, and centrifugation solids), bag house dust and floor sweepings from the production of dithiocarbamate acids and their salts. (This listing does not include K125 or K126.)	(R,T)
Inorganic Chemicals:		
K071	Brine purification muds from the mercury cell process in chlorine production, where separately prepurified brine is not used.	(T)
K073	Chlorinated hydrocarbon waste from the steps of the diaphragm cell process using graphite anodes in chlorine production.	(T)
K106	Wastewater treatment sludges from the mercury cell process in chlorine production.	(T)
Pesticides:		
K031	By-product salts generated in the production of MSMA and cacodylic acid.	(T)
K032	Wastewater treatment sludge from the production of chlordane.	(T)
K033	Wastewater and scrub water from the chlorination of cyclopentadiene in the production of chlordane.	(T)
K034	Filter solids from the filtration of hexachloro-cyclopentadiene in the production of chlordane.	(T)

K035	Wastewater treatment sludges generated in the production of creosote.	(T)
K036	Still bottoms from toluene reclamation distillation in the production of disulfoton.	(T)
K037	Wastewater treatment sludges from the production of disulfoton.	(T)
K038	Wastewater from the washing and stripping of phorate production.	(T)
K039	Filter cake from the filtration of diethylphos-phorodithioic acid in the production of phorate.	(T)
K040	Wastewater treatment sludge from the production of phorate.	(T)
K041	Wastewater treatment sludge from the production of toxaphene.	(T)
K042	Heavy ends or distillation residues from the distillation of tetrachlorobenzene in the production of 2,4,5-T.	(T)
K043	2,6-Dichlorophenol waste from the production of 2,4-D.	(T)
K097	Vacuum stripper discharge from the chlordane chlorinator in the production of chlordane.	(T)
K098	Untreated process wastewater from the production of toxaphene.	(T)
K099	Untreated wastewater from the production of 2,4-D.	(T)
K123	Process wastewater (including supernates, filtrates, and washwaters) from the production of ethylenebisdithiocarbamic acid and its salts.	(T)
K124	Reactor vent scrubber water from the production of ethylenebisdithiocarbamic acid and its salts.	(C,T)
K125	Filtration, evaporation, and centrifugation solids from the production of ethylenebisdithiocarbamic acid and its salts.	(T)
K126	Baghouse dust and floor sweepings in milling and packaging operations from the production or formulation of ethylenebisdithiocarbamic acid and its salts.	(T)
K131	Wastewater from the reactor and spent sulfuric acid from the acid dryer from the production of methyl bromide.	(C,T)
K132	Spent absorbent and wastewater separator solids from the production of methyl bromide.	(T)
Explosives:		
K044	Wastewater treatment sludges from the manufacturing and processing of explosives.	(R)
K045	Spent carbon from the treatment of wastewater containing explosives.	(R)

K046	Wastewater treatment sludges from the manufacturing, formulation and loading of lead-based initiating compounds.	(T)
K047	Pink/red water from TNT operations.	(R)
Petroleum refining:		
K048	Dissolved air flotation (DAF) float from the petroleum refining industry.	(T)
K049	Slop oil emulsion solids from the petroleum refining industry.	(T)
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry.	(T)
K051	API separator sludge from the petroleum refining industry.	(T)
K052	Tank bottoms (leaded) from the petroleum refining industry.	(T)
Iron and steel:		
K061	Emission control dust/sludge from the primary production of steel in electric furnaces.	(T)
K062	Spent pickle liquor generated by steel finishing operations of facilities within the iron and steel industry (SIC Code 331 and 332).	(C,T)
Primary copper:		
K064	Acid plant blowdown slurry/sludge resulting from the thickening of blowdown slurry from primary copper production.	(T)
Primary lead:		
K065	Surface impoundment solids contained in and dredged from surface impoundments at primary lead smelting facilities.	(T)
Primary zinc:		
K066	Sludge from treatment of process wastewater and/or acid plant blowdown from primary zinc production.	(T)
Primary aluminum:		
K088	Spent potliners from primary aluminum reduction.	(T)
Ferroalloys:		
K090	Emission control dust or sludge from ferrochromium-silicon production.	(T)
K091	Emission control dust or sludge from ferrochromium production.	(T)
Secondary lead:		
K069	Emission control dust/sludge from secondary lead smelting, except sludge generated from secondary acid scrubber systems.	(T)

K100	Waste leaching solution from acid leaching of emission control dust/sludge from secondary lead smelting.	(T)
Veterinary pharmaceuticals:		
K084	Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.	(T)
K101	Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.	(T)
K102	Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.	(T)
Ink formation:		
K086	Solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead.	(T)
Coking:		
K060	Ammonia still lime sludge from coking operations.	(T)
K087	Decanter tank tar sludge from coking operations.	(T)
K141	Process residues from the recovery of coal tar, including, but not limited to, collecting sump residues from the production of coke from coal or the recovery of coke by-products produced from coal. This listing does not include K087 (decanter tank tar sludges from coking operations).	(T)
K142	Tar storage tank residues from the production of coke from coal or from the recovery of coke by-products produced from coal.	(T)
K143	Process residues from the recovery of light oil, including, but not limited to, those generated in stills, decanters, and wash oil recovery units from the recovery of coke by-products produced from coal.	(T)
K144	Wastewater sump residues from light oil refining, including, but not limited to, intercepting or contamination sump sludges from the recovery of coke by-products produced from coal.	(T)
K145	Residues from naphthalene collection and recovery operations from the recovery of coke by-products produced from coal.	(T)
K147	Tar storage tank residues from coal tar refining.	(T)
K148	Residues from coal tar distillation, including but not limited to,	(T)

	still bottoms.	

Acute Hazardous Waste (P-List)

(Note: For the convenience of the regulated community the primary hazardous properties of the materials have been indicated by the letters T (Toxicity), and R (Reactivity). Absence of a letter indicates that the compound only is listed for acute toxicity.)

EPA hazardous waste No.	Chemical abstracts No.	Substance
P023	107-20-0	Acetaldehyde, chloro-
P002	591-08-2	Acetamide, N-(aminothioxomethyl)-
P057	640-19-7	Acetamide, 2-fluoro-
P058	62-74-8	Acetic acid, fluoro-, sodium salt
P002	591-08-2	1-Acetyl-2-thiourea
P003	107-02-8	Acrolein
P070	116-06-3	Aldicarb
P203	1646-88-4	Aldicarb sulfone
P004	309-00-2	Aldrin
P005	107-18-6	Allyl alcohol
P006	20859-73-8	Aluminum phosphide (R,T)
P007	2763-96-4	5-(Aminomethyl)-3-isoxazolol
P008	504-24-5	4-Aminopyridine
P009	131-74-8	Ammonium picrate (R)
P119	7803-55-6	Ammonium vanadate
P099	506-61-6	Argentate(1-), bis(cyano-C)-, potassium
P010	7778-39-4	Arsenic acid H_3AsO_4
P012	1327-53-3	Arsenic oxide As_2O_3
P011	1303-28-2	Arsenic oxide As_2O_5
P011	1303-28-2	Arsenic pentoxide
P012	1327-53-3	Arsenic trioxide
P038	692-42-2	Arsine, diethyl-
P036	696-28-6	Arsonous dichloride, phenyl-
P054	151-56-4	Aziridine

P067	75-55-8	Aziridine, 2-methyl-
P013	542-62-1	Barium cyanide
P024	106-47-8	Benzenamine, 4-chloro-
P077	100-01-6	Benzenamine, 4-nitro-
P028	100-44-7	Benzene, (chloromethyl)-
P042	51-43-4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-
P046	122-09-8	Benzeneethanamine, alpha, alpha-dimethyl-
P014	108-98-5	Benzenethiol
P127	1563-66-2	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.
P188	57-64-7	Benzoic acid, 2-hydroxy-, compd. w/ (3aS-cis)-1,2,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo[2,3-b]indol-5-yl methylcarbamate ester (1:1)
P001	181-81-2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-1, & salts, when present at concentrations greater than 0.3 percent
P028	100-44-7	Benzyl chloride
P015	7440-41-7	Beryllium Powder
P017	598-31-2	Bromoacetone
P018	357-57-3	Brucine
P045	39196-18-4	2-Butanone, 3,3-dimethyl- 1-(methylthio)-, O-[methylamino)carbonyl] oxime
P021	592-01-8	Calcium cyanide
P021	592-01-8	Calcium cyanide $Ca(CN)_2$
P189	55285-14-8	Carbamic acid, [(dibutylamino)-thio]methyl-, 2,3-dihydro-2,2-dimethyl-7-benzofuranyl ester
P191	644-64-4	Carbamic acid, dimethyl-, 1-[(dimethyl-amino)carbonyl]- 5-methyl-1H- pyrazol-3-yl ester.
P192	119-38-0	Carbamic acid, dimethyl-, 3-methyl-1(1-methylethyl)-1H-pyrazol-5-yl ester.
P190	1129-41-5	Carbamic acid, methyl-, 3-methylphenyl ester.
P127	1563-66-2	Carbofuran.
P022	75-15-0	Carbon disulfide
P095	75-44-5	Carbonic dichloride
P189	55285-14-8	Carbosulfan.
P023	107-20-0	Chloroacetaldehyde
P024	106-47-8	p-Chloroaniline
P026	5344-82-1	1-(o-Chlorophenyl)thiourea

P027	542-76-7	3-Chloropropionitrile
P029	544-92-3	Copper cyanide
P029	544-92-3	Copper cyanide Cu(CN)
P202	64-00-6	m-Comenyl methylcarbamate
P030		Cyanides (soluble cyanide salts), not otherwise specified
P031	460-19-5	Cyanogen
P033	506-77-4	Cyanogen chloride
P033	506-77-4	Cyanogen chloride (CN)Cl
P034	131-89-5	2-Cyclohexyl-4,6-dinitrophenol
P016	542-88-1	Dichloromethyl ether
P036	696-28-6	Dichlorophenylarsine
P037	60-57-1	Dieldrin
P038	692-42-2	Diethylarsine
P041	311-45-5	Diethyl-p-nitrophenyl phosphate
P040	297-97-2	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	55-91-4	Diisopropylfluorophosphate (DFP)
P004	309-00-2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a,-hexahydro-,(1alpha, 4alpha,4abeta,5alpha,8alpha,8abeta)-
P060	465-73-6	1,4,5,8- Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a-hexahydro-,(1alpha,4alpha,4abeta,5beta,8beta,8abeta)-
P037	60-57-1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro, (1-a-alpha,2beta,2aalpha,3beta,6beta, 6aalpha,7beta,7aalpha)-
P051	172-20-8	2,7:3,6-Dimethanonaphth [2,3-b]oxirene,3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro, (1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7aalpha)-, & metabolites
P044	60-51-5	Dimethoate
P046	122-09-8	alpha,alpha-Dimethylphenethylamine
P191	644-64-4	Dimetilan
P047	1534-52-1	4,6-Dinitro-o-cresol, & salts
P048	51-28-5	2,4-Dinitrophenol
P020	88-85-7	Dinoseb
P085	152-16-9	Diphosphoramide, octamethyl-
P111	107-49-3	Diphosphoric acid, tetraethyl ester

P039	298-04-4	Disulfoton
P049	541-53-7	Dithiobiuret
P185	26419-73-8	1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O-[(methylamino)-carbonyl]oxime
P050	115-29-7	Endosulfan
P088	145-73-3	Endothall
P051	72-20-8	Endrin
P051	72-20-8	Endrin, & metabolites
P042	51-43-4	Epinephrine
P031	460-19-5	Ethanedinitrile
P194	23135-22-0	Ethanimidothioc acid, 2-(dimethylamino)-N-[[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester
P066	16752-77-5	Ethanimidothioic acid, N-[[(methylamino)carbonyl]oxy]-, methyl ester
P101	107-12-0	Ethyl cyanide
P054	151-56-4	Ethyleneimine
P097	52-85-7	Famphur
P056	7782-41-4	Fluorine
P057	640-19-7	Fluoroacetamide
P058	62-74-8	Fluoroacetic acid, sodium salt
P198	23422-53-9	Formetanate hydrochloride
P197	17702-57-7	Formparanate
P065	628-86-4	Fulminic acid, mercury(2+) salt (R,T)
P059	76-44-8	Heptachlor
P062	757-58-4	Hexaethyl tetraphosphate
P116	79-19-6	Hydrazinecarbothioamide
P068	60-34-4	Hydrazine, methyl-
P063	74-90-8	Hydrocyanic acid
P063	74-90-8	Hydrogen cyanide
P096	7803-51-2	Hydrogen phosphide
P060	465-73-6	Isodrin
P192	119-38-0	Isolan
P202	64-00-6	3-Isopropylphenyl N-methylcarbamate
P007	2763-96-4	3(2H)-Isoxazolone, 5-(aminomethyl)-
P196	15339-363	Manganese, bis(dimethylcarbamodithioato-S,S')-

P196	15339-36-3	Manganese dimethyldithiocarbamate
P092	62-38-4	Mercury, (acetato-O)phenyl-
P065	628-86-4	Mercury fulminate (R,T)
P198	23422-53-9	Methanimidamide, N,N-dimethyl-N'-[3-[[(methyl amino) -carbonyl]oxy]phenyl]-, monohydrochloride
P197	17702-57-7	Methanimidamide, N,N-dimethyl-N'-[2-methyl-4-[(methylamino)carbonyl]oxy]phenyl]-
P082	62-75-9	Methanamine, N-methyl-N-nitroso-
P064	624-83-9	Methane, isocyanato-
P016	542-88-1	Methane, oxybis[chloro-
P112	509-14-8	Methane, tetranitro- (R)
P118	75-70-7	Methanethiol, trichloro-
P050	115-29-7	6,9-Methano-2,4, 3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
P059	76-44-8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P199	2032-65-7	Methiocarb
P066	16752-77-5	Methomyl
P068	60-34-4	Methyl hydrazine
P064	624-83-9	Methyl isocyanate
P069	75-86-5	2-Methyllactonitrile
P071	298-00-0	Methyl parathion
P190	1129-41-5	Metolcarb
P128	315-8-4	Mexacarbate
P072	86-88-4	alpha-Naphthylthiourea
P073	13463-39-3	Nickel carbonyl
P073	13463-39-3	Nickel carbonyl $Ni(CO)_4$, (T-4)-
P074	557-19-7	Nickel cyanide
P074	557-19-7	Nickel cynaide $Ni(CN)_2$
P075	154-11-5	Nicotine, & salts
P076	10102-43-9	Nitric oxide
P077	100-01-6	p-Nitroaniline
P078	10102-44-0	Nitrogen dioxide
P076	10102-43-9	Nitrogen oxide NO
P078	10102-44-0	Nitrogen oxide NO_2
P081	55-63-0	Nitroglycerine (R)

P082	62-75-9	N-Nitrosodimethylamine
P084	4549-40-0	N-Nitrosomethylvinylamine
P085	152-16-9	Octamethylpyrophosphoramide
P087	20816-12-0	Osmium oxide OsO_4, (T-4)-
P087	20816-12-0	Osmium tetroxide
P088	145-73-3	7-Oxabicyclo[2.2.1]heptane- 2,3-dicarboxylic acid
P194	23135-22-0	Oxamyl
P089	56-38-2	Parathion
P034	131-89-5	Phenol, 2-cyclohexyl-4,6-dinitro-
P128	315-18-4	Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester).
P199	2032-65-7	Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate
P202	64-00-6	Phenol, 3-(1-methylethyl)-, methyl carbamate
P201	2631-37-0	Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate
P048	51-28-5	Phenol, 2,4-dinitro-
P047	1534-52-1	Phenol, 2-methyl-4,6-dinitro-, & salts
P020	88-85-7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
P009	131-74-8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P092	62-38-4	Phenylmercury acetate
P093	103-85-5	Phenylthiourea
P094	298-02-2	Phorate
P095	75-44-5	Phosgene
P096	7803-51-2	Phosphine
P041	311-45-5	Phosphoric acid, diethyl 4-nitrophenyl ester
P039	298-04-4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
P094	298-02-2	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
P044	60-51-5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl]ester
P043	55-91-4	Phosphorofluoridic acid, bis (1-methylethyl) ester
P089	56-38-2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P040	297-97-2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P097	52-85-7	Phosphorothioic acid, O-[4- [(dimethylamino) sulfonyl]phenyl]O,O-dimethyl ester
P071	298-00-0	Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester

P204	57-47-6	Physostigmine
P188	57-64-7	Physostigmine salicylate
P110	78-00-2	Plumbane, tetraethyl-
P098	151-50-8	Potassium cyanide
P098	151-50-8	Potassium cyanide K(CN)
P099	506-61-6	Potassium silver cyanide
P201	2631-37-0	Promecarb
P070	116-06-3	Propanal, 2-methyl-2- (methylthio)-, O-[(methylamino)carbonyl]oxime
P203	1646-88-4	Propenal, 2-methyl-2-(methyl-sulfonyl)-0-[(methylamino)carbonyl] oxime
P101	107-12-0	Propanenitrile
P027	542-76-7	Propanenitrile, 3-chloro-
P069	75-86-5	Propanenitrile, 2-hydroxy-2-methyl-
P081	55-63-0	1,2,3-Propanetriol, trinitrate (R)
P017	598-31-2	2-Propanone, 1-bromo-
P102	107-19-7	Propargyl alcohol
P003	107-02-8	2-Propenal
P005	107-18-6	2-Propen-1-ol
P067	75-55-8	1,2-Propylenimine
P102	107-19-7	2-Propyn-1-ol
P008	504-24-5	4-Pyridinamine
P075	154-11-5	Pyridine, 3-(1-methyl- 2-pyrrolidinyl)-, (S)-, & salts
P204	57-47-6	Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a, 8-trimethyl-, methylcarbamate (ester), (3aS-cis)-
P114	12039-52-0	Selenious acid, dithallium(1+) salt
P103	630-10-4	Selenourea
P104	506-64-9	Silver cyanide
P104	506-64-9	Silver cyanide Ag(CN)
P105	26628-22-8	Sodium azide
P106	143-33-9	Sodium cyanide
P106	143-33-9	Sodium cyanide Na(CN)
P108	157-24-9	Strychnidin-10-one, & salts
P018	357-57-3	Strychnidin-10-one, 2,3-dimethoxy-
P108	157-24-9	Strychnine, & salts

P115	7446-18-6	Sulfuric acid, dithallium(1+) salt
P109	3689-24-5	Tetraethyldithio pyrophosphate
P110	78-00-2	Tetraethyl lead
P111	107-49-3	Tetraethyl pyrophosphate
P112	509-14-8	Tetranitromethane (R)
P062	757-58-4	Tetraphosphoric acid, hexaethyl ester
P113	1314-32-5	Thallic oxide
P113	1314-32-5	Thallium oxide Tl_2O_3
P114	12039-52-0	Thallium(I) selenite
P115	7446-18-6	Thallium(I) sulfate
P109	3689-24-5	Thiodiphosphoric acid, tetraethyl ester
P045	39196-18-4	Thiofanox
P049	541-53-7	Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$
P014	108-98-5	Thiophenol
P116	79-19-6	Thiosemicarbazide
P026	5344-82-1	Thiourea, (2-chlorophenyl)-
P072	86-88-4	Thiourea, 1-naphthalenyl-
P093	103-85-5	Thiourea, phenyl-
P185	26419-73-8	Tirpate
P123	8001-35-2	Toxaphene
P118	75-70-7	Trichloromethanethiol
P119	7803-55-6	Vanadic acid, ammonium salt
P120	1314-62-1	Vanadium oxide V_2O_5
P120	1314-62-1	Vanadium pentoxide
P084	4549-40-0	Vinylamine, N-methyl-N-nitroso-
P001	181-81-2	Warfarin, & salts, when present at concentrations greater than 0.3 percent
P121	557-21-1	Zinc cyanide
P121	557-21-1	Zinc cyanide $Zn(CN)_2$
P205	137-30-4	Zinc, bis(dimethylcarbamodithioato-S,S')-,
P122	1314-84-7	Zinc phosphide Zn_3P_2, when present at concentrations greater than 10 percent (R,T)
P205	137-30-4	Ziram

[1] CAS Number given for parent compound only.

Commercial Chemical Products (U - List)

(Note for the convienience of the regulated community, the primary hazardous properties of theses materials have been indicated by the letters T (Toxicity), R (Reactivity), I (Ignitability), and C (Corrosivity). Absence of a letter indicates that the compound is only listed for toxicity).

EPA hazardous waste No.	Chemical abstracts No.	Substance
U394	30558-43-1	A2213
U001	75-07-0	Acetaldehyde (I)
U034	75-87-6	Acetaldehyde, trichloro-
U187	62-44-2	Acetamide, N-(4-ethoxyphenyl)-
U005	53-96-3	Acetamide, N-9H-fluoren-2-yl-
U240	194-75-7	Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
U112	141-78-6	Acetic acid ethyl ester (I)
U144	301-04-2	Acetic acid, lead(2+) salt
U214	563-68-8	Acetic acid, thallium(1+) salt
see F027	93-76-5	Acetic acid, (2,4,5-trichlorophenoxy)-
U002	67-64-1	Acetone (I)
U003	75-05-8	Acetonitrile (I,T)
U004	98-86-2	Acetophenone
U005	53-96-3	2-Acetylaminofluorene
U006	75-36-5	Acetyl chloride (C,R,T)
U007	79-06-1	Acrylamide
U008	79-10-7	Acrylic acid (I)
U009	107-13-1	Acrylonitrile
U011	61-82-5	Amitrole
U012	62-53-3	Aniline (I,T)

U136	75-60-5	Arsinic acid, dimethyl-
U014	492-80-8	Auramine
U015	115-02-6	Azaserine
U010	50-07-7	Azirino[2',3':3,4] pyrrolo[1,2-a]indole-4,7-dione, 6-amino-8-[[(aminocarbonyl)oxy]methyl]-1,1a,2,8a,8b-hexahydro- 8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta,8aalpha,8balpha)]-
U280	101-27-9	Barban
U278	22781-23-3	Bemdocarb
U364	22961-82-6	Bendiocarb phenol
U271	17804-35-2	Benomyl
U157	56-49-5	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-
U016	225-51-4	Benz[c]acridine
U017	98-87-3	Benzal chloride
U192	23950-58-5	Benzamide, 3,5-dichloro-N- (1,1-dimethyl-2-propynyl)-
U018	56-55-3	Benz[a]anthracene
U094	57-97-6	Benz[a]anthracene, 7,12-dimethyl-
U012	62-53-3	Benzenamine (I,T)
U014	492-80-8	Benzenamine, 4,4' -carbonimidoylbis[N,N-dimethyl-
U049	3165-93-3	Benzenamine, 4-chloro- 2-methyl-, hydrochloride
U093	60-11-7	Benzenamine, N,N-dimethyl-4- (phenylazo)-
U328	95-53-4	Benzenamine, 2-methyl-
U353	106-49-0	Benzenamine, 4-methyl-
U158	101-14-4	Benzenamine, 4,4' -methylenebis[2-chloro-
U222	636-21-5	Benzenamine, 2-methyl-, hydrochloride
U181	99-55-8	Benzenamine, 2-methyl-5-nitro-
U019	71-43-2	Benzene (I,T)

U038	510-15-6	Benzeneacetic acid, 4-chloro- alpha-(4-chlorophenyl)- alpha-hydroxy-,ethyl ester
U030	101-55-3	Benzene, 1-bromo-4-phenoxy-
U035	305-03-3	Benzenebutanoic acid, 4-[bis (2-chloroethyl)amino]-
U037	108-90-7	Benzene, chloro-
U221	25376-45-8	Benzenediamine, ar-methyl-
U028	117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U069	84-74-2	1,2-Benzenedicarboxylic acid, dibutyl ester
U088	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
U102	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
U107	117-84-0	1,2-Benzenedicarboxylic acid, dioctyl ester
U070	95-50-1	Benzene, 1,2-dichloro-
U071	541-73-1	Benzene, 1,3-dichloro-
U072	106-46-7	Benzene, 1,4-dichloro-
U060	72-54-8	Benzene, 1,1'-(2,2- dichloroethylidene) bis[4-chloro-
U017	98-87-3	Benzene, (dichloromethyl)-
U223	26471-62-5	Benzene, 1,3-diisocyanatomethyl- (R,T)
U239	1330-20-7	Benzene, dimethyl- (I)
U201	108-46-3	1,3-Benzenediol
U127	118-74-1	Benzene, hexachloro-
U056	110-82-7	Benzene, hexahydro- (I)
U220	108-88-3	Benzene, methyl-
U105	121-14-2	Benzene, 1-methyl-2,4-dinitro-
U106	606-20-2	Benzene, 2-methyl-1,3-dinitro-
U055	98-82-8	Benzene, (1-methylethyl)- (I)
U169	98-95-3	Benzene, nitro-
U183	608-93-5	Benzene, pentachloro-
U185	82-68-8	Benzene, pentachloronitro-
U020	98-09-9	Benzenesulfonic acid chloride (C,R)
U020	98-09-9	Benzenesulfonyl chloride (C,R)

U207	95-94-3	Benzene, 1,2,4,5-tetrachloro-
U061	50-29-3	Benzene, 1,1'-(2,2,2-trichloroethylidene) bis[4-chloro-
U247	72-43-5	Benzene, 1,1-(2,2,2-trichloroethylidene) bis[4- methoxy-
U023	98-07-7	Benzene, (trichloromethyl)-
U234	99-35-4	Benzene, 1,3,5-trinitro-
U021	92-87-5	Benzidine
U202	81-07-2	1,2-Benzisothiazol- 3(2H)-one, 1,1-dioxide, & salts
U203	94-59-7	1,3-Benzodioxole, 5-(2-propenyl)-
U141	120-58-1	1,3-Benzodioxole, 5-(1-propenyl)-
U090	94-58-6	1,3-Benzodioxole, 5-propyl-
U278	22781-23-3	1,3-Benzodioxol-4-ol,2,2-dimethyl-, methyl carbamate
U364	22961-82-6	1,3-Benzodioxol-4-ol,2,2-dimethyl-,
U367	1563-38-8	7-Benzofuranol,2,3-dihydro-2,2-dimethyl-
U064	189-55-9	Benzo[rst]pentaphene
U248	181-81-2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3 percent or less
U022	50-32-8	Benzo[a]pyrene
U197	106-51-4	p-Benzoquinone
U023	98-07-7	Benzotrichloride (C,R,T)
U085	1464-53-5	2,2'-Bioxirane
U021	92-87-5	[1,1'-Biphenyl]-4,4'-diamine
U073	91-94-1	[1,1'-Biphenyl]-4,4'- diamine, 3,3'-dichloro-
U091	119-90-4	[1,1'-Biphenyl]-4,4'- diamine, 3,3'-dimethoxy-
U095	119-93-7	[1,1'-Biphenyl]-4,4'- diamine, 3,3'-dimethyl-
U225	75-25-2	Bromoform
U030	101-55-3	4-Bromophenyl phenyl ether
U128	87-68-3	1,3-Butadiene, 1,1,2, 3,4,4-hexachloro-
U172	924-16-3	1-Butanamine, N-butyl- N-nitroso-
U031	71-36-3	1-Butanol (I)
U159	78-93-3	2-Butanone (I,T)
U160	1338-23-4	2-Butanone, peroxide (R,T)
U053	4170-30-3	2-Butenal

U074	764-41-0	2-Butene, 1,4-dichloro- (I,T)
U143	303-34-4	2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy- 2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]- 2,3,5,7a- tetrahydro-1H- pyrrolizin-1-yl ester, [1S-[1alpha(Z), 7(2S*,3R*),7aalpha]]-
U031	71-36-3	n-Butyl alcohol (I)
U136	75-60-5	Cacodylic acid
U032	13765-19-0	Calcium chromate
U238	51-79-6	Carbamic acid, ethyl ester
U372	10605-21-7	Carbamic acid, 1H-benzimidazol-2-yl, methyl ester
U271	17804-35-2	Carbamic acid, [1-[(butylamino)carbonyl]-1H-benzimidazol-2-yl]-,methyl ester
U280	101-27-9	Carbamic acid, (3-chlorophenyl)-, 4-chloro-2-butynyl ester
U409	23564-05-8	Carbamic acid, [1,2-phenylenebis (iminocarbonothioyl)]bis-, dimethyl ester
U373	122-42-9	Carbamic acid, phenyl-, 1-methylethyl ester
U178	615-53-2	Carbamic acid, methylnitroso-, ethyl ester
U097	79-44-7	Carbamic chloride, dimethyl-
U114	111-54-6	Carbamodithioic acid, 1,2-ethanediylbis-, salts & esters
U062	2303-16-4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl)ester
U279	63-25-2	Carbaryl
U372	10605-21-7	Carbendazim
U367	1563-38-8	Carbofuran phenol
U215	6533-73-9	Carbonic acid, dithallium(1+) salt
U033	353-50-4	Carbonic difluoride
U156	79-22-1	Carbonochloridic acid, methyl ester (I,T)
U033	353-50-4	Carbon oxyfluoride (R,T)
U211	56-23-5	Carbon tetrachloride
U034	75-87-6	Chloral
U035	305-03-3	Chlorambucil
U036	57-74-9	Chlordane, alpha & gamma isomers
U026	494-03-1	Chlornaphazin
U037	108-90-7	Chlorobenzene

U038	510-15-6	Chlorobenzilate
U039	59-50-7	p-Chloro-m-cresol
U042	110-75-8	2-Chloroethyl vinyl ether
U044	67-66-3	Chloroform
U046	107-30-2	Chloromethyl methyl ether
U047	91-58-7	beta-Chloronaphthalene
U048	95-57-8	o-Chlorophenol
U049	3165-93-3	4-Chloro-o-toluidine, hydrochloride
U032	13765-19-0	Chromic acid H2CrO4, calcium salt
U050	218-01-9	Chrysene
U051		Creosote
U052	1319-77-3	Cresol (Cresylic acid)
U053	4170-30-3	Crotonaldehyde
U055	98-82-8	Cumene (I)
U246	506-68-3	Cyanogen bromide (CN)Br
U197	106-51-4	2,5-Cyclohexadiene- 1,4-dione
U056	110-82-7	Cyclohexane (I)
U129	58-89-9	Cyclohexane, 1,2,3,4, 5,6-hexachloro-, (1alpha,2alpha,3beta,4alpha,5alpha,6beta)-
U057	108-94-1	Cyclohexanone (I)
U130	77-47-4	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U058	50-18-0	Cyclophosphamide
U240	194-75-7	2,4-D, salts & esters
U059	20830-81-3	Daunomycin
U060	72-54-8	DDD
U061	50-29-3	DDT
U062	2303-16-4	Diallate
U063	53-70-3	Dibenz[a,h]anthracene
U064	189-55-9	Dibenzo[a,i]pyrene
U066	96-12-8	1,2-Dibromo- 3-chloropropane
U069	84-74-2	Dibutyl phthalate
U070	95-50-1	o-Dichlorobenzene
U071	541-73-1	m-Dichlorobenzene

U072	106-46-7	p-Dichlorobenzene
U073	91-94-1	3,3'-Dichlorobenzidine
U074	764-41-0	1,4-Dichloro-2-butene (I,T)
U075	75-71-8	Dichlorodifluoromethane
U078	75-35-4	1,1-Dichloroethylene
U079	156-60-5	1,2-Dichloroethylene
U025	111-44-4	Dichloroethyl ether
U027	108-60-1	Dichloroisopropyl ether
U024	111-91-1	Dichloromethoxy ethane
U081	120-83-2	2,4-Dichlorophenol
U082	87-65-0	2,6-Dichlorophenol
U084	542-75-6	1,3-Dichloropropene
U085	1464-53-5	1,2:3,4-Diepoxybutane (I,T)
U395	5952-26-1	Diethylene glycol, dicarbamate
U108	123-91-1	1,4-Diethyleneoxide
U028	117-81-7	Diethylhexyl phthalate
U086	1615-80-1	N,N'-Diethylhydrazine
U087	3288-58-2	O,O-Diethyl S-methyl dithiophosphate
U088	84-66-2	Diethyl phthalate
U089	56-53-1	Diethylstilbesterol
U090	94-58-6	Dihydrosafrole
U091	119-90-4	3,3'-Dimethoxybenzidine
U092	124-40-3	Dimethylamine (I)
U093	60-11-7	p-Dimethylaminoazobenzene
U094	57-97-6	7,12-Dimethylbenz[a]anthracene
U095	119-93-7	3,3'-Dimethylbenzidine
U096	80-15-9	alpha,alpha- Dimethylbenzylhydroperoxide (R)
U097	79-44-7	Dimethylcarbamoyl chloride
U098	57-14-7	1,1-Dimethylhydrazine
U099	540-73-8	1,2-Dimethylhydrazine
U101	105-67-9	2,4-Dimethylphenol
U102	131-11-3	Dimethyl phthalate
U103	77-78-1	Dimethyl sulfate

U105	121-14-2	2,4-Dinitrotoluene
U106	606-20-2	2,6-Dinitrotoluene
U107	117-84-0	Di-n-octyl phthalate
U108	123-91-1	1,4-Dioxane
U109	122-66-7	1,2-Diphenylhydrazine
U110	142-84-7	Dipropylamine (I)
U111	621-64-7	Di-n-propylnitrosamine
U041	106-89-8	Epichlorohydrin
U001	75-07-0	Ethanal (I)
U174	55-18-5	Ethanamine, N-ethyl-N-nitroso-
U404	121-44-8	Ethanamine, N,N-diethyl-
U394	30558-43-1	Ethanimidothioic acid, 2-(dimethylamino)-N-hydroxy-2-oxo-, methyl ester
U410	59669-26-0	Ethanimidothioic acid, N,N'-[thiobis[(methylimino)carbonyloxy]]bis-, dimethyl ester
U155	91-80-5	1,2-Ethanediamine, N,N-dimethyl- N'-2-pyridinyl-N'- (2-thienylmethyl)-
U067	106-93-4	Ethane, 1,2-dibromo-
U076	75-34-3	Ethane, 1,1-dichloro-
U077	107-06-2	Ethane, 1,2-dichloro-
U131	67-72-1	Ethane, hexachloro-
U024	111-91-1	Ethane, 1,1'- [methylenebis(oxy)]bis [2-chloro-
U117	60-29-7	Ethane, 1,1'-oxybis-(I)
U025	111-44-4	Ethane, 1,1'-oxybis[2-chloro-
U184	76-01-7	Ethane, pentachloro-
U208	630-20-6	Ethane, 1,1,1,2- tetrachloro-
U209	79-34-5	Ethane, 1,1,2,2- tetrachloro-
U218	62-55-5	Ethanethioamide
U226	71-55-6	Ethane, 1,1,1-trichloro-
U227	79-00-5	Ethane, 1,1,2-trichloro-
U359	110-80-5	Ethanol, 2-ethoxy-
U173	1116-54-7	Ethanol, 2,2'- (nitrosoimino)bis-
U395	5952-26-1	Ethanol, 2,2'-oxybis-, dicarbamate
U004	98-86-2	Ethanone, 1-phenyl-

U043	75-01-4	Ethene, chloro-
U042	110-75-8	Ethene, (2-chloroethoxy)-
U078	75-35-4	Ethene, 1,1-dichloro-
U079	156-60-5	Ethene, 1,2-dichloro-, (E)-
U210	127-18-4	Ethene, tetrachloro-
U228	79-01-6	Ethene, trichloro-
U112	141-78-6	Ethyl acetate (I)
U113	140-88-5	Ethyl acrylate (I)
U238	51-79-6	Ethyl carbamate (urethane)
U117	60-29-7	Ethyl ether (I)
U114	1111-54-6	Ethylenebisdithiocarbamic acid, salts & esters
U067	106-93-4	Ethylene dibromide
U077	107-06-2	Ethylene dichloride
U359	110-80-5	Ethylene glycol monoethyl ether
U115	75-21-8	Ethylene oxide (I,T)
U116	96-45-7	Ethylenethiourea
U076	75-34-3	Ethylidene dichloride
U118	97-63-2	Ethyl methacrylate
U119	62-50-0	Ethyl methanesulfonate
U120	206-44-0	Fluoranthene
U122	50-00-0	Formaldehyde
U123	64-18-6	Formic acid (C,T)
U124	110-00-9	Furan (I)
U125	98-01-1	2-Furancarboxaldehyde (I)
U147	108-31-6	2,5-Furandione
U213	109-99-9	Furan, tetrahydro-(I)
U125	98-01-1	Furfural (I)
U124	110-00-9	Furfuran (I)
U206	18883-66-4	Glucopyranose, 2-deoxy-2- (3-methyl-3-nitrosoureido)-, D-
U206	18883-66-4	D-Glucose, 2-deoxy-2- [[(methylnitrosoamino)- carbonyl]amino]-
U126	765-34-4	Glycidylaldehyde
U163	70-25-7	Guanidine, N-methyl- N'-nitro-N-nitroso-

U127	118-74-1	Hexachlorobenzene
U128	87-68-3	Hexachlorobutadiene
U130	77-47-4	Hexachlorocyclopentadiene
U131	67-72-1	Hexachloroethane
U132	70-30-4	Hexachlorophene
U243	1888-71-7	Hexachloropropene
U133	302-01-2	Hydrazine (R,T)
U086	1615-80-1	Hydrazine, 1,2-diethyl-
U098	57-14-7	Hydrazine, 1,1-dimethyl-
U099	540-73-8	Hydrazine, 1,2-dimethyl-
U109	122-66-7	Hydrazine, 1,2-diphenyl-
U134	7664-39-3	Hydrofluoric acid (C,T)
U134	7664-39-3	Hydrogen fluoride (C,T)
U135	7783-06-4	Hydrogen sulfide
U135	7783-06-4	Hydrogen sulfide H2S
U096	80-15-9	Hydroperoxide, 1-methyl-1-phenylethyl-(R)
U116	96-45-7	2-Imidazolidinethione
U137	193-39-5	Indeno[1,2,3-cd]pyrene
U190	85-44-9	1,3-Isobenzofurandione
U140	78-83-1	Isobutyl alcohol (I,T)
U141	120-58-1	Isosafrole
U142	143-50-0	Kepone
U143	303-34-4	Lasiocarpine
U144	301-04-2	Lead acetate
U146	1335-32-6	Lead, bis(acetato-O)tetrahydroxytri-
U145	7446-27-7	Lead phosphate
U146	1335-32-6	Lead subacetate
U129	58-89-9	Lindane
U163	70-25-7	MNNG
U147	108-31-6	Maleic anhydride
U148	123-33-1	Maleic hydrazide
U149	109-77-3	Malononitrile

U150	148-82-3	Melphalan
U151	7439-97-6	Mercury
U152	126-98-7	Methacrylonitrile (I, T)
U092	124-40-3	Methanamine, N-methyl- (I)
U029	74-83-9	Methane, bromo-
U045	74-87-3	Methane, chloro- (I, T)
U046	107-30-2	Methane, chloromethoxy-
U068	74-95-3	Methane, dibromo-
U080	75-09-2	Methane, dichloro-
U075	75-71-8	Methane, dichlorodifluoro-
U138	74-88-4	Methane, iodo-
U119	62-50-0	Methanesulfonic acid, ethyl ester
U211	56-23-5	Methane, tetrachloro-
U153	74-93-1	Methanethiol (I, T)
U225	75-25-2	Methane, tribromo-
U044	67-66-3	Methane, trichloro-
U121	75-69-4	Methane, trichlorofluoro-
U036	57-74-9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-
U154	67-56-1	Methanol (I)
U155	91-80-5	Methapyrilene
U142	143-50-0	1,3,4-Metheno- 2H-cyclobuta[cd]pentalen- 2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-
U247	72-43-5	Methoxychlor
U154	67-56-1	Methyl alcohol (I)
U029	74-83-9	Methyl bromide
U186	504-60-9	1-Methylbutadiene (I)
U045	74-87-3	Methyl chloride (I,T)
U156	79-22-1	Methyl chlorocarbonate (I,T)
U226	71-55-6	Methyl chloroform
U157	56-49-5	3-Methylcholanthrene
U158	101-14-4	4,4'-Methylenebis (2-chloroaniline)

U068	74-95-3	Methylene bromide
U080	75-09-2	Methylene chloride
U159	78-93-3	Methyl ethyl ketone (MEK) (I,T)
U160	1338-23-4	Methyl ethyl ketone peroxide (R,T)
U138	74-88-4	Methyl iodide
U161	108-10-1	Methyl isobutyl ketone (I)
U162	80-62-6	Methyl methacrylate (I,T)
U161	108-10-1	4-Methyl-2-pentanone (I)
U164	56-04-2	Mytomycin C
U059	20830-81-3	5,12-Naphthacenedione, 8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl)oxy]- 7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-, (8S-cis)-
U167	134-32-7	1-Naphthalenamine
U168	91-59-8	2-Naphthalenamine
U026	494-03-1	Naphthalenamine, N,N'-bis(2-chloroethyl)-
U165	91-20-3	Naphthalene
U047	91-58-7	Naphthalene, 2-chloro-
U166	130-15-4	1,4-Naphthalenedione
U236	72-57-1	2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'- dimethyl[1,1'-biphenyl]-4,4'-diyl)bis(azo)bis [5-amino-4-hydroxy]-, tetrasodium salt
U279	63-25-2	1-Naphthalenol, methylcarbamate
U166	130-15-4	1,4-Naphthoquinone
U167	134-32-7	alpha-Naphthylamine
U168	91-59-8	beta-Naphthylamine
U217	10102-45-1	Nitric acid, thallium(1+) salt
U169	98-95-3	Nitrobenzene (I,T)
U170	100-02-7	p-Nitrophenol
U171	79-46-9	2-Nitropropane (I,T)
U172	924-16-3	N-Nitrosodi-n-butylamine
U173	116-54-7	N-Nitrosodiethanolamine
U174	55-18-5	N-Nitrosodiethylamine
U176	759-73-9	N-Nitroso-N-ethylurea

U177	684-93-5	N-Nitroso-N-methylurea
U178	615-53-2	N-Nitroso- N-methylurethane
U179	100-75-4	N-Nitrosopiperidine
U180	930-55-2	N-Nitrosopyrrolidine
U181	99-55-8	5-Nitro-o-toluidine
U193	1120-71-4	1,2-Oxathiolane, 2,2-dioxide
U058	50-18-0	2H-1,3,2-Oxazaphosphorin- 2-amine, N,N-bis (2-chloroethyl)tetrahydro-,2-oxide
U115	75-21-8	Oxirane (I,T)
U126	765-34-4	Oxiranecarboxyaldehyde
U041	106-89-8	Oxirane, (chloromethyl)-
U182	123-63-7	Paraldehyde
U183	608-93-5	Pentachlorobenzene
U184	76-01-7	Pentachloroethane
U185	82-68-8	Pentachloronitrobenzene (PCNB)
See F027	87-86-5	Pentachlorophenol
U161	108-10-1	Pentanol, 4-methyl- (I)
U186	504-60-9	1,3-Pentadiene (I)
U187	62-44-2	Phenacetin
U188	108-95-2	Phenol
U048	95-57-8	Phenol, 2-chloro-
U039	59-50-7	Phenol, 4-chloro-3-methyl-
U081	120-83-2	Phenol, 2,4-dichloro-
U082	87-65-0	Phenol, 2,6-dichloro-
U089	56-53-1	Phenol, 4,4'-(1,2-diethyl- 1,2-ethenediyl)bis-, (E)-
U101	105-67-9	Phenol, 2,4-dimethyl-
U052	1319-77-3	Phenol, methyl-
U132	70-30-4	Phenol, 2,2'-methylenebis [3,4,6-trichloro-
U411	114-26-1	Phenol, 2-(1-methylethoxy)-, methylcarbamate
U170	100-02-7	Phenol, 4-nitro-
See F027	87-86-5	Phenol, pentachloro-
See F027	58-90-2	Phenol, 2,3,4,6 -tetrachloro-

See F027	95-95-4	Phenol, 2,4,5-trichloro-
See F027	88-06-2	Phenol, 2,4,6-trichloro-
U150	148-82-3	L-Phenylalanine, 4-[bis(2-chloroethyl) amino]-
U145	7446-27-7	Phosphoric acid, lead(2+) salt (2:3)
U087	3288-58-2	Phosphorodithioic acid, O,O-diethyl S-methyl ester
U189	1314-80-3	Phosphorus sulfide (R)
U190	85-44-9	Phthalic anhydride
U191	109-06-8	2-Picoline
U179	100-75-4	Piperidine, 1-nitroso-
U192	23950-58-5	Pronamide
U194	107-10-8	1-Propanamine (I,T)
U111	621-64-7	1-Propanamine, N-nitroso-N-propyl-
U110	142-84-7	1-Propanamine, N-propyl- (I)
U066	96-12-8	Propane, 1,2-dibromo- 3-chloro-
U083	78-87-5	Propane, 1,2-dichloro-
U149	109-77-3	Propanedinitrile
U171	79-46-9	Propane, 2-nitro- (I,T)
U027	108-60-1	Propane, 2,2'-oxybis[2-chloro-
U193	1120-71-4	1,3-Propane sultone
See F027	93-72-1	Propanoic acid, 2- (2,4,5-trichlorophenoxy)-
U235	126-72-7	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U140	78-83-1	1-Propanol, 2-methyl- (I,T)
U002	67-64-1	2-Propanone (I)
U007	79-06-1	2-Propenamide
U084	542-75-6	1-Propene, 1,3-dichloro-
U243	1888-71-7	1-Propene, 1,1,2,3,3,3 -hexachloro-
U009	107-13-1	2-Propenenitrile
U152	126-98-7	2-Propenenitrile, 2-methyl- (I,T)
U008	79-10-7	2-Propenoic acid (I)
U113	140-88-5	2-Propenoic acid, ethyl ester (I)
U118	97-63-2	2-Propenoic acid, 2-methyl-, ethyl ester
U162	80-62-6	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U373	122-42-9	Propham
U411	114-26-1	Propoxur
U194	107-10-8	n-Propylamine (I,T)

U083	78-87-5	Propylene dichloride
U387	52888-80-9	Prosulfocarb
U148	123-33-1	3,6-Pyridazinedione, 1,2-dihydro-
U196	110-86-1	Pyridine
U191	109-06-8	Pyridine, 2-methyl-
U237	66-75-1	2,4-(1H,3H)-Pyrimidinedione, 5-[bis(2- chloroethyl)amino]-
U164	56-04-2	4(1H)-Pyrimidinone, 2,3-dihydro- 6-methyl-2-thioxo-
U180	930-55-2	Pyrrolidine, 1-nitroso-
U200	50-55-5	Reserpine
U201	108-46-3	Resorcinol
U202	181-07-2	Saccharin, & salts
U203	94-59-7	Safrole
U204	7783-00-8	Selenious acid
U204	7783-00-8	Selenium dioxide
U205	7488-56-4	Selenium sulfide
U205	7488-56-4	Selenium sulfide SeS2(R,T)
U015	115-02-6	L-Serine, diazoacetate (ester)
See F027	93-72-1	Silvex (2,4,5-TP)
U206	18883-66-4	Streptozotocin
U103	77-78-1	Sulfuric acid, dimethyl ester
U189	1314-80-3	Sulfur phosphide (R)
See F027	93-76-5	2,4,5-T
U207	95-94-3	1,2,4,5- Tetrachlorobenzene
U208	630-20-6	1,1,1,2- Tetrachloroethane
U209	79-34-5	1,1,2,2- Tetrachloroethane
U210	127-18-4	Tetrachloroethylene
See F027	58-90-2	2,3,4,6- Tetrachlorophenol
U213	109-99-9	Tetrahydrofuran (I)
U214	563-68-8	Thallium(I) acetate
U215	6533-73-9	Thallium(I) carbonate
U216	7791-12-0	Thallium(I) chloride
U216	7791-12-0	Thallium chloride TlCl
U217	10102-45-1	Thallium(I) nitrate
U218	62-55-5	Thioacetamide
U410	59669-26-0	Thiodicarb

U153	74-93-1	Thiomethanol (I,T)
U244	137-26-8	Thioperoxydicarbonic diamide [(H2N)C(S)]2S2, tetramethyl-
U409	23564-05-8	Thiophanate-methyl
U219	62-56-6	Thiourea
U244	137-26-8	Thiram
U220	108-88-3	Toluene
U221	25376-45-8	Toluenediamine
U223	26471-62-5	Toluene diisocyanate (R,T)
U328	95-53-4	o-Toluidine
U353	106-49-0	p-Toluidine
U222	636-21-5	o-Toluidine hydrochloride
U389	2303-17-5	Triallate
U011	61-82-5	1H-1,2,4-Triazol-3-amine
U227	79-00-5	1,1,2-Trichloroethane
U228	79-01-6	Trichloroethylene
U121	75-69-4	Trichloromonofluoromethane
See F027	95-95-4	2,4,5-Trichlorophenol
See F027	88-06-2	2,4,6-Trichlorophenol
U404	121-44-8	Triethylamine
U234	99-35-4	1,3,5-Trinitrobenzene (R,T)
U182	123-63-7	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	126-72-7	Tris(2,3-dibromopropyl) phosphate
U236	72-57-1	Trypan blue
U237	66-75-1	Uracil mustard
U176	759-73-9	Urea, N-ethyl-N-nitroso-
U177	684-93-5	Urea, N-methyl-N-nitroso-
U043	75-01-4	Vinyl chloride
U248	181-81-2	Warfarin, & salts, when present at concentrations of 0.3 percent or less
U239	1330-20-7	Xylene (I)
U200	50-55-5	Yohimban-16- carboxylic acid, 11,17-dimethoxy- 18-[(3,4,5-trimethoxybenzoyl)oxy]-,methyl ester, (3beta,16beta, 17alpha, 18beta,20alpha)-

U249	1314-84-7	Zinc phosphide Zn3P2, when present at concentrations of 10 percent or less
[1] CAS Number given for parent compound only.		

APPENDIX K
Toxicity Concentration for Listed Waste

Maximum Concentration of Contaminants for the Toxicity Characteristic

Source: EPA 40 CFR 261.24

Contaminant	CAS Number	Regulatory Level (mg/l)
Arsenic	7440-38-2	5.0
Barium	7440-39-3	100.0
Benzene	71-43-2	0.5
Cadmium	7440-43-9	1.0
Carbon tetrachloride	56-23-5	0.5
Chlordane	57-74-9	0.03
Chlorobenzene	108-90-7	100.0
Chloroform	67-66-3	6.0
Chromium	7440-47-3	5.0
o-Cresol	95-48-7	200.0
m-Cresol	108-39-4	200.0
p-Cresol	106-44-5	200.0
Cresol	……..	200.0
2,4-D	94-75-7	10.0
1,4-Dichlorobenzene	106-46-7	7.5
1,2-Dichloroethane	107-06-2	0.5
1,1-Dichloroethylene	75-35-4	0.7
2,4-Dinitrotoluene	121-14-2	0.13
Endrin	72-20-8	0.02
Heptachlor (and its epoxide)	76-44-8	0.008
Hexachlorobenzene	118-74-1	0.13
Hexachlorobutadiene	87-68-3	0.5
Hexachloroethane	67-72-1	3.0
Lead	7439-92-1	5.0
Lindane	58-89-9	0.4
Mercury	7439-97-6	0.2
Methoxychlor	72-43-5	10.0
Methyl ethyl ketone	78-93-3	200.0
Nitrobenzene	98-95-3	2.0
Pentrachlorophenol	87-86-5	100.0
Pyridine	110-86-1	5.0
Selenium	7782-49-2	1.0
Silver	7440-22-4	5.0
Tetrachloroethylene	127-18-4	0.73
Toxaphene	8001-35-2	0.5
Trichloroethylene	79-01-6	0.5
2,4,5-Trichlorophenol	95-95-4	400.0
2,4,6-Trichlorophenol	88-06-2	2.0
2,4,5-TP (Silvex)	93-72-1	1.0
Vinyl chloride	75-01-4	0.2

APPENDIX: L

Lab Move Guide

This document provides general guidance to those laboratory personnel preparing to move their laboratory work to another room or to a new facility. Moving a research laboratory can be a complex process, especially if hazardous materials are involved. However, the steps outlined below can help to ensure a safe and smooth transition. If you are moving your laboratory and have specific questions, contact Environmental Health and Safety at 274-3353.

GENERAL CONSIDERATIONS

- Once you have made the decision to move your lab, inform your Lab Coordinator (LC) as soon as possible – well in advance of your planned move.

- When cleaning up your old lab, please be considerate of the next occupants (custodial staff, maintenance workers, and new laboratory staff) and ensure all items are removed from the lab (or scheduled to be removed), including items in drawers, cabinets, fume hoods, refrigerators, freezers, etc.

- Keep in mind the value of limited laboratory space when cleaning out your old lab. Now is the time to discard old equipment, paper, boxes, and other materials that have not been used in a long time (and will not be used in the foreseeable future). For any surplus equipment, tables, cabinets, etc. that you plan on discarding, check with your LC to see if these items should remain in the lab you are leaving or if they could be donated to someone else in your department or if you would like to donate them to the campus, contact the Chemical Hygiene Officer at Environmental Health and Safety at 274-3353.

- Before the actual move occurs, visit the new lab and identify where equipment from the old lab will be located. Check to see if the correct electrical, water, gas, and space requirements are available for your new equipment and processes. Conducting this type of preplanning will greatly facilitate the moving process and occupation of your new facility.

- When moving equipment and materials to the new lab, keep in mind that no equipment, boxes, or other materials may be stored in hallways, stairwells, or other egress points used in the event of a fire or other emergency. If you do need to temporarily store these items in the hallway, please contact Environmental Health and Safety at 274-3353 so proper arrangements can be made. No items may be allowed to accumulate in the hallway and they must be removed by the end of each day. No hazardous materials (chemical, biological, or radiological) may be left in the hallways unattended at any time.

- When you arrive at the new lab, identify the location of emergency eyewashes and safety showers, fire extinguishers, and other safety equipment before bringing hazardous materials to the new lab. Do not block access to emergency eyewashes and safety showers at any time. Do not stack boxes under or around emergency eyewashes or safety showers, even on a temporary basis.

- If fire extinguishers are not present in the new facility, contact Environmental Health and Safety at 274-3353 to have fire extinguishers installed. If you have not been trained in the use of fire extinguishers, you can obtain this training from Environmental Health and Safety.

- For laboratories with fume hoods, keep in mind that fume hoods come in a variety of designs and can function differently than hoods at your old lab. Familiarize yourself with the new hoods before conducting any work involving hazardous materials.

- At the completion of your move, return all keys to the old lab to your LC and provide them with your contact information at your new facility in case questions arise during laboratory renovation of your old facility.

CHEMICALS

- Before preparing to move chemicals to your new lab, now is the time to inventory all of your chemicals or update your current chemical inventory.

- Only move those chemicals that will be needed for your research at the new lab or those chemicals you expect to use in the near future. Before your move, now is the time to get rid of old, outdated chemicals or chemicals that do not have any foreseeable use in the new facility. For those chemicals that are in good condition, contact your LC to see if anyone in your department could use the chemicals. All other chemicals that cannot or will not be used in the new facility should be disposed of properly.

- Do not move containers of chemical wastes to your new lab. Contact Environmental Health and Safety at 274-3353 for proper disposal of any hazardous wastes. EH&S can provide assistance with making waste determinations (i.e.: hazardous waste, universal waste, biomedical waste, radioactive waste, oil waste, etc.) and laboratory cleanouts.

- Only trained laboratory workers may move chemicals. Any highly toxic or highly hazardous or reactive chemicals should only be moved by staffs who have received special training. When moving highly toxic or highly hazardous chemicals, EH&S recommends a "buddy system" be used in the event of a spill or other emergency.

- When moving chemicals, be sure all containers are properly labeled and all are securely closed. When transporting chemicals by vehicle, it is best to use DOT approved shipping containers. Please note: There are special regulations associated with transporting hazardous chemicals off campus.

- When transporting chemicals, it is best to use carts with lips or trays to prevent containers from being knocked off. Other items that are useful for transport include rubber bottle carriers, five gallon pails, or other forms of secondary containment.

- When moving chemicals, wear appropriate personal protective equipment such as safety glasses (splash goggles for corrosives), lab coat, and gloves. Remember to remove gloves when touching door knobs and latches, and elevator buttons. If possible, avoid using passenger elevators. If you must use a passenger elevator, request that no passengers ride along with you.

- After removing all chemicals and waste from your old lab facility, ensure all spills have been cleaned up and all potentially contaminated surfaces have been cleaned with water and detergent thoroughly. This includes bench tops, fume hoods, storage cabinets and drawers (both inside and outside), shelving, and the outside of large equipment that is scheduled to be moved by a moving company. Remember to clean out refrigerators and freezers thoroughly and defrost freezers. Please keep in mind the next immediate occupants of your old lab will be custodians and maintenance workers. Please be considerate of their health and safety by thoroughly cleaning up any potentially hazardous (chemical, biological, and radiological) contamination.

- When storing chemicals in your new lab, remember to segregate and store chemicals according to hazard class. EH&S recommends using secondary containment such as trays, buckets, or bottle carriers when storing chemicals to help prevent spills.

COMPRESSED GAS CYLINDERS

- Before moving to your new lab, be sure to make arrangements for the removal of any compressed gas cylinders that will no longer be used or for any empty cylinders. If you need assistance having the cylinders removed, contact your LC or Environmental Health and Safety at 274-3353.

- Before moving any compressed gas cylinders, remove the regulator and replace the safety cap over the cylinder valve. Only use an appropriate cylinder handcart to move compressed gas cylinders. Do not attempt to "roll" cylinders from one area to another.

- Any compressed cylinders containing highly toxic or highly reactive gases should only be moved by staff with special training in the use and hazards of these materials.

- After moving compressed gas cylinders, secure them with a strap or chain at once Do not leave compressed gas cylinders unsecured for any period of time, even temporarily. Any new gas distribution systems, using metal or plastic tubing, must be pressure tested (leak tested) before use. All cylinders must either have a regulator or a cap depending on if it is in use or stored.

BIOHAZARDOUS MATERIALS

- All biohazardous materials must be properly packaged and only moved by properly trained laboratory staff. Non-laboratory personnel (including moving company staff) or untrained laboratory personnel are not permitted to move biohazardous materials.

- All potentially contaminated equipment and surfaces such as bench tops, fume hoods, storage cabinets and drawers (both inside and outside), shelving, refrigerators, freezers, incubators, and the outside of large equipment that is scheduled to be moved by a moving company, must be thoroughly decontaminated. Please be considerate of the health and safety of future occupants by thoroughly cleaning up any potentially hazardous (chemical, biological, and radiological) contamination.

- Before moving to the new facility, dispose of all biohazardous waste properly.

- Keep in mind that certain types of research, such as that with recombinant DNA and some pathogens, may need to have prior approval or registration for use at your new location - before you move. Check with the appropriate College committee well in advance of your move to see if campus prior approval is required.

- If you are having your Biosafety Cabinet (BSC) moved to your new location, thoroughly decontaminate both the inside and outside of the cabinet. You will also need to have the BSC recertified by a third party. Check with the manufacturers guidelines before moving your BSC.

DECOMMISSIONING FACILITIES AND EQUIPMENT

Laboratory renovations may require more formal decommissioning procedures of both facilities and equipment depending on the extent of renovation and the past use of the room and/or facility. The purpose of decommissioning procedures includes:

- Decommissioning labs require standardized processes, strategies, and validation methods for screening and characterization of hazardous debris and other regulated waste streams and for compliance with hazardous waste regulations.

- Cost-benefit analysis of decontamination and recycling versus disposal without decontamination.

Areas and materials of concern for decommissioning of facilities and equipment include:

- Asbestos containing materials – floor tiles, insulation, fireproofing, fume hood panels
- Chemical and biological contamination and/or spills
- Fluorescent light bulbs
- Fume hoods
- Gas cylinders and lecture bottles
- Lead shielding
- Mercury sources – sink traps, thermometers, switches, etc.
- PCBs – window caulking, transformers, ballasts, etc.
- Perchloric acid hoods
- Reaction chambers

- RCRA heavy metals
- Unknown chemicals
- Vacuum pumps
- …and other materials and equipment

Specific roles and responsibilities for decommissioning activities include:

EH&S roles/responsibilities:

- Provide the initial EH&S assessment.
- Provide the EH&S technical guidance and advice.
- Advise on decontamination and hazardous chemical waste disposal.
- Ensure compliance with EH&S laws, regulations, policies and guidelines.
- Provide continuous EH&S related updates of the plan or project on the basis of new evidence, findings, or information.
- Provide continual review of project decommissioning as new information is obtained.
- Perform or review appropriate risk assessment.

Research staff members roles/responsibilities:

- Provide advice on needs, concerns and issues with lab decommissioning to EH&S.
- Provide to EH&S with historical use of biohazardous materials, radioactive materials, and hazardous chemical usage for decontamination analysis.
- Identify and label materials (both biological and chemical) and create an inventory to be submitted to EH&S.
- Segregate chemicals in accordance to the compatibility and pack them into a sturdy container/box for transportation. EH&S can provide research groups with information and assistance with segregation and proper packaging of hazardous chemicals.
- Clean work and storage surfaces with soap and water, with special attention given to areas with visible decontamination.
- Identify biological/chemical contaminated area(s) that they cannot be cleaned by researchers and work with EH&S to facilitate decontamination of the area(s).

Additional guidance on decommissioning procedures can be found in the ANSI standard – Z9.11-2008 – Laboratory Decommissioning. If you have additional questions or would like more information, then please contact EH&S at 274-3353.

SUMMARY

In conclusion, the above steps are ways laboratory staff can ensure a planned move to a new facility goes smoothly. The guidelines mentioned above and the following key points will help to provide a safe and successful transition to your new laboratory facility:

- Plan the move well in advance, including providing proper notification where required.
- Pre-plan where items and equipment in your new lab will be placed before your begin the move.

- Take advantage of the move to dispose of old or discontinued items, equipment, and chemicals.
- Keep your LC informed of the progress of the move.
- Contact your LC or Environmental Health and Safety if you have any questions.
- Please be courteous to the new occupants of your old lab – leave your old lab in the condition you want your new lab to be in when you arrive.

APPENDIX: M
Self Inspection Checklist

Laboratory and Research Area Safety Inspection Checklist

Name:________________ Building:_________________ Room(s):_______________ Date:____________

See explanation sheet for more details on questions	**Y** = YES **N** = NO **n/a** = not applicable **C** = corrected	**Items marked "NO" need to be corrected**

General	**Y**	**N**	**n/a**	**C**
Are you familiar with the Injury and Illness reporting process?				
Do you understand how to obtain MSDS?				
Is there Life Safety Box sign intact outside of main entrance to lab				
Is a Chemical Hygiene Plan available?				
Are all chemicals inventoried?				
Are all chemicals labeled with original labels or with Right-To-Know labels?				
Chemical Safety				
Are all chemicals labeled?				
Are all chemical containers in good condition?				
Are Standard Operating Procedures (SOPs) written for hazardous chemicals and processes?				
Are incompatible chemicals segregated?				
Is secondary containment (such as plastic containers) being used?				
Are flammables stored in flammable liquid storage cabinet? (if over 10 gallons)				
Are flammables stored in refrigerator/freezer that is rated for flammable liquid storage?				
Proper storage on shelves, with no heavy containers/materials or hazardous liquids stored above eye level?				
Is storage appropriate, with no unwanted/surplus chemicals?				
Specific Chemicals				
Are Ethidium Bromide use areas marked?				
Are cryogenic materials stored properly?				
Are silver-containing products being recycled?				

General	**Y**	**N**	**n/a**	**C**
Are peroxide-forming chemicals dated and checked with test strips for peroxides at least semi-annually?				
Are expired chemicals being disposed of properly?				
Compressed Gases				
Are gas cylinders secured to immovable object by chain or strap around top half of cylinder?				
Are cylinders capped when “stored” and have a regulator when “in use”? (never a bare valve stem)				
Do cylinders have labels that are legible and are empty cylinders marked as such?				
Are oxygen cylinders separated from flammable gas by 20 ft or a wall?				
Are cylinders stored safely? (away from heat, electrical or ignition sources, and direct sun light; not under stairs, etc.)				
EPA Compliance				
Are hazardous waste containers labeled appropriately? (with the words “hazardous waste”, identity of chemicals, concentration)				
Are waste containers being kept closed?				
Is waste stored at or near the point of generation? (rule of thumb is same room)				
Is secondary containment being used for storage of hazardous waste containers				
Is waste removed properly, with no accumulation of excess waste?				
Are containers in good condition, with no old/ inherently waste-like containers?				
Fume Hood				
Has the fume hood been tested within the last year?				
Is hood clear, with no items blocking the air flow?				
Is the fume hood base cabinet in good condition?				
Is the fume hood functioning correctly?				

General	Y	N	n/a	C
Electrical Safety				
Are electrical panels accessible, closed, with no combustibles or flammables stored nearby?				
Are the circuit breakers labeled appropriately?				
Is the panel interior intact? (openings covered)				
Are extension cords being used only on a temporary basis?				
Are power strips being used correctly and not plugged into other power strips or extension cords?				
Are electrical cords intact and in good condition?				
Lab Equipment Safety				
Is equipment labeled for use? (i.e. refrigerator, freezer, microwave, as for research use or for food)				
Are moving parts, pinch points, belts, etc. guarded?				
Are rotovaporators wrapped with protective material				
Has mercury (Hg)-containing equipment been labeled, a Hg spill kit available, and has alternative non-Hg containing equipment been considered?				
Is all equipment in good working order?				
Are ladders safe for the application and have they been inspected prior to use?				
Emergency Preparedness				
Is there an Emergency Response Guide available?				
Is there an appropriate spill kit available and the location labeled?				
Eyewash / Safety Shower				
Is an eyewash present where corrosive chemicals are being used?				
Is the eyewash/safety shower accessible?				
Has the eyewash/safety shower been tested within the last year?				
Is the eyewash/safety shower labeled?				

General	Y	N	n/a	C
Fire Safety				
Are combustibles stored away from ignition sources, not unnecessarily accumulated, and non-combustibles not stored within 18 inches of the level plane of the sprinkler head? (24 inches if sprinklers are not present)				
Is the extinguisher secured to the wall?				
Has the fire extinguisher been inspected this year				
Housekeeping				
Is aisle space adequate? (at least 3 foot clearance)				
Is the policy of “No eating/drinking in labs being followed?				
Are workspaces clean and tidy? (lab bench, fume hood work area, refrigerators, no excess trash)				
Have all chemical spills been cleaned up?				
Are lights in working order?				
Are floors clear, with no slip, trip, or fall hazards?				
BioSafety				
Do you have a certificate of need from DOH to possess hypodermic needles and syringes?				
Are hypodermic needles in locked storage and inventoried with a Needle Log or signout sheet?				
Do you have a MUA with the IBC, if using biohazardous or infectious material?				
Is Regulated Medical Waste being generated?				
Are contaminated sharps and hypodermic needles (regardless of use) placed in a sharps container?				
Are other non-biohazards or non-infectious sharps disposed of in sturdy, puncture resistant containers?				
Is there an Exposure Control Plan?				
Has the BioSafety cabinet been inspected within the last year?				
Training				
Have all lab personnel taken the appropriate required trainings, including “Laboratory Safety and Chemical Waste Disposal”?				

Laboratory and Research Area Safety Inspection Explanation Sheet

General

Self inspection – It is good practice for staff in laboratories and research areas to use the self-inspection checklist to go through their laboratories and research areas and conduct their own laboratory/research area inspections identifying the same topics covered during the Laboratory and Research Area Inspection conducted by the Department of Environmental Health and Safety.

Injury and illness reporting – All accidents and exposures to harmful chemicals no matter how minor need to be reported to the supervisor, and the accident injury report needs to be filled out.

Life Safety Box signage – Each room should have a hazard identification sign next to the door indicating the primary hazards present in the room. Signs need to be updated annually.

MSDS – OHSA regulations require that employees have access to Material Safety Data Sheets, within five (5) minutes. In addition, emergency responders may need a hard copy of an MSDS. MSDS sheets are available through 3E Company by calling 800-451-8346. hard copies will be faxed to Ithaca College Police Dispatch unless another fax number is provided.

Research Laboratory

Chemical Hygiene Plan – A Chemical Hygiene Plan (CHP) for laboratories is required by OSHA. It must be accessible in all labs either electronically or as hard copy.

Research Hazard Communication Areas

Policy – Each non-laboratory space is required to have access to the Hazard Communication Program.

Training – OSHA also requires training on the Hazard Communication Program. Non-laboratory personnel should take the "Hazard Communication" class provided by EH&S. The "Laboratory Safety" class also meets these requirements.

Chemical Inventory - An inventory of all hazardous chemicals should be maintained.

Labeling – All containers that are not empty must be labeled with their contents and must be marked with the right-to-know information for any hazardous chemicals present. The original manufacturer's label is fine, but if the chemical is transferred to a non-original container, it must have a right-to-know label.

Chemical Safety

Labeling – For safety reasons as well as EPA and OSHA regulations, every container that appears to have a chemical in it must be labeled and easily identified by every user within the lab. Some common labeling methods are original manufacturer labels, right-to- know labels

Container Integrity – Containers in bad condition run the risk of being cited by EPA as "inherently wastelike". Containers should be in good condition, with no leaks or spills, no broken caps, and no rusty cans.

SOPs – Standard Operating Procedures - Each lab is required to develop safe handling instructions for their highly hazardous, highly toxic, and carcinogenic chemicals. If a format is needed see section 6.2 of the CHP.

Segregation – Chemicals must be segregated, by the hazards they present, to avoid incompatible materials being stored together. Storing chemicals by hazard class in different cabinets or in different secondary containment is recommended.

Secondary Containment - Use trays or bins, to conduct your experiment in and for storage of particularly hazardous substances and hazardous waste containers.

Flammables in Flammable-rated Cabinet – Larger volumes of flammable liquids must be stored in a flammable rated cabinet. As a general guide, we recommend that rooms with more than 10 gallons of flammable liquids use a flammable rated storage cabinet.

Flammables in Flammable-rated Refrigerator – Flammable liquids (flashpoint below 100 deg F) should not be stored in regular refrigerators because of the risk of explosion (this includes walk-in units). Flammable liquids may be stored in flammable or explosion rated refrigerators. Using an ice bath to cool chemicals before an experiment might be an option for some laboratories.

Overhead or Floor Storage – Hazardous chemicals should be not stored above eye level or on the floor. Heavy equipment and heavy boxes should not be stored overhead. Surplus Chemicals – Some surplus chemicals may be able to be used by other groups on campus, if the chemicals cannot be used, they should be disposed properly.

Specific Chemicals

Perchloric Acid – Heating perchloric acid requires a specific fume hood with a washdown system. When working with Perchloric acid, be sure to remove all organic materials, such as solvents, from the immediate work area.

Ethidium Bromide(EtBr) – The areas where EtBr is used should be labeled and require special deactivation process.

Hydrofluoric Acid(HF) – The areas where HF is used should be labeled. Calcium gluconate is required to be available for first aid treatment in case of accidental exposure.

Cryogenic Liquids – Cryogenics are extremely cold and their vapors pose an asphyxiation hazard, dispensing and storage areas need to be well ventilated.

Silver – Groups that develop film or use silver nitrate in staining solutions should know where a silver filtering unit is, and how to use it. For information please contact EH&S.

Peroxide Formers - Peroxide forming chemical containers should be dated when they are received, and need to be checked regularly with peroxide test strips. If peroxides begin to form, the material must be treated to remove peroxides, or disposed of properly.

Security for Highly Hazardous Materials – Laboratories need to take specific actions in order to provide security against theft of highly hazardous materials. Examples include using locked cabinets, locked drawers, and lock boxes, in addition to keeping laboratory doors locked when the room is unoccupied.

Compressed Gases

Secured - Cylinders must be secured to a sturdy object to prevent toppling. A chain (preferred) or strap should be tight enough and strong enough to secure the cylinder. Placement of strap should be in the upper 1/2 of the cylinder but not around the cap or valve. A cylinder chained on a cylinder cart is acceptable, but not as safe as if it were chained to an immobile object.

Cap / Regulator – Cylinders that are ‘in use’ must have a regulator attached. Cylinders that are not hooked up to equipment or considered ‘in use’ must be capped with a valve protection cap. Cylinders must be capped during transport. Hang Tags – Cylinders should be tagged with ‘Full’, ‘In-use’, or ‘Empty’ tags. Gas vendors are usually willing to provide tags at no charge to customers.

Segregation / Storage – Flammable gases and oxidizing gases must be separated by an acceptable fire barrier. This separation could be a fire rated wall or a minimum 20 foot space between the types of cylinders. Flammable gases or oxygen should not be stored near a source of ignition such as electrical panels or open flames.

EPA Compliance

Labeling – Hazardous waste is required to be labeled with the words “Hazardous Waste” and the chemical contents. Using the EH&S hazardous waste label is recommended.

Closed – Hazardous waste containers must to be kept closed with a tight sealing lid. For containers hooked up to equipment, bottles still need to be closed when not in process.

Point of Generation – Hazardous Waste must be stored in the area where it was generated. We have interpreted this to mean ‘in the same room’.

Accumulation of Excess Waste – Large quantities of stored hazardous waste should be removed to prevent accidental spills.

Old/Inherently Wastelike Containers – Degraded containers can release hazardous vapors that are detrimental to the health of laboratory personnel and allow chemicals to become contaminated, which can have an adverse effect on experiments.

Universal wastes - Universal wastes include batteries and fluorescent light bulbs. Universal Wastes require the labeling: “Universal Wastes - Bulbs” or “Universal Waste - Batteries”. Universal Waste must be labeled with an accumulation start date and must be disposed of at least once a year. We recommend that universal wastes be disposed of every 9 months to give the solid waste group time to process it. Alkaline batteries may go in the regular trash.

Fume hoods

Tested – Fume hoods are tested semi-annually by EH&S. Items in Hood Blocking Flow - Keep all materials from blocking vents or baffles in the back of the hood by elevating materials at least one inch off the work surface.

Bench Cabinet – The cabinet where chemicals are stored should be good condition. If the interior is degraded, the cabinet should be replaced.

PPE

PPE Assessment - Personal Protective Equipment (PPE) is the equipment necessary for you to protect yourself while performing your job. The assessment determines the type of PPE is needed, when it is appropriate, and the limitations of the PPE. The PPE includes the following (but is not limited to): respirators, eyewear, gloves, clothing, hearing protection, and foot protection.

Use of Respirator - The use of all types of respiratory protection at Ithaca College is governed by the OSHA standards and the Ithaca College EH&S Respiratory Protection Program. A laboratory worker at Ithaca College may not purchase a respirator and bring it to their lab for personal use without prior consultation with EH&S.

Electrical Safety

Electrical panels – The area in front (minimum of 3 feet) is required to be free of material, to allow access. The circuit breakers need to be labeled appropriately to what each circuit breaker controls and the breaker panel needs to be intact; all openings must be covered with appropriate material.

Extension Cord/Power strip – Equipment should be grounded or double insulated and be tested by a third party such as Underwriters Laboratories (UL approved). You must not use equipment that has a worn or frayed cord. Extension cords are allowed only for temporary use on portable power equipment. A power strip can not be plugged into another power strip or have extension cords plugged in to it. Inspect the cord prior to use for any deficiencies if any are found, the cord needs to be replaced.

GFCI – When working with electrical equipment around wet and/or damp environments, a Ground Fault Circuit Interrupter is required to be used. Temporary GFCI plug adapters can also be used, but are not a substitute for GFCI outlets or circuit breakers.

Lab Equipment Safety

Equipment Labeled for use – Refrigerators, freezers, microwaves, and dishwashers need to be labeled: ‘Chemical storage only’, ‘Research Use Only’, ‘Human Food Only’, or other appropriate labels.

Rotovaporators – Due to vacuum pressure upon the glass there is increased risk of implosion hazard. The glass should be wrapped in a protective coating, for example with a plastic mesh sleeve or with clear packing tape.

Mercury-containing Equipment – Equipment that contains mercury is recommended to be changed out with like equipment that does not contain mercury. If not applicable, then the equipment should be labeled with a sticker ‘Contains mercury’ and an appropriate mercury spill clean-up kit should be available.

Equipment in Working Order – Equipment that is used needs to be functioning according to manufactures specifications. If the equipment is not functioning properly it should be tagged and taken out of service until repaired.

Machine Guarding - All moving parts on equipment must be properly guarded.

Ladder Safety – Ladders need to be functioning properly and sized appropriately for the application.

Emergency Preparedness

Emergency Response Guide – This is a guide covering various emergencies that may occur and how to respond if they were to occur.

Spill Kit - A well prepared spill kit will help manage small spills quickly and safely. The rule of thumb for safety on spill cleanup is: If you don’t feel comfortable doing it, or you don’t have the necessary materials, evacuate the area and call your emergency number for help.

Eyewash/Safety Shower

Corrosive Chemical Use – An efficient functioning eyewash station is required to 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.

Weekly Testing – Laboratory personnel should flush the eyewash on a weekly basis, and post a test sheet for logging who and when the flushing occurred. EH&S tests the eyewashes semi-annually and tags them appropriately. Eyewash/Safety shower labeled – A sign(s) denoting the location of the eyewash/safety shower should be posted.

FireSafety

Fire Extinguisher – All workers must have immediate access to a fire extinguisher (within 75 feet). The extinguisher needs to have a current inspection, and needs to be appropriate for the fire risks present. Personnel should frequently check the pressure gauge to make sure that their extinguisher is still properly charged.

Combustible Storage – Combustibles (materials that burn easily) must not be stored within 2 feet of the ceiling in a non-sprinklered room or, if the room is sprinklered, both combustibles and non-combustibles must be kept 18 inches below the level of the sprinkler head. Combustible materials should not be stored near sources of ignition including electrical panels, sparking equipment, and open flames.

Excess Combustible Storage – Large amounts of combustible material (paper, plastic, cardboard, etc) that is being stored within an area should be removed or recycled, due to the fire hazard the material presents.

Potential Fire Hazards – Special consideration about surrounding material needs to be taken when using equipment that produces an open flame, high heat, or electrical spark.

Housekeeping

Aisle Space - Fire code requires a minimum 36" aisle space. Spaces between work benches should not be cluttered with storage of materials and/or equipment.

Eat/Drinking - It is possible for the food or drink to absorb chemical vapors and thus lead to a chemical exposure when the food or drink is consumed. Eating or drinking in areas exposed to toxic materials is prohibited by the OSHA Sanitation standard, 29 CFR 1910.141(g)(2).

Work Space/Fume Hood – Cluttered and messy workspaces can lead to safety issues and can attract attention when regulators inspect the area. Workspaces should be kept orderly and all chemical spills must be cleaned up.

Chemical Spills Cleaned Up - Ensure all spills have been cleaned up and all potentially contaminated surfaces have been thoroughly cleaned with water and detergent.

Lighting – Work areas should always have adequate lighting to work safely. Slips/trips/fall

Hazards – Floors should be kept clean and free from debris and electrical cords. Chemicals and hazardous materials should not be stored in floor spaces.

BioSafety

Hypodermic Needles – A certificate of need from the Department of Health is required to possess hypodermic needles and syringes either by the department or PI. Stocks of hypodermic needles must be kept in locked storage with an inventory system(log of use) that is kept for three years.

Sharps Disposal - Hypodermic needles must always be discarded in a red sharps container. Hypodermic Needles should never be removed from a syringe; instead the entire unit should be put into a sharps container. Other sharps such as razor blades can be collected in sturdy puncture resistant container, taped shut and disposed of directly into the dumpster.

Work with Biohazards, Infectious Material, Recombinant DNA – The Ithaca College Institutional Bio-Safety Committee issues a Memorandum of Understanding to investigators to assure appropriate health and safety measures are in place and to comply with existing government regulations and applicable University policies.

Regulated Medical Waste – Waste generated at BioSafety Levels 2 and 3 is defined as that generated in the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, or in production and testing of biologicals. Additionally, regulated medical waste cannot contain any hazardous chemical or radioactive waste components. The biological component must first be decontaminated, and then treated as chemical or radioactive waste.

Exposure Control Plan – OSHA requires that an employer implement the plan when employees are working with bloodborne pathogens. Research groups may need to add additional information relevant to their particular site in order to have an effective and comprehensive plan.

BioSafety Cabinet - BioSafety Cabinets (BSC) need to be inspected and certified for use annually. BSCs should only be used for the work for which they were designed. Most BioSafety Cabinets (BSC) are not designed for chemical use. Alcohol for disinfection should have only limited use in BSCs.

Training

Every person who handles Hazardous Waste must know what their role is in making sure that the waste is handled properly. EH&S provides a “Chemical Waste Disposal” class that covers these requirements.

Appendix N
Pre-Operational Safety, Health & Environmental Review (POSHER) Form

Ithaca College **Environmental Health and Safety Office**	**STANDARD FORM**	
Title: Pre-Operational Safety, Health & Environmental Review Form (POSHER)	**Number:** EHS-01	**Revision:** #1/03-03-09

Research Process Overview					
Date:		Project #:		**Research/Process Title:**	
Principal Investigator (PI):				**Department:**	
Building:				**Room #:**	
Review Team Members:					
Brief Overview of Research/Laboratory Process:					
Brief Description of Primary Hazards:					

Facilities Services Requirements Review				
What Type of Facilities Services Do You Need?	**YES**	**NO**	**If Services Don't Exist, Then List Actions Required**	**Action Owner**
House Compressed air?				
House Vacuum?				
House DI/RO Water?				
House Natural Gas?				
Local process cooling water?				
Local (process specific) gas source?				
Fume Hood?				
Cold Room?				
Electromagnetic Interference protection?				
Is this process likely to be a source of EMI to others?				
Vibration protection?				
Is a sanitary drain required?				
Will a biosafety cabinet be required? If yes, initial and annual certification is required. If relocating the biosafety cabinet from another location, the cabinet should be decontaminated.				
Are hazardous gases (flammable, toxic, corrosive, etc.) used? How?				
Are non-hazardous compressed gases used? How?				
Are there special electrical requirements for your equipment (Voltage, Amperage, Phase or Plug Connections)?				
Are there specific labels/signage required beyond basic HASP signage? (i.e. Laser, X-ray, radioactive, biohazard, etc.)				

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Hazard Identification

Which Type of Hazards Exist in Your Work?	YES	NO	Comments	If “Yes”, Go to Section:
Chemical Hazards (Solids, Liquids, or Gases)				**A**
Biological Hazards (Pathogens, Pesticides, Animals, etc.)				**B**
Radiation Hazards (Ionizing – Radioactive Material, RPE)				**C.1**
Radiation Hazards (Non-Ionizing – Lasers, RF, magnetic fields, etc.)				**C.2**
General Equipment/Process Hazards (e.g. high temp. or noise)				**D**

Section A – Chemical Hazard Review

Section A.1 – Hazardous Chemical Use Information, based on MSDS data and OSHA definitions of hazardous chemicals, 29CFR 1910.1200

List: All hazardous chemicals, biological agents, and by-products associated with this process that presents a health, flammability or reactivity hazard of 3 or 4 as indicated on the NFPA chemical hazard label: 	**Identify:** Solid Liquid Gas	**Estimate:** Maximum hourly and annual use rates	**Indicate:** Storage capacity, size of container	**Estimate amount to:** Drain Exhaust Hazardous Waste	**Indicate if:** Toxic Pyrophoric Flammable/Combustible Oxidizer Dust Source Corrosive Odor detectable Volatile organic compound Radioactive Asphyxiant Carcinogenic Reproductive toxin

Section A.2 – Chemical Hazard Review Questions/Action Items				
Chemical Process Details	**YES**	**NO**	**Engineering Controls/Details**	**Action Owner**
Are there pressurized process or system liquids? (i.e. pumped chemical lines, hydraulics)				
Are there pressurized process gas systems?				
Are external chemical delivery systems required (liquids)?				
Are there open liquid baths (wetbench)?				
Beyond standard Right To Know (MSDS), are communications to employees working with individually regulated chemicals required? (e.g. Formaldehyde, asbestos, methylene chloride, lead, mercury)				
Is a chemical delivery procedure document required/provided?				
Is a Standard Operating Procedure for gas connection/purging or chemical filling required?				
Is special chemical handling training required?				
Is there special chemical handling equipment or personal protective equipment required?				
Is chemical storage required near the process? (In addition to chemical/gas in use) Storage capacity?				
Will manual chemical mixing be required? Explain.				
Is there a chemical reaction in the process?				
It is assumed that ALL containers are properly labeled. Are there special container-labelling requirements? (e.g. biohazard)				
Is there adequate laboratory security in light of chemical and operational hazards?				
Is heat required or generated in the process?				
Is there appropriate door signage per the HASP program?				

Section B– Biological Hazard Review				
Biological Process Details	**YES**	**NO**	**Engineering Controls/Details**	**Action Owner**
Does the process involve the use of hypodermic syringes and needles?				
Will this project involve the use of controlled substances?				
Does the process involve occupational exposure to blood, human body fluids, unfixed tissues or organs, HIV/HBV containing cell or tissue cultures? If yes, Bloodborne Pathogen Training is required.				
Does the procedure involve the use of human subjects?				
Does the process involve the use of pesticides? If so, attach any applicable SOPs and MSDS forms for each chemical. • Any employee who works with plants that may be treated with pesticides must attend Worker Protection Standard training, unless s/he is a certified pesticide applicator. • Any employee who works with pesticides, with the exception of laboratory-scale experiments with pesticides, must become a licensed pesticide applicator in the state of Texas.				
Will the project involve the centrifugation, blending, sonication or maceration of infectious or biohazardous materials? If yes, you must perform these operations in a certified biological safety cabinet or utilize other suitable secondary containment (e.g. centrifuge safety cup)				
Does the process involve the use of biohazardous agents as listed below? • Infectious/pathogenic agents classified in the following categories: ○ Class 2 bacterial, fungal, parasitic, viral, rikettsail or chlamydial agents as identified in the lists from the NIH, CDC, ABSA or other resources ○ Note: Class 3 and 4 infectious agents are not allowed at Ithaca College facilities. • Other agents that have the potential for causing disese in healthy individuals, animals, or plants: ○ Regulated plant pests as published in Animal, Plant Health Inspection Service (APHIS) of USDA ○ Select biological agents and toxins as published in lists at CDC and APHIS. If yes, then has this process been approved by the Institutional Biological Safety Committee (IBSC)? Provide a copy of the IBSC approval letter and any applicable SOPs.				

Section B– Biological Hazard Review				
Biological Process Details	**YES**	**NO**	**Engineering Controls/Details**	**Action Owner**
Does the process involve the use of recombinant DNA molecules or gene therapy? • Molecules which are constructed outside living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in a living cell or, • DNA molecules that result from the replication of those described above. • Delivery of exogenous genetic material (DNA or RNA) to somatic cells for the purpose of modifying those cells. If yes, then has this process been approved by the Institutional Biological Safety Committee (IBSC)? Provide a copy of the IBSC approval letter and any applicable SOPs.				

Section C – Radiation Hazard Review				
Section C.1 – Ionizing Radiation Hazards				
Radiation Process Details	**YES**	**NO**	**Engineering Controls/Details**	**Action Owner**
Does this process involve the use of ionizing radiation devices (i.e. Radiation Producing Equipment)? **Examples:** accelerators, x-ray machines (diagnostic, therapy, diffraction, CHESS), electron microscope, reactor or fusion device • A permit must be obtained from the Radiation Safety Officer (RSO) in advance of any use or acquisition (by purchase, transfer, loan, donation or otherwise) of ionizing RPE at Ithaca College • Have training and user forms been completed?				
Does this process involve the use of radioactive material? • All possession and use of radioactive material at Ithaca College requires a formal written authorization issued by the Radiation Safety Officer (RSO). • A permit or registration is required for use of sealed sources of radioactive material. • Have training and user forms been completed?				

Section C.2 – Non-Ionizing Radiation Hazards				
Radiation Process Details	**YES**	**NO**	**Engineering Controls/Details**	**Action Owner**
Does any equipment present a source of RF/Microwave energy which can present a hazard in normal use or in service? If yes, are there interlocks or other user protection?				
Does the equipment involve the use of Class 2 or 3a lasers? If yes, are the following requirements in place for labeling: • “Caution LASER” • Hazard class • Power of the LASER • Type of LASER • Wavelength • Pulse duration if applicable NOTE: For Class 3a LASER – Door should be labeled with the same information as the LASER label.				
Does the equipment involve the use of Class 3b or 4 lasers? If yes, then are the following requirements in place? • Have all users attended Laser Safety Training? • Has the laser been registered with the Radiation Safety Officer (RSO) or the Environmental Safety Office? • Is there appropriate entryway protection and access control for the laser work area? • Is there appropriate eye protection available? • If excimer lasers are present, is Cl or F gas properly supplied and vented? (e.g. gas cabinets for cylinders and sufficient exhaust for the laser?)				
Are there any other sources of non-ionizing radiation that require controls to ensure personnel safety? (e.g. magnetic fields >5 gauss, UV etc.)				

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Section D – General Equipment/Process Hazard Review

General Equipment/Process Issues	YES	NO	Engineering Controls/Details	Action Owner
Are there processes or equipment that should have "off hour" use restrictions for normal use or service? Describe and explain.				
Should the equipment or process have buddy-system requirements for normal use or service? Describe and explain.				
Are there noises over or approaching 85db? If yes, then hearing protection and appropriate signage will be required.				
Are there exposed sources of electrical voltage?				
Are there exposed hot surfaces?				
Is a written standard operation procedure (SOP), including start up/shut down of equipment, available?				
Are there special hazards associated with start up or shut down?				
Is equipment specific training required for users? How are training records maintained?				
Is personal protective equipment required for the user/operators?				
Is maintenance required while the equipment is on? Interlocks?				
Is mechanical guarding required?				
Are there vibration sources? Vibration mitigation?				
Is there a potential health risk from normal operation or does the procedure present reproductive health hazards? If so, provide additional detail.				
Is a health surveillance required for users or staff other than those surveillances already required for animal use or radioactive material use?				
Are there ergonomic concerns with the process or equipment?				
Is a local process exhaust required? Why?				
Will the process involve the production of chemical waste, regulated medical waste, biological waste, radioactive waste, or other hazardous waste? If yes, then how will it be collected and disposed of (red bags, sharps, burn boxes)? Have personnel been trained accordingly?				
Will the process involve the shipping or transfer of any hazardous materials? If yes, have all shippers of hazardous material been trained and have received certification to show compliance with U.S. DOT regulations?				

Training Assessment				
Minimum Training Requirements	**YES**	**NO**	**Engineering Controls/Details**	**Action Owner**
The following training is required for your lab regardless of the type of process or research utilized: • Laboratory Safety Training • Chemical Waste Disposal Training • Community Right To Know Training or Laboratory Standards Training	X X X			
Additional Training Requirements	**YES**	**NO**	**Engineering Controls/Details**	**Action Owner**
Identify the additional training required for laboratory personnel based on the hazards involved. Examples of additional training are Radiation Safety for Radioactive Material Users, Laser Safety Training, Formaldehyde Awareness, or HF Acid Awareness.				

Final Review and Assessment				
Emergency Requirements	**YES**	**NO**	**Engineering Controls/Details**	**Action Owner**
Are eyewash/showers required?				
Are chemical spill kits required?				
Is local fire suppression required?				
Is Toxic Gas Monitoring required?				
Are local Alarms/Indicators required?				
Will changes be required to Emergency Response Protocols?				
Are emergency instructions, emergency escape routes, evacuations plans, etc. conspicuously posted?				
Are emergency contact information and phone numbers posted outside of the lab?				
Are there any special lab shut down procedures?				

Summary of Attachments: List all documents and SOPs that are or will be provided in associated with the POSHER
Examples include: Institutional Biological Safety Committee Approvals, Radiation Safety Officer approvals, Equipment Operating Procedures including emergency shut down/start up, Equipment information sheet, etc.

Risk Assessment Questions

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NOTES:

1. Identify consequences assuming there are not controls in place.
2. Identify the hazard level of the consequences assuming there are not controls (High, Medium, Low) in place.
3. Identify the controls designed to mitigate the consequences.
4. Identify the Risk Level taking the controls into account.
   Acceptable (A) = Low
   Unacceptable (U) = High, Medium
5. Actions: Identify actions and detail on the action list tabled at the end of the review.

WHAT IF…?	CONSEQUENCES	Hazard Level	CONTROLS	Risk	Actions
… there is a gas release?					
... there is a large chemical spill?					
… there is a radiation incident?					
… there is a biohazard incident?					
… there is a power failure?					
… there is an exhaust failure?					
… Other (specify)					

Conclusion

Given what is currently known and assuming all open actions are closed, can this research process be safely conducted at Ithaca College?	YES		NO		

Action Registry		
Issue	**Action Required**	**Action Owner**

Appendix O

Mandatory Information for employees using respirators when not required under the standard

Appendix D to §1910.134: Information for Employees Using Respirators When Not Required Under the Standard (Mandatory)

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer pro- vides respirators for your voluntary use, or if you
provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

You should do the following:

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is de- signed for and how much it will protect you.

3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.

4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

[63 FR 1152, Jan. 8, 1998; 63 FR 20098, 20099, April 23, 1998; assembled at 69 FR 46993, Aug. 4, 2004, 71 FR 16672, April 3, 2006; 71 FR 50187, August 24, 2006]