Laboratory Safety Manual

and

Chemical Hygiene Plan

Updated: November 2010
PURPOSE OF THIS MANUAL

The purpose of this manual is to meet the regulatory requirements of the OSHA Laboratory Standard for the development of a Chemical Hygiene Plan and to provide laboratories with useful recommendations that can help achieve compliance with the intent of the OSHA Lab Standard. Throughout this document, areas where regulatory or University requirements exist will be clearly identified using words such as “must”, “required”, “shall”, and “it is the responsibility”, etc. All other information provided within this document are recommendations that Environmental Health and Safety (EH&S) encourages laboratories to follow as best management practices.

Colleges, departments, other units, and individual laboratories are free to establish the guidelines found within this document as required policies for their units or laboratories.

To take advantage of the Internet, this document is formatted to be a “front door” to other resources, including useful web links. Where appropriate, web links will be embedded within the document and identified as a hyperlinked word that can be clicked on to view the webpage. Please note, by clicking on these external resources you will be leaving the Laboratory Safety Manual and will need to click the “Back” button on your browser to return to the manual. For those internal hyperlinks, including the table of contents, you can move around the document by clicking on the back and forward hyperlink arrow buttons located in the upper left hand side of your toolbar. If this toolbar is not visible, then go to your menu command “View”, then “Toolbars”, and then select the “Web” or “Navigation” button to make the toolbar and hyperlink arrow buttons accessible.

If you encounter a broken web link, please send an email to EH&S and include the section and page number of the manual and the name of the link you were trying to reach. If you have any suggestions to improve this document, including sharing useful web links or would like to request a section or topic to be added, please send an email to EH&S. This Laboratory Safety Manual should be considered a living document and will be reviewed at least annually and updated with your participation, comments, and suggestions.

IN CASE OF AN EMERGENCY, CALL 911 from any campus phone or 777-2393 from a cell phone.
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1.0 INTRODUCTION

This Laboratory Safety Manual includes the University’s Chemical Hygiene Plan and recommendations for good laboratory practices to serve as a useful resource and to assist laboratories in designing their own site-specific laboratory safety procedures to meet these requirements.

The Occupational Safety and Health Administration (OSHA) regulation 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories", mandates health and safety practices and procedures in laboratories that use hazardous chemicals. The Standard became effective May 1, 1990 and requires that a Chemical Hygiene Plan be developed for each laboratory workplace. The purpose of the Laboratory Standard is to protect laboratory employees from harm due to chemicals while they are working in a laboratory. This regulation applies to all employers engaged in the laboratory use of hazardous chemicals which OSHA defines as:

"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.

“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 hematopoietic systems and agents which damage the lungs, skins, eyes, or mucous membranes. Appendix A and Appendix B of the
Hazard Communication standard (29 CFR 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 the purposes of this standard.

A complete description of definitions applicable to laboratories can be found in the OSHA Laboratory Standard. In all other areas that use chemicals, but do not fall under the OSHA definition of a “laboratory”, the OSHA regulation 29 CFR 1910.1200 – Hazard Communication Standard” applies.

Most laboratories at Binghamton using chemicals are subject to the requirements of the Laboratory Standard. In addition to employees who ordinarily work full-time within a laboratory space, other employees (such as office, custodial, maintenance and repair personnel) who regularly spend a significant amount of their time within a laboratory environment as part of their duties, may also fall under the requirements of the Laboratory Standard. OSHA considers graduate students who get paid for working in a lab as employees who are subject to the requirements of the Laboratory Standard.

The 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. Binghamton University Environmental Health & Safety has taken responsibility for maintaining an institutional Chemical Hygiene Plan. Each college, center, department, or laboratory may adopt or modify this plan or write their own chemical hygiene plan as long as the requirements of the OSHA Laboratory Standard are met. It is assumed if a college, center, department, or laboratory has not developed their own chemical hygiene plan, then that unit or laboratory has adopted the Binghamton University Chemical Hygiene Plan.

The Binghamton University CHP is maintained by the department of Environmental Health and Safety (EH&S). The campus CHP is designed to supplement department and laboratory specific safety manuals and procedures that already address chemical safety in laboratories.

{If you would like to submit a link to your department safety manual to be included in the appendix for other campus personnel to view, please submit the web link to EH&S.}

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. While EH&S recommends a hard copy be kept in the laboratory, electronic access is acceptable and encouraged. The Chemical Hygiene Plan can be found in Appendix A of this manual.

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

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 University Chemical Hygiene Plan, the University Health and Safety Policy, and any other department or University 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 recommendations and guidelines (as found in this Laboratory Safety Manual), developing and 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) (and Manager For Laboratory Safety Programs) is to facilitate the implementation of the campus Chemical Hygiene Plan and this Laboratory Safety Manual in laboratories across campus and outlying facilities, and to serve as a technical resource to the campus laboratory community. The CHO can be reached by contacting EH&S at 777-2211.

The major duties of the Chemical Hygiene Officer are:

- Work with campus stakeholders to evaluate, implement, review annually, and make updates as needed to the Chemical Hygiene Plan and Laboratory Safety Manual.

- Provide technical expertise to the laboratory community in the area of laboratory safety and health, and serve as a point of contact to direct inquiries to other appropriate resources.

- Ensure that guidelines are in place and communicated for particularly hazardous substances regarding proper labeling, handling, use, and 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, and decontamination of hazardous chemicals, and the proper selection and use of personal protective equipment.

- 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 to assist with the design and construction process.

• Keep senior administration informed on the progress of continued implementation of the Chemical Hygiene Plan and Laboratory Safety Manual and bring campus-wide issues affecting laboratory safety to their attention.

1.2.3 Deans, Directors, and Department Chairpersons

The Deans, Directors, and Department Chairpersons are responsible for laboratory safety within their department(s) and must know and understand the University Health & Safety Policies and know and understand the guidelines and requirements of the Laboratory Safety Manual. In addition to the responsibilities outlined within the University Health & Safety Policy, the laboratory safety responsibilities of Deans, Directors, and Department Chairpersons - which can be delegated to other authorized personnel within the department such as a Department Safety Representative (DSR) - are:

• Be familiar with and implement the University Health & Safety Policy within units under their control or designate a person in the department (such as the DSR) with the authority to carry out these requirements.

• Communicate and implement the University 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 and Laboratory Safety Manual.

• 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 students 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 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 DSR, Building Administrator, and 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. For more information, see the Lab Move Guide in the appendix.

• 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 University Health & Safety Policy, 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 University Health & Safety Policies and all other University safety practices and programs, including the guidelines and procedures found within the Laboratory Safety Manual, in laboratories under your supervision or control.

• Establish laboratory priorities, objectives and targets for laboratory safety.

• Communicate roles and responsibilities for individuals within the laboratory relative to environmental, health, and safety according to this Laboratory Safety Manual.
• Conduct hazard evaluations for procedures conducted in the laboratory and maintain a file of standard operating procedures 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.

• Require all staff members and students under their direction to obtain and maintain required health and safety training.

• Conduct laboratory self inspections with their laboratory employees or designate someone in the laboratory to conduct these inspections on a regular basis.

• 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 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 and/or Department Safety Representative and that a written Incident/Accident Report (CS–13) is filed with EH&S for each injured person.

• Ensure laboratory personnel under your supervision know and follow the guidelines and requirements contained within the Laboratory Safety Manual.

• Follow the guidelines identified within this manual as Principal Investigator and laboratory supervisor responsibilities. A compiled version of these responsibilities can be found in the appendix.

• Keep the Department Safety Representative, 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, are present in the 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.

In addition to the responsibilities outlined within the University Health & Safety Policy, the laboratory safety duties of laboratory employees are:

- Comply with the University Health & Safety Policy 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 a supervisor or instructor of any safety hazards in the workplace, classroom, or laboratory, including reporting any unsafe working conditions, faulty fume hoods, or other non-working emergency safety equipment to the laboratory supervisor.

- Ensure an MSDS is present for all new chemicals you purchase and a copy is supplied to EH&S. It is strongly recommended a copy is stored in the lab. Review the MSDSs for chemicals you are working with and check with your laboratory supervisor or principal investigator if you have any questions.

- 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.

- Participate in laboratory self inspections.

- Follow the standard operating procedures for your laboratory and incorporate the guidelines and requirements outlined in this Laboratory Safety Manual into everyday practice.
1.2.6 Building Administrator

Building Administrators serve as an important conduit for information with regard to building wide issues. This information includes reporting and coordinating routine maintenance issues, scheduling building shutdowns, and communicating building wide maintenance and repairs and building system shutdowns to all occupants.

Laboratory safety responsibilities of Building Administrators include:

- Comply with the University Health and Safety policy and all other University health and safety practices and programs by maintaining common building areas safe and free from hazards.

- Attend required health and safety training as designated by your supervisor.

- Keep the DSR, Department Chairperson, and the Chemical Hygiene Officer informed of plans for renovations or new laboratory construction projects, and the laboratory needs of new faculty and staff.

- Ensure that service requests for safety equipment (such as fume hoods and emergency eyewash/showers) and other laboratory equipment are processed in a timely manner.

- Ensure that requests from EH&S related to building-wide laboratory safety issues are addressed promptly.

- Be aware of building issues that could impact the health and safety of laboratory personnel and contact EH&S at 777-221 whenever building-wide health and safety issues arises in laboratories.

- Be familiar with what to do in the event of an emergency situation.

1.2.7 Department Safety Representatives

The Department Safety Representative (DSR) serves a very important function in implementing the Chemical Hygiene Plan and Laboratory Safety Manual within the department. The role of the DSR is to assist the director,
unit head, and/or department chairperson to meet their responsibilities for safety and compliance.

Laboratory safety responsibilities of DSRs include:

- Comply with the University Health and Safety policy and all other University health and safety practices and programs.

- Request and coordinate assistance from EH&S and other organizations that can provide guidance, training, and other services to assist laboratory personnel.

- Assist directors, unit heads, department chairpersons, supervisors, and individuals within the areas they represent to establish departmental, unit, or facility-wide safety programs, priorities, objectives and targets for safety, health, and environmental performance.

- Assist directors, unit heads, department chairpersons, supervisors, and individuals to identify (with assistance and guidance from EH&S) if the safety needs for the areas they represent are met (e.g., training, protective equipment, acquisition of safety equipment, and corrective measures including noncompliance items identified in safety audits).

- Encourage the formation of, and participate on college, unit, departmental, and/or facility-wide safety committee(s).

- Work with EH&S to stay knowledgeable about safety, health, and environmental services available, the University Health and Safety policies and procedures that apply to, and the health and safety issues that occur within, the areas they represent.

- Communicate to individuals working within the areas they represent about these health and safety policies and procedures, including this Laboratory Safety Manual, and the safety, health, and environmental services available to them.

- Conduct and/or facilitate routine inspections of work areas in the areas they represent. Tools and resources are available from EH&S. Facilitate corrective actions for any issues identified, including bringing issues of noncompliance to the attention of directors, unit heads and department chairpersons.

- Promote safety, health, and environmental training program and workshops (particularly EH&S trainings) throughout the areas they
represent. Inform individuals working in areas they represent about the requirement to obtain necessary training as identified by their supervisor and EH&S.

- Serve as a “conduit for information exchange” through facilitation and dissemination of safety, health, and environmental information (particularly information sent out by EH&S) to all personnel, including visiting faculty and researchers, and student employees, within the areas they represent.

- Communicate with supervisors in the areas they represent that all incidents and near misses should be reported and that a written Incident/Accident Report (CS-13) is completed.

- Attend EH&S training programs (and other safety, health, and environmental training programs and workshops) to increase and maintain knowledge about safety, health, and environmental issues that are applicable to the areas they represent.

- Be aware that changes in chemical use in a particular laboratory may require a re-evaluation of the laboratory ventilation.

- Notify EH&S before a faculty member retires or leaves the University or laboratory groups move so proper laboratory decommissioning can occur. For more information, see the Lab Move Guide in the appendix.

2.0 CONTROL MEASURES

The main goals of the OSHA Laboratory Standard and the requirement to develop a Chemical Hygiene Plan are to protect employees from health hazards associated with use of hazardous chemicals in the laboratory and keep exposures below the permissible exposure limits as specified in 29 CFR Part 1910, subpart Z – Toxic and Hazardous Substances and other resources such as NIOSH and ACGIH. In addition to other requirements, the OSHA Lab Standard specifies the Chemical Hygiene Plan 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.” Engineering controls and administrative controls promote a healthy and safe work environment, and meet both the requirements and the intent of the OSHA Laboratory Standard.
2.1 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 Binghamton University 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 for benchtop 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. Physical Facilities, Building Administrators, Department Chairperson, 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 their Building Administrator or their department contact as soon as any malfunctions are discovered.

2.1.1 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. Benchtop use of chemicals that present an inhalation hazard is not permitted. Fume hoods must be used when conducting new experiments with unknown consequences also 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 working in any fume hood, ensure the fume hood is working by checking the tell-tale (green crepe paper or chem.wipe hanging from hood sash) and air monitoring device if the hood is equipped with one. DO NOT use an improperly working fume hood. If EH&S or Physical Facilities 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 inspection sticker). Keeping the hood sash lowered improves the performance of the fume hood, acts as a safety shield during experimental procedures and (for VAV hoods) helps to conserve energy.

• Keep all materials stored in hoods to a minimum. 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 laboratory personnel breathing zones.

• 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.

2.1.1.1 Perchloric Acid Use

Be aware that use of heated Perchloric acid requires a special Perchloric acid fume hood with a wash down function. DO NOT use heated Perchloric acid in a regular fume hood. If heated Perchloric acid is used in a regular fume hood (without a wash down function), shock sensitive metallic perchlorate crystals can form inside the duct work, which can result in an explosion occurring during maintenance work on the ventilation system. If you suspect your fume hood has perchlorate contamination or would like more information on Perchloric acid fume hoods, contact EH&S at 777-2211.

2.1.1.2 Fume Hood Inspection and Testing Program

EH&S performs free annual testing and inspection of fume hoods on campus. After each inspection, an inspection sticker is affixed to the fume hood. If your fume hood does not have an inspection sticker or if the existing inspection sticker on your fume hood indicates a year or more has passed since the hood was last inspected, please call EH&S at 777-2211 for air flow measurements or other questions.

The fume hood inspection program at Binghamton consists of an initial comprehensive inspection followed by annual standardized inspections for all fume hoods on campus. This initial inspection will provide baseline information including, but not limited to, hood usage, type of hood, room and building information, as well as average face velocity measurements.

Follow-up inspections for proper use and face velocity (airflow) measurements will be performed on an annual basis or upon request by laboratory personnel. Upon completion of each inspection, hoods will be labeled with an inspection sticker indicating face velocity, date inspected, and initials of the inspector. The sticker represents the sash position at
which the hood was tested for optimum working height. All inspection information will be recorded and kept on file at the EH&S office.

Fume hood testing and inspection consists of the following:

- The face velocity will be tested for compliance with American National Standards Institute (ANSI) and American Industrial Hygiene Association (AIHA) standard Z9.5-2003.
- The hood will be checked for the correct postings and a tell-tale flow indicator (Chem paper).
- A report will be sent to the Building Administrator documenting the testing and indicating any needed repairs.

Hoods will be classified as acceptable or unacceptable based on the average face velocity measurement and sash height.

- A hood will be considered **acceptable** if an average face velocity between 80 and 120 fpm occurs with a sash opening of 18”.
  The optimum working height is with the hood sash at 9” -12”.

- A hood will be considered **unacceptable** if the average face velocity falls outside of these ranges.

If a hood is found to be unacceptable, a warning sign indicating the hood did not pass inspection and does not provide optimum protection will be attached in a conspicuous location. The warning sign will include instructions on the proper procedures to have the hood repaired or maintenance service performed.

Under no circumstances should laboratory personnel continue to use a fume hood that has not passed the EH&S inspection and has a warning sign attached, even if the fume hood appears to have airflow. Laboratory personnel must make arrangements with other laboratories with functioning fume hoods if their work requires the use of a fume hood.

EH&S will coordinate fume hood repairs with the Building Administrator and Physical Facilities, to ensure a timely and accurate repair process.

2.1.1.3 Installation of New Fume Hoods

Installation of a new fume hood requires careful planning and knowledge of the existing building ventilation systems and capabilities. Improperly
installed fume hoods or other capture devices can seriously disrupt the existing ventilation system and have a negative impact in the immediate room, other fume hoods, and the ventilation system throughout the building. All fume hoods and other capture devices must be installed by physical facilities and in consultation with EH&S.

In addition to ensuring proper installation of your new fume hood, by consulting with EH&S on new installations, your new fume hood or capture device will be added to our inventory and included in our free annual fume hood inspection and testing program.

EH&S can provide information regarding the selection, purchase, and inspection requirements for laminar flow clean benches, biosafety cabinets, and portable fume hoods.

2.1.1.4 Removal of Existing Fume Hoods

As with installation of new fume hoods and capture devices, any removal of these devices requires prior consultation with your Building Administrator, Physical Facilities, and EH&S. In addition to ensuring ventilation systems are not affected by removal of fume hoods and capture devices, utility services such as electrical lines, plumbing systems, and water and gas supply lines must be properly disconnected. All fume hood removal must be conducted by Physical Facilities.

There is an additional concern for the presence of asbestos within the fume hood itself, and potentially in any pipe insulation associated with the ductwork and/or mercury in cup sinks. Any asbestos must be properly removed and disposed of by a certified asbestos removal company. Contact EH&S at 777-2211 for more information or questions about asbestos.

2.1.1.5 Other Capture Devices

Other engineering controls for proper ventilation include glove boxes, compressed gas cabinets, vented storage cabinets, canopy hoods, and snorkels. These pieces of equipment are designed to capture hazardous chemical vapors, fumes, and dusts at the source of potential contamination. Examples where these capture devices would be appropriate include welding operations, atomic absorption units, vacuum pumps, and other operations.

Please note, when other laboratory apparatus (such as vacuum pumps and storage cabinets) are vented into the face or side of a fume hood, disruptions can occur in the design flow of the hood and result in lower capture
efficiency. When such venting is deemed necessary, the connection should be further along the exhaust ducts of the hood system rather than into the face of the hood. To avoid the possibility of disrupting the efficiency and operation of the fume hood, any additional installations or adjustments should not be undertaken without first consulting with Physical Facilities, EH&S, and the appropriate campus service shops.

2.1.1.6 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 fountain).

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

1) A tube attached to a faucet without a vacuum breaker, and
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 contaminate the building water supply.

The most common example of backflow prevention found in laboratories is 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 the laboratory faucet you are planning on using has a vacuum breaker or backflow protection, contact your Building Administrator or EH&S at 777-2211. 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 back flowing up the faucet.

2.2 Personal Protective Equipment

Personal Protective Equipment (PPE) should be considered the second line of defense in protecting laboratory personnel against chemical hazards after the use of engineering controls. PPE is not a substitute for good engineering or administrative controls, or good work practices, but should be used in
conjunction with these controls to ensure the safety and health of university employees and students.

The OSHA Personal Protective Equipment standard, 29 CFR 1910 Subpart I contains the following requirements:

- Hazard assessment and equipment selection.
- Employee training.
- Record keeping requirements.
- Guidelines for selecting PPE.
- Hazard assessment certification.

More information on PPE can be found in the OSHA Safety and Health topics page on Personal Protective Equipment.

2.2.1 Laboratory Responsibilities for Personal Protective Equipment

Laboratory personnel need to conduct hazard assessments of the specific operations occurring in their laboratories to determine what Personal Protective Equipment (PPE) is necessary to safely carry out the operation. 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 clothing and equipment 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 Institute) standards should be purchased or accepted for use.

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

2.2.1.1 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. Written 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 training on conducting hazard assessments, and on the selection and use of proper PPE, the ultimate responsibility lies with the Principal Investigator or laboratory supervisor.

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.

2.2.2 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, 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.

2.2.2.1 Eye Protection Selection

All protective eye and face devices must comply with ANSI Z87.1-1989, "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 wears 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 (goggles, face shields, etc.) 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.
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.

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.

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.

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 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.

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.

**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 laser Safety Officer at EH&S at 777-2211. See the [LASER Hazards](#) for more laser information.

### 2.2.3 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, biologicals, 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).

*** Keep in mind there is no 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.
2.2.3.1 Selecting the Proper Gloves

Before working with any chemical, always read manufacturer instructions and warnings on chemical container labels and MSDSs. Recommended glove types can sometimes be listed in the section for PPE on MSDSs. If the recommended glove type is not listed on the MSDS, 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. Keep in mind that different manufacturers use different formulations so check the glove chart of the specific manufacturer for the glove you plan to use.

If the manufacturers’ glove chart does not list the specific chemical you will be using, 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.

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, remember to remove gloves 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.
2.2.3.2 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 removed left glove and dispose of them properly. Be sure to wash your hands thoroughly with soap and water after the gloves have been removed.

2.2.3.3 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 at 777-2211 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 ketones, alcohols, caustics, and organic acids.

• **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 can also 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 the appendix 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.

2.2.4 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 at 777-2211 for recommendations.
2.2.5 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. There are certain exceptions to this general rule, such as the changing out of cylinders of toxic gases and emergency response to chemical spills.

The use of all types of respiratory protection at Binghamton is governed by OSHA standards and the Binghamton EH&S Respiratory Protection Program. A laboratory worker at Binghamton University 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 at 777-2211 to schedule a hazard assessment prior to using a disposable respirator.

- 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.

- Changing out cylinders of hazardous gases (Additional training is required).

- 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 the 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. Be sure to thoroughly clean up and decontaminate working surfaces.

There are some situations in which the use of a respirator is 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.

2.2.5.1 Respiratory Protection Program

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

The Binghampton University Respiratory Protection Program includes the following:

• You will receive a medical evaluation by United Health Services (UHS) to ensure you are physically fit to wear a respirator. Wearing any type of respirator puts of stress on the body.
• You will be given a fit test by EH&S personnel to determine which size respirator fits you best. Due to differences in the sizes and shapes of faces, there is no one respirator that fits everyone.

• 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 Binghamton, call EH&S at 777-221. If you are approved for the use of a respirator after meeting the requirements of the OSHA Standard and the Binghamton EH&S Respiratory Protection Program, you will be provided with a respirator.

2.2.6 Hearing Protection

Hearing protective devices includes earplugs, earmuffs, or similar devices designed to protect your hearing. In situations where occupational noise exposures exceed permissible levels and cannot be reduced through engineering or other controls, hearing protective devices must be worn. The Binghamton University 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 noise exposure, would like to request workplace monitoring, or for more information about the Binghamton University Hearing Conservation Program, contact EH&S at 777-2211.

Additional information can be obtained from the OSHA Health and Safety Topics page for Noise and Hearing Conservation.

2.2.7 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 present. Laboratory personnel should not wear sandals or similar types of perforated or open toes shoes when working with or around hazardous chemicals. 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 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.**

In some cases, the use of steel-toed shoes may be appropriate when heavy equipment or other items are involved. Chemically resistant boots or shoe covers may be required when working with large quantities of chemicals and the potential exists for large spills to occur.

### 2.3 Standard Operating Procedures

The [OSHA Laboratory Standard](https://www.osha.gov) requires that Chemical Hygiene Plans include specific elements and measures to ensure employee protection in the laboratory. One such requirement is Standard Operating Procedures (SOPs) “relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals.”

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.

SOPs do not need to be lengthy 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 – located in the MSDS binder. 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 ON THE BINGHAMTON CAMPUS, IT IS THE RESPONSIBILITY OF EACH LABORATORY, DEPARTMENT AND COLLEGE 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.

2.4 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.

Colleges and departments 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 a written Chemical Hygiene Plan or adoption of this Laboratory Safety Manual.

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

*** In addition to meeting regulatory requirements identified within this Laboratory Safety Manual, colleges and departments are strongly encouraged to incorporate the recommendations and guidelines identified within this manual. While this Laboratory Safety Manual provides the minimum requirements and recommendations to meet the intent of the OSHA Laboratory Standard, colleges, departments, Principal Investigators, and laboratory supervisors have the authority to implement more stringent policies within laboratories under their supervision and are encouraged to do so.

2.4.1 Procedural Controls

Procedural controls incorporate best management practices for working in a laboratory. These practices serve not only to protect the health and safety of personnel in the lab, but are a common sense way of increasing productivity in a laboratory. Through implementation of good practices, laboratories can expect an increase in the efficient use of valuable lab space, in the reliability of experiments due to less potential contamination, and an increase in the awareness of health and safety issues by laboratory personnel. Following the practices outlined in this Lab Safety Manual should also result in a decrease in the number of accidents, injuries, and spills. This will result in a decrease in the overall liability for the Principal Investigator, laboratory supervisor, and the University. Procedural controls are fundamental to instilling safe work behaviors and helping to create a culture of safety within the laboratory environment.
2.4.2 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.

- 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.

- Keeping areas around emergency equipment 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 code) between benches and equipment. Exits must be clear of obstacles and tripping hazards such as bottles, boxes, equipment, electric cords, etc.

- 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 and within 18” of the crown of a sprinkler head in sprinklered rooms.

In summary, good housekeeping has obvious health and safety benefits and can have a positive 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.*
2.4.3 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.
- Do not store food or drink in refrigerators that are used to store chemicals.
- Do not start 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 to yourself or others.
- 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, scrubs, gloves, and other PPE before leaving the lab. Do not wear lab coats, scrubs, 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 Binghamton.

2.4.4 Eating, Drinking, and Applying Cosmetics in the Lab

Chemical exposure can occur through ingestion of food or drink contaminated with chemicals. This type of contamination can occur when food or drinks are brought into a lab or when food or drinks are stored in refrigerators, freezers, or cabinets with chemicals. When this occurs, 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).

A similar principle of potential chemical exposure holds true with regard to the application of cosmetics (make-up, hand lotion, etc.) in a laboratory setting when hazardous chemicals are being used. In this instance, the cosmetics have the ability of absorbing chemical vapors, dusts, and mists from the air and when applied to the skin and result in skin exposure to chemicals.

To prevent exposure to hazardous chemicals through ingestion, do not eat, drink, chew gum, or apply cosmetics in areas where hazardous chemicals are used.

Wash your hands thoroughly after using any chemicals or other laboratory materials, even if you were wearing gloves, and especially before eating or drinking.

To help promote awareness, refrigerators and freezers should be properly labeled:

- Refrigerators for the storage of food should be labeled, “Food Only, No Chemicals” or “No Chemicals or Samples”.
- Refrigerators used for the storage of chemicals should be labeled “Chemicals Only, No Food”.

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Keep in mind that some chemical exposure can result in immediate effects (acute exposure) while other effects may not be seen for some time despite repeated exposure (chronic exposure). Consuming food or drink or applying cosmetics in the lab can result in both types of exposure.

2.4.5 Working Alone

Whenever possible, laboratory personnel should avoid working alone, 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. Check with your DSR to see if your department has specific requirements for working alone.

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 Binghamton University Police at 777-2393 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 Binghamton Police upon completion of the experiment. Under no circumstances should Binghamton University Police be used in place of a “lab buddy.”

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 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.*

2.4.6 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.
- Use emergency power outlets for those pieces of equipment that could be negatively affected in the event electric service is interrupted.

*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.*

2.4.7 Access to Laboratories

Access to Binghamton University laboratories, workshops and other work areas housing hazardous materials or machinery is restricted to Binghamton University faculty, staff, students, or other persons on official business.
2.4.7.1 Visitors and Children in Labs

Due to the potential hazards and liability issues, other persons, in particular children under the age of 16 are not permitted in hazardous work areas, with the exception of University-sanctioned activity, e.g., tours, open houses, or other University related business as authorized by the Principal Investigator or laboratory supervisor. In these instances, all children under the age of 16 must be under careful and continuous supervision. Check with your DSR to see if your department has specific procedures or policies in place for visitors.

2.4.7.2 Visiting Scientists and Other Similar Users

There are potential risks associated with allowing access to labs and equipment by visiting scientists. These risks include: theft or questions of ownership for intellectual property, bodily injury, and property damage. Departments should verify that all users of the lab have the required safety and health training prior to allowing access to the lab and/or specialized equipment. It is the user’s responsibility to have or obtain the appropriate training.

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

2.4.8 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 and can facilitate acquisition of Material Safety Data Sheets (MSDS).

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 (contact the Biosafety Officer at EH&S for more information), 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 777-2211.

2.4.9 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 Physical Facilities and EH&S to ensure the building has the necessary resources to support the new piece of equipment. Lab 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 Physical Facilities 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 Physical 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.

Laboratory personnel are strongly encouraged, as responsible campus members, to give consideration to purchasing “Energy Star” energy efficient pieces of equipment to help conserve natural resources and long-term operating costs. When discussing purchases of equipment with vendors and equipment manufacturers, ask about “Energy Star” alternatives they carry.

2.4.10 Service Requests

In the event of a maintenance issue or if repairs are needed to equipment, laboratory personnel should first consult with their Building Administrator, who can then submit the appropriate paperwork with Physical Facilities Customer Service 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) 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 vicinity either verbally or by leaving a sign with the appropriate information.

2.4.11 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, 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 University.

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:

- Complete Lab Close Out, Transfer, or Temporary Shutdown Procedures
- Notify your department chairperson, lab supervisor, and DSR 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.

2.4.12 Ventilation Rates
As part of energy conservation measures, ventilation rates for laboratories are determined based on the occupancy and the type of research being conducted. Whenever the function of a room changes, it is very important to notify EH&S at 777-2211 about the change. EH&S will then verify if the ventilation rate for a given room is appropriate for the type of research being conducted.

2.4.14 Laboratory Self Inspections

An important part of any laboratory safety program is implementation of laboratory self inspections.

Laboratory 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 lab 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 laboratory self inspections:

- On a daily basis lab personnel should maintain good housekeeping within their lab.
- Informal weekly lab walkthroughs.
- Ideally, formal once per month lab self inspections should occur. These could include participation of laboratory staff, DSRs, and/or safety committee members, and use of a laboratory inspection checklist.
At least once per semester lab personnel should perform a formal lab self inspection.

EH&S can train laboratory personnel on how to properly conduct a lab inspection using the EH&S self-inspection checklist to identify potential issues and solutions to prevent future occurrences.

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.

2.4.15 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 (college, 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 required locking up of 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 five-minute window when the lab is left unattended.

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

2.4.15.1 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.
  
  o 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).
  o Do not leave hazardous materials unattended or unsecured at any time. Most importantly, close and lock laboratory doors when no one is present.
  o 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. Consider approaching anyone you don’t recognize and who appears to be wandering in laboratory areas and hallways and ask if you can help direct them or call University Police at 777-2393 or 911 from any university phone.

• **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 required to maintain a [chemical inventory](#). Report any missing inventory to University Police (777-2393) immediately.

• **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.** Department Heads 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 sure to include the lab’s emergency contact information on your emergency information sheet, located on or near your laboratory door.

- **Be aware of the classes of security risk 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 locks, lock boxes, and other security devices for chemical storage in laboratories. For more information, you can contact EH&S for assistance (777-2211) and/or consult with the Lock Shop (777-2226) about security devices.

2.4.16 Energy Conservation in Laboratories

Laboratories are well known to be energy intensive facilities, consuming many times the energy use of the average non-lab academic buildings. Laboratories use large quantities of heated and cooled, one-pass air for ventilation and fume hoods; electricity to operate fans, lighting, and
specialized lab equipment; and large quantities of water and process chilled water. Some laboratory facilities also use substantial quantities of natural gas.

Many improvements to facility design, including the computerized control of lab buildings, have led to substantial energy savings in recently constructed lab buildings. However, many of these energy saving improvements are only fully effective if the people working in the labs are also involved in the energy conservation efforts. There are a number of things that YOU can do to reduce the overall consumption of energy in YOUR laboratory:

1) Turn off the lights when you leave during the day and at the end of every day, especially if your lights do not have a setback (turn themselves off after a few minutes).

2) Whenever possible, turn off all electrical equipment when not in use, especially before you leave for the day.

3) Use timers to turn pieces of equipment on and off automatically.

4) Turn off your computer’s monitor when not in use. The monitor consumes over half of the energy used by the average computer. If for some reason you can’t turn your computer off, then turn on your computer’s energy saving features. This feature will put your computer and monitor to “sleep” after 10 minutes and cut power use nearly to zero.

5) Keep the sash closed on your fume hood, especially if you have a Variable Air Volume (VAV) type fume hood. This promotes both energy conservation and safety. A typical five-foot fume hood uses $3500 per year in heating and cooling costs. Keeping your VAV hood sash closed can cut the air volume and cost by two thirds!

6) Rooms that are too hot or too cool may be due to faulty thermostats or other controls that are malfunctioning or have drifted from set points, resulting in wasted energy as well as uncomfortable conditions for you. If you experience these problems, contact your Building Administrator for assistance.

7) Report drips of water from sink taps, chilled water connections or Reverse Osmosis (RO) faucets.

8) Buy energy efficient equipment. Look for the Energy Star logo or other statements that an electrical device is designed to be energy efficient. Each 1000 watts cost $700 per year in electricity. If the
extra cost of a “high efficiency” unit can be paid for in 5 to 7 years or less, then you should purchase the high efficiency unit.

9) When purchasing natural gas powered or consuming devices, buy equipment that uses an electronic ignition instead of a pilot light. Pilot lights waste over 20 percent of the gas used in the United States.

10) Use shades and blinds as provided to help keep your space cool on sunny days. The shade can reduce the amount of cooling required in a south or west facing room by over 30%.

Reducing energy consumption not only conserves precious natural resources, but also reduces energy costs for the University, which results in more funds being available for other research endeavors.

Additional information on selecting energy efficient products can be obtained at the [EPA Pollution Prevention website for Green products](https://www.epa.gov/p2/greenequipment) and the [Energy Star website](https://www.energystar.gov). Additional information on energy conservation for both work and home can be found on the Department of Energy’s website: [Energy Efficiency and Renewable Energy](https://www.energy.gov/energy-efficiency).

### 3.0 EMERGENCY PREPAREDNESS

**IN CASE OF AN EMERGENCY:**

CALL 911 from any campus phone or dial 777-2393 from any cell or off campus phone to reach Binghamton University Police.

Emergencies can occur at any time, without warning. Careful planning, with an emphasis on safety, can help members of the Binghamton community handle crises and emergencies with appropriate responses, and could save lives. Every member of the Binghamton community shares responsibility for emergency preparedness. Building Administrators are responsible for ensuring that their buildings have emergency plans in place, and that all persons – including faculty, staff and students – are familiar with those emergency plans. Building Administrators are also responsible for assigning emergency preparedness and response duties to appropriate staff members.

#### 3.1 Emergency Evacuation Procedures

Evacuation is required any time the fire alarm sounds, an evacuation announcement is made, or a university official orders you to evacuate. When an evacuation occurs, building occupants should exit immediately, putting their department’s evacuation plan into effect. After the building has
been evacuated, occupants must wait for an “All Clear” from University Police or EH&S before re-entry.

3.1.1 General Evacuation Procedures

- Turn equipment off if it is safe to do so.
- Quickly shutdown any hazardous operations or processes and render them safe.
- Notify others in the area of the alarm if they did not hear it while you are evacuating yourself.
- Take jackets or other clothing needed for protection from the weather.
- Close windows and doors as you leave, but do not lock the doors.
- Leave room lights on.
- Exit the room.

If you are unable to leave the building due to a physical disability:
  o Go to the nearest area where there are no hazards.
  o Dial 911 from a campus telephone or, using a cell phone, dial 777-2393 to call Binghamton University Police.
  o Be sure to give the room number so they can send help to you.
  o If possible, signal out the window to on-site emergency responders.
  o One person may remain with you if they wish to assist you.

- To exit the building, walk to the nearest safe exit route (do not run). Do not use elevators to exit.
- Move away from the building, report to the designated evacuation point and meet with other persons from the building. Wait at evacuation point for directions.
- Account for faculty, staff and students and sign in at the evacuation point. Report any missing or trapped people to the emergency responders. Keep existing groups together.

3.1.2 Evacuation of Persons with Disabilities

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

Assisting Visually Impaired Persons
• Announce the type of emergency.
• Offer your arm for guidance.
• Tell the person where you are going, and any obstacles you encounter.
• When you reach safety, ask if further help is needed.

Assisting People With Hearing Limitations
• Turn lights on/off to gain the person’s attention, or indicate directions with gestures, or write a note with evacuation directions.

Assisting People Using Crutches, Canes, or Walkers
• Evacuate these individuals as injured persons.
• Assist and accompany to evacuation site if possible, or use a sturdy chair (or one with wheels) to move the person, or help carry the individual.

Assisting Wheel Chair Users
• Non-ambulatory persons’ needs and preferences vary.
• Individuals at ground floor locations may exit without help.
• Others have minimal ability to move – lifting may be dangerous.
• Some non-ambulatory persons have respiratory complications.
• Remove them from smoke and vapors immediately.
• Wheelchair users with electrical respirators get priority assistance.
• Most wheelchairs are too heavy to take down stairs.
• Consult with the person to determine best carry options.
• Reunite the person with the chair as soon as it is safe to do so.

3.2 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.
- Terrorist actions or civil unrest.
3.2.1 Laboratory Emergency Shutdown Procedures

Each laboratory facility should develop a non-fire emergency plan or incorporate non-fire emergencies into a master emergency response plan. Employees must be trained on the contents of the plan and how to respond in a non-fire emergency. Binghamton EH&S has devised a set of simple steps for the shutdown of labs in non-fire emergency situations. These and other steps, based on the requirements of the facility, should be included in the emergency response plan of each 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 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 would include 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 – such as large cryogenic magnets, sources of radioactivity, and other pieces of equipment. Be sure to check any special operating procedures for your equipment before an emergency occurs.

3.2.2 Medical Emergency Procedures

- 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 UPD of the location, nature and extent of the injury by calling 911, 777-2393 from a cell phone or off campus 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.

3.2.3 Fire or Explosion Emergency Procedures

- 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 the building fire alarm system by pulling the handle on a fire alarm box.
- Notify UPD of the location and size of the fire by calling 911 from a campus phone, or 777-2393 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 established Emergency Evacuation Procedure. Once outside, notify emergency responders of the location, nature and size of the fire.
• If you have been trained and it is safe to do so, you may attempt to extinguish the fire with a portable fire extinguisher. If you have not been trained to use a fire extinguisher, you must evacuate the area.

3.2.3.1 Fire Extinguishers

• All fire extinguishers are inspected annually and maintained by EH&S.

• Laboratory personnel should perform regular visual checks (minimum on a monthly basis) to ensure fire extinguishers present in their labs are fully charged. For those fire extinguishers with a readout dial, labs only need to ensure the indicator arrow on the readout dial is within the green zone. If the indicator arrow is on either side of the green zone, which indicates a problem, call EH&S at 777-2211 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. You can also obtain training in using a fire extinguisher by contacting EH&S at 777-2211.

3.2.4 Power Outage Procedures

• Assess the extent of the outage in the area.
• Report the outage to Binghamton University Customer Service Center at 777-2226.
• Assist other building occupants to move to safe locations. Loss of power to fume hoods may require the evacuation of laboratories and surrounding areas.
• Implement the power outage plan. Evaluate the Departments work areas for hazards created by a power outage. Secure hazardous materials. Take actions to preserve human and animal safety and health. Take actions to preserve research.
• Turn off and/or unplug non-essential electrical equipment, computer equipment and appliances. Keep refrigerators and freezers closed throughout the outage to help keep contents cold.
• If needed, open windows (in mild weather) for additional light and ventilation.
3.2.5 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. Attempt to clean-up small spills, only if you are trained and have the proper spill clean-up materials available. Note: The following advice is intended for spills that occur within a University building. A release to the outside environment may to require the University file a report with the Environmental Protection Agency and/or the Department of Environmental Conservation. Calling University Police will initiate this determination by the Department of Environmental Health and Safety.

3.2.5.1 Small Spills

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

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

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

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

3.2.5.2 Small 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) Wash the contaminated surface with soapy water. If the spilled chemical is highly toxic, collect the rinse water for proper disposal.

11) Report the spill to your supervisor.

12) Restock any spill clean up supplies that you may have used from any spill kits.

3.2.5.3 Spill Absorbent Materials

Note: The following materials are EH&S recommended spill absorbent materials, however, they are not appropriate for every possible chemical spill – when in doubt, contact EH&S at 777-2211 for advice.
For acid spills (except Hydrofluoric acid):

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

For Hydrofluoric acid (HF) spills:

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

For 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).

For most aqueous solutions:

- Use ground corn cobs (SlikQwik)

For most organic liquid spills:

- Use ground corn cobs (SlikQwik). If the liquid is flammable, be sure to use an excess of SlikQwik.

For oxidizing liquids:

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

- Do not dispose of mercury or mercury contaminated spill debris in the regular trash or down the drain.
- Use mercury spills kits in spill buckets to clean up mercury spills.
- If you need help collecting Mercury from a spill, contact EH&S 777-2211. Note: While powdered sulfur will help reduce mercury vapors, the sulfur greatly complicates the spill cleanup.

3.2.5.4 Spill Kits

While commercially available spill kits are available from a number of safety supply vendors, laboratory personnel can assemble their own spill kits to properly clean up chemicals specific to their laboratory. Whether commercially purchased, made in-house, or provide by EH&S, every lab is required to have and maintain a spill bucket.

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

Spill kit absorbent material:

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

Equipment in the spill kit could include:

- Wisk broom and dust pan (available at home improvement stores)
- Sponge
- pH paper
- 1 gallon and 5 gallon bags - for collection of spill cleanup material
- Small and large Ziploc bags – for collection of spill cleanup material or to enclose leaking bottles/containers.
- Safety goggles
- Thick and thin Nitrile gloves
- Hazardous waste labels
The spill kit should be clearly labeled as “SPILL KIT”, with a list of the contents posted on or in the kit. This list should include information about restocking the kit after use and where to obtain restocking materials. Laboratory personnel must also be properly trained on:

- How to determine if they can or should clean up the spill, or if they should call 911 or EH&S at 777-2211.
- 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 can offer training on cleaning up small spills. More information can be obtained by contacting Environmental Health and Safety at 777-2211.

3.2.5.5 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 Binghamton Police are notified of a spill by calling 911 from a campus phone or 777-2393 from a cell phone.

3.2.5.6 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 nearby rooms that may be affected. If the hazard will affect the entire building, evacuate the building by pulling the fire alarm.

• Notify Binghamton University Police from a safe location by calling 911, using a campus Emergency Telephone, or dial 777-2393 from a cell phone.

Be prepared to provide Binghamton Police with the following information:

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

3.3 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. Hand held eyewash bottles are acceptable to use in conjunction with an eyewash, such as sink mounted or portable units.

Plumbed eyewash units and emergency showers should ideally have a tempering valve in place to prevent temperature extremes to the eyes or body. If you have questions about where eyewashes and emergency showers should be located, or which models meet ANSI standards, contact EH&S at 777-2211.

3.3.1  Testing and Inspection of Emergency Eyewash and Showers

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

It is the responsibility of laboratory personnel to activate (flush) units on a weekly basis. It is recommended to allow the water to run for at least 3 minutes. EH&S strongly encourages laboratories to post an “Eyewash Testing sign” near the eyewash to keep track and document that weekly activation is occurring.

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

If you discover your emergency shower or eyewash is not functioning properly, contact your Building Administrator to request an emergency work order.

EH&S performs free annual inspections of eyewashes and emergency showers. EH&S will test units for compliance with ANSI Z358.1-2004 including:
- Test the water flow for proper quantity, spray pattern, and good water quality.
- Ensure the unit is the proper height from the floor.
- Ensure the unit is not obstructed.
- Ensure the unit has a tempering valve (if the unit does not have a tempering valve, this will be identified as a recommended repair in the inspection report).
- Ensure valves are working properly.
- Ensure signs are posted.
- Ensure the unit is free of corrosion.

As with installation of new fume hoods and other capture devices, all new eyewashes and emergency showers must be installed in consultation with Physical Facilities, EH&S, and the appropriate technical shops.

In addition to ensuring proper installation of your new eyewash or emergency shower, by consulting with EH&S on new installations, your new eyewash or emergency shower will be added to our inventory to be included in our free annual inspection and testing program.

3.3.2 Using Emergency Eyewash and Showers

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 your fingers and roll your eyeballs around for 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! For accidents involving Hydrofluoric acid, follow the special Hydrofluoric acid precautions.

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 accident 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 campus phone or 777-2393 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! If you spill Hydrofluoric acid on yourself, follow the special Hydrofluoric acid first aid in section 3.4.3.

5) If you are alone, call 911 after you have finished flushing for at least 15 minutes.

6) Seek medical attention.

7) Complete an accident 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 911 from a campus phone or 777-2393 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 damage from flooding. The important thing to remember is to keep flushing for 15 minutes. If there is a large quantity of chemical spilled or washed off, please contact EH&S at 777-2211 to see if the rinsate needs to be collected as hazardous waste.

3.3.3 Hydrofluoric Acid First Aid

For splash:
1. YELL FOR HELP! – Stay calm
2. Go IMMEDIATELY to a shower (or sink) and wash contaminated area with water
3. Remove contaminated clothing while washing
4. Wash until all acid is removed from surface (limit washing to 5 minutes if calcium gluconate is available, otherwise wash until help arrives).
5. Dry area quickly and apply calcium gluconate gel to affected area and massage into skin (wear gloves). Do this until medical help arrives.
6. If HF is under nails, try to scrub the calcium gluconate underneath

* If you are alone dial 911 at this point

If in eyes: Hold eyes open and rinse in eyewash until help arrives – Do not use calcium gluconate gel in the eyes

If inhalation: Get victim to fresh air. If a first responder is there they should administer oxygen

** HF burn victims must always get medical treatment **
3.4 Accident Reporting

All accidents and injuries, no matter how minor, are required to be reported to University officials through the accident/injury reporting system. The supervisor of an injured employee, the department head, or a designated individual within the department must complete all sections of Accident form (CS-13) within 24 hours after the injury is first reported.

*It is the responsibility of the Principal Investigator and laboratory supervisor to ensure all accidents and injuries are reported to University officials through the use of the Binghamton University injury reporting system.*

3.5 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.

3.5.1 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). If you do not have a copy please contact EH&S at 777-2211

- 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.

3.5.2 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 facility in accordance with 29 CFR 1910.1020.
Access to employee exposure and medical records. Exposure monitoring records of contaminate levels in laboratories will be maintained at EH&S (777-2211).

4.0 EMPLOYEE INFORMATION AND TRAINING

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

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

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

- The contents of the Laboratory Standard and its appendices (Appendix A and Appendix B) shall be made available to employees.

- The location and availability of the employer’s Chemical Hygiene Plan (in the EH&S office, located in the Health Services Building).

- The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard (available through the MSDS for the substance).

- 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.*

4.1 Training Options

Principal Investigators and laboratory supervisors have a number of options available to them to ensure laboratory employees under their supervision have received proper training. These options include:

• Training programs provided by EH&S
• Training programs provided by outside vendors
• In-house training programs (provided by the Principal Investigator or laboratory supervisor)
• Training manuals and booklets
• Training videos
• Web-based training modules

The keys to any training programs are:
1) The instructor providing the training is technically qualified to provide training on the particular subject.

2) The training program(s) address the hazards present in the laboratory and describe ways employees can protect themselves.

3) The training program and attendance must be documented using a sign-in sheet and these records must be readily available and accessible upon request.

Please note that one training class is usually not comprehensive enough to cover all of the hazards found within a laboratory. Principal Investigators and laboratory supervisors will find that it is necessary to use a combination of the options available to ensure their employees are properly trained.

EH&S Training Programs
EH&S offers a number of training programs which you can request. For any “Upon Request” training class, EH&S can come to your building or laboratory and provide the training program for your laboratory group. All EH&S provided training programs and attendance sheets are kept on file at the EH&S office.

Outside Vendor Training Programs
Principal Investigators and laboratory supervisors can provide training programs to their employees through contracts with outside training companies or product vendors. A number of vendors are willing to provide free training programs upon request. If using an outside company or vendor, be sure to ask for documentation including training content, date of training, copies of handouts, and the sign-in sheet. All of this documentation must be kept on file.

In-House Training Programs
In-house training can include department provided training, and training by Principal Investigators and laboratory supervisors. Training sessions can be stand-alone classes, on-the-job training, or short trainings incorporated as part of a laboratory group meeting. The key is to make sure the training is documented with a sign-in sheet.

Training Manuals and Booklets
Principal Investigators and laboratory supervisors can utilize training manuals, booklets, webpage downloads, etc., as part of an ongoing training program by simply having laboratory staff review the material, be given an opportunity to ask any questions, and sign off that they read and understood
the material. All training material must be retained as part of training records.

Training Videos
Principal Investigators and laboratory supervisors can make use of videos to supplement training of their employees. As with any training, it is important to document the training took place by using a sign-in sheet. When videos are used, the training sign-in sheet should have the date, time, location, and name and running time of the video, in addition to signatures of those people who watched the video.

5.0 SAFE CHEMICAL USE

Laboratory personnel can safely handle and use chemicals. Topics include: minimizing exposure to chemicals, proper training, understanding chemical hazards, proper labeling, proper storage and segregation, and proper transport.

5.1 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 experiments whenever possible.

- Always use the smallest possible quantity of chemical for all experiments. Consider microscale 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 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.

• Contact EH&S at 777-2211 to 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.

• When working in cold rooms, keep all toxic and flammable substances tightly closed as cold rooms have recirculated atmospheres.

• Be aware of the potential asphyxiation hazard when using cryogenic materials and compressed gases in confined areas such as cold rooms and environmental chambers. If necessary, install an oxygen monitor/oxygen deficiency alarm and/or toxic gas monitor before
working these materials in confined areas. Contact EH&S at 777-2211 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.

5.2 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.” Separate sections on physical hazards will be covered in later in this manual.

### 5.2.1 Chemical Hazard Information

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

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

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

- This Laboratory Safety Manual
- **Known reference materials** (EH&S maintains a reference library)
- Training videos
- Other **department’s safety manuals**
- Material Safety Data Sheets (MSDSs)
- Websites
- **EH&S Training Programs**
- Departmental Safety Committees
- Container labels
- Laboratory **Standard Operating Procedures**

### 5.2.2 Material Safety Data Sheets

Material Safety Data Sheets (MSDSs) are an important part of any laboratory safety program in communicating information to chemical users. MSDSs provide useful information such as:
• The identity of the chemical substance.
• Physical and chemical characteristics.
• Physical and health hazards.
• Primary routes of entry.
• OSHA Permissible Exposure Limits (PELs).
• Carcinogenic and reproductive health status.
• Precautions for safe handling and use (including PPE).
• Spill response procedures.
• Emergency and first aid questions.
• Date the MSDS was prepared.

Any chemical shipment received should be accompanied by an MSDS (unless one has been shipped with a previous order). If you do not receive an MSDS with your shipment, check the chemical manufacturers website first (or call the manufacturer directly), or check the web, or contact EH&S at 777-2211 to request assistance.

If you have questions on how to read MSDSs, or questions about the terminology or data used in MSDSs, you can contact EH&S at 777-2211 for more information. Additional information, including how to read an MSDS, can be found in the MSDS FAQ and a glossary of terms used on MSDSs can be found in the “Hyperglossary”. Information on the National Fire Protection Association - NFPA diamond and the Hazardous Materials Information Guide and Hazardous Materials Information System – HMIG and HMIS is also available.

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

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

EH&S strongly encourages paper copies of MSDSs be kept in the laboratory, however, having MSDS websites bookmarked is acceptable as long as all employees in the workplace know where to find the MSDS and are trained on the use of computers to access MSDSs. If a laboratory chooses to use electronic access, then EH&S recommends the MSDS website link be posted
on the computer or in another conspicuous location. Some departments maintain three ring binders with MSDSs.

Any accidents involving a chemical will require an MSDS 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 MSDS for any hazardous chemical found in the lab within five minutes.

5.2.3 MSDSs and Newly Synthesized Chemicals

Principal Investigators will be responsible for ensuring that newly synthesized chemicals are used exclusively within their laboratories and are properly labeled. If the hazards of a chemical synthesized in the laboratory are unknown, then the chemical must be assumed to be hazardous and the label should indicate the potential hazards of that substance have not been tested and are unknown.

The Principal Investigator must ensure a MSDS is prepared for newly synthesized chemicals if:

- The chemical is hazardous according to the OSHA definition of hazardous (if the hazards are not known, then the chemical must be assumed to be hazardous).

AND

- The newly created chemical or intermediate compound is going to be transferred to a different researcher or testing lab on or off of the Binghamton University campus.

OR

- The newly created chemical or intermediate compound is going to be kept in the lab for an on-going basis for use by current and/or future researchers in the lab where it was originally made.

OR

- The newly created chemical or intermediate compound is going to be provided to another research group at Binghamton University.
Additional information on developing MSDSs can be found in the MSDS FAQ. A blank MSDS form (OSHA Form 174) can be found on the OSHA website. A description of how to fill out an MSDS can be found in the appendix.

5.3 Routes of Chemical Entry

The potential health effects 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 mixture 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 do damage. The four main routes of entry are inhalation, ingestion, injection, and absorption through the skin and eyes.

5.3.1.1 Inhalation

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

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

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

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

Symptoms of chemical exposure through ingestion include metallic or other strange tastes in the mouth, stomach discomfort, vomiting, problems swallowing, and a general ill feeling. If you think you may have accidentally ingested a chemical, seek medical attention immediately and/or call the Poison Control Center at 1-(800) 222-1222 or University Police at 911 from a campus phone or (607) 777-2393 from a cell phone or off campus phone. After seeking medical attention, complete an accident report.

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

5.3.1.3 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 plasticware 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 try to 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. For other items that can cause cuts or puncture wounds, such as needles and razor blades, never leave these items out in the open where someone could come into contact with them. EH&S recommends using a device such as a piece of Styrofoam or similar item to secure them for later use. For disposal, use an appropriate “sharps” container.

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

5.3.1.4 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, 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 accident report.

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

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

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

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

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

5.3.2 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 K.

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

5.3.3 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. The EH&S Occupational Health and Safety Section can help evaluate the effectiveness of your controls by monitoring exposures to a variety of laboratory materials. Exposure monitoring is the determination of the airborne concentration of a hazardous material in the work environment. Exposure monitoring data is compared to existing OSHA and ACGIH exposure guidelines and is often used to make recommendations concerning engineering controls, work practices, and PPE.

If you think you are receiving a chemical exposure in excess of OSHA exposure limits, such as feeling symptoms commonly associated with exposure to hazardous materials, or work with any of the chemicals listed
below, contact EH&S at 777-2211 and our staff 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. Chemicals that fall into this category include:

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

Other substances that have exposure monitoring requirements include:

- Lead
- Cadmium
- Silica

5.3.4 Toxicity

Toxicity refers to the ability of a chemical to cause harmful effects to the body. As was described by Paracelsus (1493-1541):

“What is it that is not poison? All things are poison and nothing is without poison. It is the dose only that makes a thing not a poison.”

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

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

5.3.4.1 Toxic Effects

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

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

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

5.3.4.2 Evaluating Toxicity Data

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

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

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

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

<table>
<thead>
<tr>
<th>Toxicity Class</th>
<th>Animal LD50</th>
<th>Probable Lethal Dose for 70 kg Person (150 lbs.)</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super Toxic</td>
<td>Less than 5 mg/kg</td>
<td>A taste (7 drops or less)</td>
<td>Botulinum toxin</td>
</tr>
</tbody>
</table>
### 5.4 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. It is also important to note several factors can have influence the hazards of chemicals:

- 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.).

All of these factors can influence how a chemical will behave and the hazards the chemical presents. It is important to note here that MSDSs and other chemical resources provide information related to the specific hazards a chemical possesses in addition to any special storage, handling, and use requirements.

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 (which will be discussed in the Chemical Segregation section and where appropriate, will be noted as such). A general description of the hazards of various chemical functional groups can be found in the appendix.

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<table>
<thead>
<tr>
<th>Hazard Level</th>
<th>Hazard Range</th>
<th>Quantity</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Toxic</td>
<td>5 - 50 mg/kg</td>
<td>&lt; 1 tsp</td>
<td>Arsenic trioxide, Strychnine</td>
</tr>
<tr>
<td>Very Toxic</td>
<td>50 - 500 mg/kg</td>
<td>&lt; 1 oz</td>
<td>Phenol, Caffeine</td>
</tr>
<tr>
<td>Moderately Toxic</td>
<td>0.5 - 5 g/kg</td>
<td>&lt; 1 pt</td>
<td>Aspirin, Sodium chloride</td>
</tr>
<tr>
<td>Slightly Toxic</td>
<td>5 - 15 g/kg</td>
<td>&lt; 1 qt</td>
<td>Ethyl alcohol, Acetone</td>
</tr>
</tbody>
</table>

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

5.4.1 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 777-2211 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, 2,4-Dinitrophenyl 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 777-2211 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)

5.4.2 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. An important point to keep in mind is 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.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Flash Point</th>
<th>Boiling Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flammable Liquid</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class IA</td>
<td>&lt; 73 degrees F</td>
<td>&lt; 100 degrees F</td>
</tr>
<tr>
<td>Class IB</td>
<td>&lt; 73 degrees F</td>
<td>&gt; = 100 degrees F</td>
</tr>
<tr>
<td>Class IC</td>
<td>&gt; = 73 degrees F, &lt; 100 degrees F</td>
<td>&gt; 100 degrees F</td>
</tr>
<tr>
<td><strong>Combustible Liquid</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class II</td>
<td>&gt; = 100 degrees F, &lt; 140 degrees F</td>
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</tr>
<tr>
<td>Class IIIA</td>
<td>&gt; = 140 degrees F, &lt; 200 degrees F</td>
<td>--</td>
</tr>
<tr>
<td>Class IIIB</td>
<td>&gt; = 200 degrees F</td>
<td>--</td>
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</tbody>
</table>

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 Binghamton University 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 at 777-2211 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.

5.4.2.1 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 - $5000 each. In the case of limited funding where a laboratory cannot purchase a flammable storage refrigerator for the laboratory’s own use, EH&S strongly encourages departments and laboratory groups on each floor consider purchasing a communal flammable storage refrigerator for the proper and safe storage of flammable liquids.

5.4.2.2 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 at 777-2211 for more information.

5.4.3 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.

5.4.3.1 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.

5.4.3.2 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, contact EH&S at 777-2211 for more assistance.

5.4.4 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 an 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 kept 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 autoignition temperatures for these compounds and ensure any device used to heat oxidizers has an overtemperature 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 at 777-2211. Indicate on the hazardous waste tag that the chemical is an oxidizer or organic peroxide and that you suspect contamination.
5.4.4.1 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 the motion of 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:

1) 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. Those compounds in the appendix designated as Class III should be disposed of within 3 months of opening and those compounds in the appendix designated as Class I and Class II should be disposed of within 12 months of opening.

2) Each peroxide forming chemical container must be tested for peroxides when opened and at least every 3 months thereafter. The results of the peroxide test and the test date must be marked on the outside of the container.

3) Peroxide test strips can be purchased from the Science Stores or from a variety of safety supply vendors, such as VWR and Laboratory Safety Supply. 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. 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.

4) Due to sunlight’s ability to promote formation of peroxides, all peroxidizable compounds should be stored away from heat and sunlight.

5) 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.

6) 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.

7) 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.

8) 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.

9) 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 777-2211 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.

The appendix 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.
5.4.5 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 also draws a distinction between toxic chemicals and acutely toxic chemicals. For more information on acutely toxic chemicals, see Particularly Hazardous Substances. 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. Material Safety Data Sheets (MSDS) 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 Exposure Monitoring section and Routes of Chemical Entry section.

If you think you may have received an exposure 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 University Police at 911 from a campus phone or (607) 777-2393 from a cell phone or off campus phone. If possible, bring a copy of the MSDS with you. Upon completion of seeking medical attention, complete an accident report.

5.4.6 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 accident 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 accident report.
Please note some chemicals, such as Hydrofluoric acid, require the use of a special antidote (such as Calcium gluconate gel) and special emergency procedures. Read the MSDSs for any chemical(s) you work with to determine if a special antidote is needed if a chemical exposure occurs.

5.4.6.1 Perchloric Acid

Perchloric acid is a strong oxidizing acid that can react violently with organic materials. Perchloric acid can also explode if concentrated above 72%. For any work involving heated Perchloric acid (such as in Perchloric acid digestions), the work must be conducted in a special Perchloric acid fume hood with a wash down function. If heated Perchloric acid is used in a standard fume hood, the hot Perchloric acid vapors can react with the metal in the hood ductwork to form shock sensitive metallic perchlorates. When working with Perchloric acid, be sure to remove all organic materials, such as solvents, from the immediate work area. Due to the potential danger of Perchloric acid, if possible, try to use alternate techniques that do not involve the use of Perchloric acid. If you must use Perchloric acid in your experiments, only purchase the smallest size container necessary.

Because Perchloric acid is so reactive, it is also important to keep it stored separate from other chemicals, particularly organic solvents, organic acids, and oxidizers. All containers of Perchloric acid should be inspected regularly for container integrity and the acid should be checked for discoloration. Discolored Perchloric acid should be discarded as hazardous waste. Perchloric acid should be used and stored away from combustible materials, and away from wooden furniture. Like all acids, but particularly with Perchloric acid, secondary containment should be used for storage.

5.4.6.2 Hydrofluoric Acid

Hydrofluoric Acid (HF) is one of the most hazardous chemicals at used Cornell. Small exposures to HF can be fatal if not treated properly. The critical minutes immediately after an exposure can have a great effect on the chances of a victim’s survival.

HF is a gas that is dissolved in water to form Hydrofluoric acid. The concentration can vary from very low such as in store bought products up to the most concentrated 70% form (anhydrous), with the most common lab use around 48%. The liquid is colorless, non-flammable and has a pungent odor. The OSHA permissible exposure limit is 3 ppm, but concentrations should be kept as low as possible. HF is actually a weak acid by definition and not as corrosive as strong acids such as Hydrochloric (HCl), however, corrosivity is the least hazardous aspect of HF. The toxicity of HF is the main
concern.

HF is absorbed though the skin quickly and is a severe systemic toxin. The fluoride ion binds calcium in the blood, bones and other organs and causes damage to tissues that is very painful and can be lethal. At the emergency room, the victim is often given calcium injections, but pain medication is not generally given since the pain subsiding is the only indication that the calcium injections are working.

Due to the serious hazard of working with HF, the following requirements and guidelines are provided:

- All users of HF must receive training from supervisor and provide EH&S with proof of training prior to working with Hydrofluoric Acid.

- A Standard Operating Procedure (SOP) must be written for the process in which HF is used. This SOP should be posted or readily available near the designated area where HF use will occur.

- HF should only be used in a designated fume hood and the fume hood should be identified by posting a HF Designated Area sign.

- **First Aid** - An HF first aid kit must be available that includes 2.5% calcium gluconate gel. The Calcium gluconate gel can be obtained through EH&S and should be replaced with new stock annually. The Hydrofluoric Acid First Aid sign should be posted in a prominent place where the Calcium gluconate gel is located.

- **Spill Kits** - An HF spill kit must be available with calcium compounds such as Calcium carbonate, Calcium sulfate or Calcium hydroxide. Sodium bicarbonate should never be used since it does not bind the fluoride ion and can generate toxic aerosols.

- **Prior approval** - Before anyone uses HF they must have prior approval from the Principal investigator. The names of lab personnel should be added to an HF Prior Approval form showing that they have are familiar with the following:
  
  - Has read the MSDS for HF
  - Has read the HF Use SOP developed by the lab
  - Has read the Hydrofluoric acid section in this Lab Safety Manual
  - Is aware of the designated area for HF use
- Knows the first aid procedure in case of an HF exposure
- Knows what to do in case of an HF spill

- Personal Protective Equipment (PPE) – The following PPE is required for HF use:
  - Rubber or plastic apron
  - Plastic arm coverings
  - Gloves
    - Incidental use - double glove with heavy nitrile exam gloves and re-glove if any exposure to the gloves
    - Extended use – heavy neoprene or butyl over nitrile or silver shield gloves
  - Splash goggles in conjunction with a fume hood sash
  - Closed toed shoes
  - Long pants and a long sleeve shirt with a reasonably high neck (no low cut)

The following are safe practice guidelines when working with HF:

- Never work alone with HF. Use the buddy system.
- Use a plastic tray while working with HF for containment in case of a spill.
- Keep containers of HF closed. HF can etch the glass sash of a hood and make it hard to see through.
- Material Safety Data Sheet (MSDS) – A MSDS for HF must be available.
- All containers of HF must be clearly labeled. EH&S recommends using Right-To-Know labels for all non-original containers.
- The stock HF should be stored in plastic secondary containment and the cabinet should be labeled. HF should be stored in lower cabinets near the floor.
• Wash gloves off with water before removing them.

Additional information on the safe use and handling of Hydrofluoric acid (HF) can be found on the Honeywell website - the world’s largest producer of Hydrofluoric Acid. This website contains useful information on HF such as:

• Material Safety Data Sheets
• Technical Data Sheets
• Recommended Medical Treatment for HF exposure
• HF Properties charts
• Online Training

5.5 Chemical Labeling

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

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

5.5.1 Non-Original Containers

Non-original containers (secondary use containers) such as wash bottles, squirt bottles, temporary storage containers, beakers, flasks, bottles, vials, etc. or any container that a chemical from an original container is transferred into, must be properly labeled. In general, EH&S recommends writing out the full chemical name and any hazards associated with that chemical.
Laboratory personnel are strongly encouraged to use commercially available pre-labeled containers (such as squirt bottles) for chemicals that get used frequently. However, labs can also choose to label chemical containers in other ways such as:

1) **EH&S labeling sticker**
   EH&S strongly encourages laboratories to take advantage of our FREE labeling stickers found in the Science Store (Science 2 B71) for hazardous chemicals in non-original containers, especially for containers that are used for the same purpose repeatedly, or are used slowly over time.

2) **Abbreviations – Structures and Formulas**
   Use of abbreviations such as structures, formulas, or acronyms is acceptable. However, if you use any abbreviations, you must hang up a “key” to the abbreviations in a visible location (preferably close to the chemicals and/or by the door). The “key” must contain the abbreviation and the name of the chemical. Including the hazards of the chemical on the “key” is also useful information. The abbreviation key must be readily available upon request by visitors, emergency responders, and state and federal regulatory agencies such as EPA, OSHA, or New York State Office of Fire Prevention inspectors.

3) **Small Containers and Sample Storage**
   For small containers, such as vials and eppendorf tubes, which may be too small to write out a chemical name, structure, or formula, laboratories can implement other systems to identify the chemicals such as:
   
   - Placing the vial or small container in a Ziploc bag or other type of overpack container (beaker, plastic bottle, etc.) and labeling the overpack container with the chemical name.
   
   - Laboratories can use “price tag” style labels in which the chemical name is written out on a tag, and the tag is then attached to the small container with string or a rubber band.
   
   - For vials in a test tube rack – laboratory personnel can simply label the rack with the chemical name, and then label the vials with an abbreviation, color, number, or letter code that corresponds to the label on the test tube rack. For example, if a lab had 10 small vials of ethanol in one rack, the rack could be labeled a 1-E = Ethanol. All of the vials would then be labeled as 1-E. Be sure that the
number or letter code is clearly identifiable and would not be confused with other chemicals in the lab.

- For preserved specimens, bottles should be labeled with the preservative (i.e. ethanol or formaldehyde). A large number of these labels could easily be produced on the computer using Avery style mailing labels.

- For sample storage in refrigerators, laboratory personnel should label sample containers with one of the above methods, including labeling boxes that hold the small vials or chemical containers. Laboratories should include a key to any abbreviations on the outside of the refrigerator and label the key as “Sample Storage abbreviation = chemical name”.

4) Number, Letter, and Color Codes
For vials and other small containers, laboratory personnel can make use of number, letter, and color-coded systems as long as a “key” is hung up which clearly identifies the chemical name that the number, letter, or color code represents. While this type of system is available for laboratory personnel to use, EH&S does not recommend using such a system for hazardous chemicals. Such a system would be more appropriate for non-hazardous compounds such as agar and buffer solutions.

*** Please keep in mind that some laboratory workers may be color-blind. This fact needs to be taken into consideration, BEFORE a color-coding system is used.

5.5.2 Labeling Requirements

In all cases, regardless of the labeling system used, the following labeling requirements must be followed:

- All chemical containers (both hazardous and non-hazardous) MUST be labeled. Chemical names must be written out in English. If a label is starting to fall off a chemical container or is becoming degraded, then the container needs to be relabeled (using tape, permanent marker, EH&S chemical labeling sticker.) or the chemical needs to be transferred to another properly labeled container.
• If abbreviations such as formulas, structures, or acronyms are used, then a “key” to the abbreviations must be hung up in a conspicuous location.

• All personnel working in the laboratory must be fully trained on how to label chemicals using the system and how to understand the labeling system. Training must occur when a new person begins working in the laboratory, when new chemicals are introduced, and should occur on a regular basis – annually at a minimum.

5.6 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.

5.6.1 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.
• All chemical containers MUST be labeled. Labels should include the name of the chemical constituent(s) and any hazards present. Be sure to check chemical containers regularly and replace any labels that are deteriorating or falling off and/or relabel with another label before the chemical becomes an unknown.

• 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 towards 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 a bottle 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 get used up 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 get used up 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 get 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.

• Be aware of any special antidotes or medical treatment 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.

### 5.7 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 5-gallon 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 also 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 transporting or shipping any hazardous chemicals off the main campus, be aware there are specific procedures,
training and other legal requirements that must be followed. For more information, refer to the Shipping Hazardous Materials section.

5.8 Chemical Segregation

Chemicals should be stored according to compatibility and hazard classes. Rather than store chemicals alphabetically, or by carbon number, or by physical state, etc., EH&S recommends that you segregate them by DOT hazard class first.

The potential hazards of storing incompatible chemicals together, and when an emergency occurs, include:

- Generation of heat.
- Possible fires and explosion.
- Generation of toxic and/or flammable gases and vapors.
- Formation of toxic compounds.
- Formation of shock and/or friction sensitive compounds.
- Violent polymerization.

The benefits of chemical segregation by hazard class include:

- Safer chemical storage.
- Understanding the hazards a chemical exhibits will increase your knowledge about the chemical.
- Identifying potentially explosive chemicals.
- Identifying multiple containers of the same chemical.

There are a number of segregation schemes recommended in the literature by government agencies, chemical manufacturers, safety supply companies, and other universities. However, EH&S is recommending segregation of chemicals using a modified version of the Department of Transportation (DOT) Hazard Class System. While this modified DOT system results in most common chemicals being segregated properly, there is no one system that solves all problems. The modified DOT system is less complicated than other segregation schemes and the information to make decisions of which hazard classes to use can easily be found in MSDSs, container labels, container markings and stickers, and other resources.

Please note that DOT hazard classes segregate chemicals according to the hazards posed during transportation and not necessarily based on health
hazards. Keep in mind that chemicals do not always fall neatly into one hazard class and can pose multiple hazards – including both physical and health hazards (such as flammable liquid, corrosive or flammable liquid, poison).

When you are making decisions on how to segregate, keep in mind the following:

- Physical hazards of the chemical.
- Health hazards of the chemical.
- The chemical form (solid, liquid or gas).
- Concentration of the chemical.

Segregation of different chemical hazard classes (such as acids and bases) can occur in the same cabinet as long as there is some form of physical separation, such as using trays with high sides or deep trays. However never store oxidizers and flammables in the same cabinet. Also, do not store compounds such as inorganic cyanides and acids in the same cabinet.

Once chemicals have been separated, ensure everyone in the lab knows the process and what system is being used. It is best to clearly identify where chemicals in each hazard class will be stored by labeling cabinets with signs, or hazard class labels. These can be purchased from a safety supply company or you can create your own.

If you need assistance with cleaning out your lab of old and excess chemicals, or would like assistance with segregating your chemicals, contact EH&S at 777-2211. EH&S also offers a training class on Chemical Segregation.

For more information on reading chemical container labels see the following manufacturer’s webpages:

- Fisher Scientific labels
- JT Baker labels
- Mallinckrodt labels
- Sigma labels

Examples of incompatible chemicals can be found in the appendix.

5.8.1 EH&S Modified DOT Hazard Class System
The basic DOT hazard classes and hazard class numbers are:

<table>
<thead>
<tr>
<th>DOT Hazard Class Number</th>
<th>Hazard Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Explosives</td>
</tr>
<tr>
<td>Class 2</td>
<td>Compressed gases</td>
</tr>
<tr>
<td>Class 3</td>
<td>Flammable liquids</td>
</tr>
<tr>
<td>Class 4</td>
<td>Flammable solids</td>
</tr>
<tr>
<td>Class 5</td>
<td>Oxidizers</td>
</tr>
<tr>
<td>Class 6</td>
<td>Poisons</td>
</tr>
<tr>
<td>Class 7</td>
<td>Radioactive materials</td>
</tr>
<tr>
<td>Class 8</td>
<td>Corrosives</td>
</tr>
<tr>
<td>Class 9</td>
<td>Store with Class 6</td>
</tr>
</tbody>
</table>

The DOT hazard class numbers can be found on hazard class labels, in MSDSs (under the “Transportation Information Section”), on container labels, and in other reference texts. An explanation of the DOT Hazard Class system can be found in the DOT Training Modules.

The EH&S chemical segregation scheme modifies the DOT system by breaking down hazard classes into subcategories. A handout on the EH&S Chemical Segregation Scheme can be found in the appendix.

6.0 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 be given to the following provisions where appropriate:

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

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

6.1.1 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 procedures as well. These and other special precautions should be included within the lab’s SOPs.

6.1.2 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 at hazwaste@binghamton.edu or 777-2211 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.

6.1.3 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 if special
decontamination procedures are required. If they are required, this information should be included in all laboratory’s SOPs and appropriate training needs to be provided to laboratory personnel who work with these chemicals.

6.2 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 to keep exposures to a minimum.

- Always obtain prior approval from the Principal Investigator before ordering any particularly hazardous substances.

- Plan your experiment out in advance, including layout of apparatus and chemical and waste containers that are necessary.

- Before working with any particularly hazardous substance, review chemical resources for any special decontamination/deactivation procedures and ensure you have the appropriate spill cleanup materials and absorbent on hand.

- Ensure that you have the appropriate PPE, particularly gloves (check glove selection charts or call EH&S at 777-2211).

- 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) 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.

6.3 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.

6.3.1 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 or Bio Safety Officer at 777-2211.
• Recombinant DNA use – contact the Institutional Biosafety Committee or the Bio Safety Officer at 777-2211.

• Use of Radioactive Materials – contact the Radiation Safety Officer (RSO).

• Use of Human Subjects - contact the Institutional Review Board (IRB).

6.4 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 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.
With regard to mixtures, OSHA requires that a mixture “shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of **0.1% or greater**, which is considered to be carcinogenic.” When working with carcinogens, laboratory staff should adhere to **Guidelines for Working with Particularly Hazardous Substances**.

Note that the potential for carcinogens to result in cancer can also be dependent on other 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.

### 6.5 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.

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.

6.6 Acute Toxins

OSHA defines a chemical as 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. In addition to following the Guidelines for Working with Particularly Hazardous Substances, additional guidelines for working with acute toxins include:

- Consider storing highly toxic materials in a locked storage cabinet.

- Be aware of any special antidotes that may be required in case of accidental exposure (Hydrofluoric acid and inorganic cyanides for example).

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

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

7.0 HAZARDOUS CHEMICAL WASTE DISPOSAL

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

EH&S provides the following chemical waste compliance services:

• Management of University hazardous waste storage area.
• Collection of chemical waste from laboratories.
• General compliance assistance.
• Work space consultations.

7.1 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) Determine if chemical deactivation or drain disposal is an option.

3) Label containers of hazardous chemical wastes with the identity of the chemical(s) AND the words “Hazardous Waste” or label with a Binghamton University Hazardous Waste label.

4) Keep containers of hazardous chemical wastes closed at all times when they are not in use.
5) Store the hazardous waste containers within the room in which they are generated in.

Recommended practices that should be followed:

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

_It is the responsibility of the 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._

7.2 Hazardous Waste Pickup Procedures

To have your hazardous waste picked up by EH&S, please complete the following procedures:

1) Place an EH&S Hazardous Waste label on each container.
   a. Labels are available from the science store located in the basement of Science 2 or
   b. By sending an email to hazwaste@binghamton.edu

2) Fill out the waste label and list all of the ingredients (no trade names or chemical formulas, please). Do not put a date on the tag until you are ready to dispose of the waste through EH&S.

3) Send an email to hazwaste@binghamton.edu requesting a waste pickup with an inventory of the waste you have.

4) EH&S will collect the waste during the next schedule waste pickup (Hazardous Waste Schedule).

The following types of materials have different requirements for disposal:

- Biohazardous materials
- Construction debris (such as asbestos and lead)
- CRTs (computer monitors and televisions)
- Radioactive materials
- Scrap electronics (circuit boards)
• Used oils
• Universal Waste (Fluorescent bulbs, batteries)

If you need further information, refer to the Hazardous Waste Guide, or call EH&S at 777-2211, or e-mail hazwaste@binghamton.edu.

8.0 HAZARDOUS MATERIAL SHIPPING

The transport of hazardous materials is regulated by the U.S. Department of Transportation (DOT) and the International Civil Aviation Organization. An additional regulatory body formed by the airlines is called the International Air Transport Association (IATA); however, their regulations are only enforceable by the airlines. All University transportation (including shipping) of hazardous materials off University owned property is subject to DOT enforcement.

8.1 Regulated Hazardous Materials

The following materials are regulated as hazardous materials for transportation:

• Alcohol solutions
• Compressed gases
• Corrosives
• Dry Ice (air shipments only)
• Explosives
• Flammable liquids and solids
• Formaldehyde - solutions between 0.1% and 25% (air shipments only)
• Infectious substances (animals and humans only)
• Oxidizers
• Poisons
• Radioactive materials

*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 has received the proper training.*

For any other questions, contact EH&S at 777-2211 or visit our webpage at ehs.binghamton.edu.
9.0 PESTICIDES

A pesticide is defined as a substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest, or intended for use as a plant regulator, defoliant or desiccant.

1) EPA Registered Pesticides (the EPA registration number can be found on the manufacturer’s label).

2) Those experimental chemicals for which a pesticidal effect has been determined.

All university personnel (includes faculty members, staff members, students, and any other university-affiliated individuals) who label, store, use, transport, dispose of, or clean up spills of pesticides are responsible for adhering to federal and state regulations.

It is essential that teaching, research, extension, and ground maintenance involving pesticide use be conducted properly and legally for the protection of the pesticide applicator, other employees, staff, students, public health, and the environment.

The responsibility for ensuring that all work with pesticides at Binghamton is conducted properly and legally rests on the individual user.

9.1 Pesticide Certification

Binghamton University requires that all individuals handling pesticides as a part of university programs must be NYS certified pesticide applicators.

9.1.1 Exemptions from Pesticide Certification

As per state and federal regulations, a number of exemptions exist from pesticide certification requirements. These exemptions include:

1) Licensed veterinarians, as well as licensed veterinary technicians, interns, residents, and veterinary students working under the direct supervision of a veterinarian in a veterinary facility are exempt from the certification requirement when engaged in the use of general-use pesticides.

2) Small laboratory quantities of pesticides used for analysis and
treatment of samples in a laboratory and in an environmentally non-dispersive manner (e.g., microgram or gram quantities used inside a fume hood, mixed into media, etc.) are exempt from policy requirements. As with all other chemical use in the laboratory, use of laboratory quantity pesticides is regulated by the OSHA Laboratory Standard and other appropriate rules and regulations.

3) Testing of materials for pesticide efficacy, toxicity, or other properties could also be exempted - for clarifications refer to the federal regulation: 40 CFR part 172.3.

4) Teaching/demonstration of pesticide application(s), as well as recommendation of pesticide application or use is exempted from the certification requirements. However, the individual engaged in such activities is responsible for ensuring that these activities are compliant with federal, state, and local pesticide laws and regulations.

When using pesticides in a non-dispersive manner in a laboratory setting, an individual must follow the safety rules outlined in the Binghamton University Laboratory Safety Manual.

10.0 BIOHAZARDS

Complete information on the Biosafety Program at Binghamton can be found on the EH&S Biological Safety webpage.

10.1 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 completed application 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 University policies.

10.1.1 Recombinant DNA
Binghamton University requires that all recombinant DNA work done at the University 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.

10.1.2 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, chlamydial, and prion agents.

See the following links 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)

10.1.3 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 EH&S. 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.

10.2 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. Binghamton University 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.

Lastly, all persons having direct or indirect contact with animals used in research and teaching must be included in the Laboratory Animal Research Occupation Health and Safety (LAR OHS) program. The LAR OHS has responsibility for establishing institutional occupational health and safety policy and procedures for animal users and other individuals having contact with animals used in research and teaching.

10.3 Human Subjects

The institution’s official Institutional Review Board (IRB), is responsible for all research projects which involves human subject. All research projects that use human subjects -- regardless of the source of funding -- must be reviewed and approved by the IRB before the investigator may commence with the study. Research investigators may not make the final determination of exemption from applicable Federal regulations or provisions of Binghamton’s Assurance. Only the IRB Administrator or a committee member 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 Binghamton University.

All BU 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 Institutional Review Board (IRB).
10.4 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](https://www.transportation.gov).

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.

Contact EH&S at 777-2211 for training inquiries and alternative shipping options.
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. Include a courtesy letter in the shipment.

**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](#) page.

**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](#).

10.5 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.

Contact the Biological Safety Officer at EH&S at 777-2211 to determine the appropriate cabinet for your applications and space. BSCs may be purchased from a variety of vendors including, but not limited to:

• **Baker**
• **Labconco**
• **NuAire**
• **Thermo Forma**
10.5.1 Biological Safety Cabinet Certifications

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

- 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. Some available contractors that can provide service here on campus include:

- Certification if coordinated by the biosafety officer at 777-2211

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.*

10.5.2 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 for potential contamination.

10.5.3 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.

10.5.4 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.

10.5.5 Types of Biological Safety Cabinets

Biological safety cabinets are divided into 3 classifications: Class I and Class II cabinets, and the total containment Class III cabinets. Class II cabinets are the most common type of cabinet used on campus.

- **Class I**: The Class I biological safety cabinet is designed to provide personnel and environmental protection only. Unfiltered air is directed through the front opening, across the work area and out through the HEPA filter on top. This cabinet is conventionally used with a full width open front, or can be used with an attached armhole front panel with or without attached rubber gloves. Although Class I cabinets are simple and economical, and radioisotopes and some toxic chemicals can be used (if the exhaust is ducted to the outside), filtered air is not provided over the work area. These cabinets do not protect your materials from contaminants introduced from the environment or the operator.

- **Class II**: A Class II cabinet meets the requirements for the protection of product, personnel, and the environment. The capacity to protect materials within the cabinet is provided by the flow of HEPA-filtered
air over the work surface. There are four subtypes of Class II cabinets based on the construction, inflow air velocities, and exhaust systems. These cabinets can be used to manipulate low to moderate risk agents.

- **Class IIA1**: Air, at a face velocity of 75 lfpm, is drawn into the front grille of the cabinet away from the work surface. HEPA-filtered air is directed downward over the work area. As the air approaches the work surface, the blower part of the air is directed through the front grille and the remainder through the rear grille. From a common plenum, approximately 70% of the air is recirculated to the work zone through a HEPA filter and about 30% is exhausted to the room through another HEPA filter. This cabinet is unsuitable for work that involves radioactive materials and toxic chemicals because of the buildup of vapors in the air recirculated within the cabinet and exhausted out into the laboratory.

- **Class IIA2**: This cabinet has a face velocity of 100 lfpm. About 70% of the air directed over the work surface is recirculated through a HEPA supply filter, and about 30% is exhausted through a HEPA exhaust filter. Exhaust air can be directed to the room or to a facility exhaust system. Minute amounts of toxic chemicals and trace amounts of radioisotopes can be used within the hood (if used with facility exhaust), although activities should be conducted toward the rear of the cabinet.

- **Class IIB1**: This cabinet has a face velocity of 100 lfpm. In contrast to the A2 cabinet, approximately 70% of the circulated air passes through a HEPA exhaust filter, whereas the remaining 30% of the air is recirculated to the work area through a HEPA supply filter.

- **Class IIB2**: These are total exhaust cabinets (no recirculation of air within the work area), and are widely used in toxicology laboratories and similar applications where chemical effluent is present and clean air is essential. Room air enters through a blower/motor in the top of the cabinet and passes through a HEPA supply filter into the work area as laminar unidirectional airflow. Descending air is pulled through the base of the cabinet through the perforated front and rear grilles. All of the air is pulled into a dedicated, hard-ducted exhaust system. Small quantities of toxic chemicals and radioisotopes can be used within the hood. The exhaust of a large volume of conditioned room air makes this cabinet very expensive to
operate. Additionally, the cabinet must be running continuously so as not to interfere with room exhaust.

10.6 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.

Please reference the [regulated medical waste web page](#) for disposal procedures. All RMW generated on campus within LAR & Science III is self-transported in covered secondary containers to the regulated medical waste accumulation facility (Science III B20).

10.6.1 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 Binghamton possess
Certificates that cover all members within the respective department (please consult with your administrative assistant 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.

11.0 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 can cause 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 electrons 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, they can be blocked by a sufficient thickness of material such as 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 reduce eliminate your exposure.
11.1 Where Ionizing Radiation is Used

Small amounts of radioactive material are used and stored in laboratory rooms around the campus. Some of the material is contained in small sealed capsules. Examples of these “sealed sources” include test sources for radiation detectors and ionization detectors in gas chromatographs. Most often radioactive material is found in small vials of radioactively labeled chemicals in solution. These labeled chemicals are widely used in research. With very few exceptions, only very small amounts of radioactive material are used and levels of radiation exposure are quite low.

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.

11.2 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.

11.2.1 How to Protect Yourself

Responsible 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.

11.3 Control of Ionizing Radiation

All use of material or equipment that produces ionizing radiation requires prior approval by Binghamton University Radiation Safety Committee. This group of faculty and staff members set policies and personally reviews each operation to ensure safety and compliance with state and federal regulations. The University Radiation Safety Officer provides 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 university radiation safety program is available through the Radiation Safety Officer.

The information presented here is only a brief overview of how sources of ionizing radiation are used at Binghamton University. While BU 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 777-2211.

11.4 Radioactive Waste Disposal

Radioactive material cannot be disposed of in the regular trash. For proper disposal procedures please contact the Radiation Safety Officer.

12.0 LASER HAZARDS
Binghamton University has a Laser Safety Program designed to establish guidelines to protect students and employees from the potential hazards associated with laser devices and systems used to conduct laboratory, educational, or research activities at Binghamton University. To achieve this goal, EH&S recognizes the American National Standard for the Safe Use of Lasers, ANSI Z136.1-2000 and New York Department of Labor’s Part 50, LASER Regulation.

For additional information regarding laser safety please contact EH&S at 777-2211. Additional information can be found on the OSHA Safety and Health topics webpage for laser hazards.

13.0 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.

13.1 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.

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

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. 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 Binghamton University Police at 911 (777-2393 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 Binghamton University Police and begin CPR IMMEDIATELY!

13.1.2 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 Physical Facilities.

- 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. Always wear safety glasses and electrically insulated gloves when working on live circuits. 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.

• 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 Binghamton University lock-out/tag-out procedures which can be found at the EH&S website.

• If you need additional power supply, the best solution is to have additional outlets installed by Physical Facilities. Do not use extension cords or power strips ("power taps") as a substitute for permanent wiring.

• Extension cords and power strips may be used 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, 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. For more information on extension cords, see the Consumer Product Safety Commission - Extension Cords Fact Sheet (CPSC Document #16).

• 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 Building Administrator 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 and is not allowed at Binghamton University.

- 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, 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. Contact your Building Administrator for assistance.

- 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 Administrator 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.

For additional information, see the following resources:

1) OSHA Pamphlet 3075
3) Creighton University EH&S
4) Berkeley University EH&S
5) National Fire Protection Association (NFPA) 70E
6) UC Davis EH&S
13.1.3 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.

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 at 777-2211 for information on individuals approved to perform retrofitting.

3) 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.

13.2 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 to protect workers from such preventable injuries. When operation of or accidental contact with a machine can cause injury, the hazards must be either eliminated or controlled.

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.

13.2.1 Machine Safety Responsibilities

Machine safety 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.

13.2.1 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 lock-out 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.

13.3 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).
- Light bulbs that are mounted low and susceptible to contact should be guarded.
- For proper disposal of fluorescent bulbs (“universal waste”), contact EH&S at 777-2211.
- As an energy conservation measure, please remember to turn off your lights when you leave your lab.

13.4 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.

13.4.1 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 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 violently strike anything.

13.4.2 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 on the cylinder to keep it from tipping over.

• Do not store incompatible gases 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.

13.4.3 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.

Basic operating guidelines include:

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 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.

13.4.4 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.

13.4.5 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.

13.5 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 777-2211.
- 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 a spill kit available. The waste from a spill may contain lead and neutralized wastes may be toxic. Contact EH&S at 777-2211 for hazardous waste disposal.
- Properly dispose of your used batteries.

13.6 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 following 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, 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.

13.6.1 Heat Stress
Another form of heat hazard occurs when working in a high heat area. Under certain conditions, your body might have trouble regulating its temperature. If your body cannot regulate its temperature, it overheats and suffers some degree of heat stress. This can occur very suddenly and, if left unrecognized and untreated, can lead to very serious health affects.

Heat stress disorders range from mild disorders such as fainting, cramps, or prickly heat to more dangerous disorders such as heat exhaustion or heat stroke. Symptoms of mild to moderate heat stress can include: sweating, clammy skin, fatigue, decreased strength, loss of coordination and muscle control, dizziness, nausea, and irritability. You should move the victim to a cool place and give plenty of fluids. Place cool compresses on forehead, neck, and under their armpits.

**Heat stroke is a medical emergency.** It can cause permanent damage to the brain and vital organs, or even death. Heat stroke can occur suddenly, with little warning. Symptoms of heat stroke may include: no sweating (in some cases victim may sweat profusely), high temperature (103˚ or more), red, hot, and dry skin, rapid and strong pulse, throbbing headache, dizziness, nausea, convulsions, delirious behavior, unconsciousness, or coma.

**In the case of heat stroke, call 911 & get medical assistance ASAP!** In the meantime, you should move the victim to a cool place, cool the person quickly by sponging with cool water and fanning, and offer a conscious person 1/2 glass of water every 15 minutes.

There are a number of factors that affect your body’s temperature regulation:

- Radiant heat sources such as the sun or a furnace.
- Increased humidity causes decreased sweat evaporation.
- Decreased air movement causes decreased sweat evaporation. As ambient temperature rises, your body temperature rises and its ability to regulate decreases.

You should be especially careful if:

- You just started a job involving physical work in a hot environment.
- You are ill, overweight, physically unfit, or on medication that can cause dehydration.
- You have been drinking alcohol.
- You have had a previous heat stress disorder.
In order to prevent heat stress, please follow these recommendations:

- Acclimatize your body to the heat. Gradually increase the time you spend in the heat. Most people acclimatize to warmer temperatures in 4-7 days. Acclimatization is lost when you have been away from the heat for one week or more. When you return, you must repeat the acclimatization process.

- Drink at least 4-8 ounces of fluid every 15-20 minutes to maintain proper balance during hot and/or humid environments. THIRST IS NOT A GOOD INDICATOR OF DEHYDRATION. Fluid intake must continue until well after thirst has been quenched.

- During prolonged heat exposure or heavy workload, a carbohydrate-electrolyte beverage is beneficial.

- Alternate work and rest cycles to prevent an overexposure to heat. Rest cycles should include relocation to a cooler environment.

- Perform the heaviest workloads in the cooler part of the day.

- There should be no alcohol consumption during periods of high heat exposure.

- Eat light, preferably cold meals. Fatty foods are harder to digest in hot weather.

### 13.7 Cold Traps

**Cold traps:**

- Because many chemicals captured in cold traps are hazardous, care should be taken and appropriate protective equipment should be worn when handling these chemicals. Hazards include flammability, toxicity, and cryogenic temperatures, which can burn the skin.

- If liquid nitrogen is used, the chamber should be evacuated before charging the system with coolant. Since oxygen in air has a higher boiling point than nitrogen, liquid oxygen can be produced and cause an explosion hazard.
• Boiling and splashing generally occur when charging (cooling) a warm container, so stand clear and wear appropriate protective equipment. Items should be added slowly and in small amounts to minimize splash.

• A blue tint to liquid nitrogen indicates contamination with oxygen and represents an explosion hazard. Contaminated liquid nitrogen should be disposed of appropriately.

• If working under vacuum see the “reduced pressure” section.

• See “cryogenics” for safety advice when working with cryogenic materials.

13.8 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.

13.9 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 "de-rated" (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.

13.9.1 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:
  o Regular cleaning
  o Routine inspections
  o Regular polishing
  o Lubricating O-rings
  o 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.

13.10 Cryogenic Safety

A cryogenic gas is a material that is normally a gas at standard temperature and pressure, but which has been supercooled 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 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.

13.10.1 Cryogenic Safety Guidelines

1) **Responsibilities**
   Personnel who are responsible for any cryogenic equipment must conduct a safety review prior to the operating 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 at 777-2211.

• 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 overpressurization of the vessel. Do not ever attempt to seal the caps of liquid nitrogen dewars. Doing so can present a significant hazard of overpressurization 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) First Aid
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.

• Contact University Police 911

• Complete an accident report. CS-13 available at ehs.binghamton.edu.

13.10.2 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 (777-2211).
- 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:
  o Isolation of the experiment.
  o Provision of adequate ventilation.
  o Exclusion of ignition sources plus system grounding/bonding to prevent static charge build-up.
  o Containment in helium purged vessels.
  o Efficient monitoring for hydrogen leakage.
  o Limiting the amount of hydrogen cryopumped in the vacuum system.

13.11 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 overpressurization, 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 dry 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.

13.12 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.

Vacuum pumps
• 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 vacuum pumps, be sure to follow appropriate lock-out procedures.

13.13 Glass Cleaning

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 not be used 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 “Nocchromix Reagent”.

When handling glassware, check for cracks and chips before use. Handle glassware with care – avoid impacts, scratches, and intense heating of glassware. 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.

13.14 General Equipment Set Up

The following recommended laboratory techniques for general equipment set up was taken from the American Chemical Society’s booklet – Safety in Academic Chemistry Laboratories.
13.14.1 Glassware and Plasticware

- 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.

13.14.2 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.

13.14.3 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.

13.14.4 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 autoignition 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 aisles 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 a 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.

13.15 Ergonomics

Many lab tasks such as looking through microscopes, working in exhaust hoods, pipetting and continuously looking down require both lots of repetitive movements, and sustained posturing, usually reaching. Often there is no leg room when sitting at counters or hoods, which causes more
reaching. There may be few obvious equipment changes you can make. Although the essential job tasks probably cannot change, you can develop important personal strategies that can reduce task-related discomfort. These strategies include:

1) Work as much as you can in a neutral posture - head balanced over shoulders, upper arms vertical, wrists neutral, and spine supported. Use the chair and other adjustments as you can to facilitate this. It is often difficult in lab work to balance the degree of reaching with the need to look down at your task. If reaching is minimal, the demand to look down is usually greater, and vice-versa. Strategies to improve this include:

   • Raising what you are looking at to higher level; this usually improves the head/neck posture, but often requires more reach.

   • Alternate positions; e.g. for a time work with hands close, looking down more; then for a time with hands away, holding head/neck more neutral.

   • Hold hands away, but with forearms supported.

The choices will depend on the specific task and equipment being used, such as working in a hood, looking through a microscope, or using long pipettes.

2) Be aware that reaching demands are usually greater when sitting. Standing permits easy weight shifting side to side or leaning forward, all of which can reduce your shoulder reach. If you have consistent discomfort or strain in shoulders or upper back when doing sitting tasks, and you can't move items closer, try to do them standing (obviously, items you use will have to be raised).

If you want to sit at a lab counter using a high chair, be sure there is sufficient leg room under the counter so you can sit at the counter without twisting or leaning.

3) Take advantage of built-in task interruptions and pauses to frequently stretch and reposition yourself.

4) Listen to your body. Some discomfort after a long, active day, might be expected, but it should not be present after you get home, nor should it affect activities you want to do after work.
5) If a specific task is causing discomfort, stop briefly every 15-20 minutes and stretch and move the body part that is uncomfortable for a few seconds.

Stretch even before the symptoms start; exercise ahead of your pain. Stretches can be effective despite only doing 2 or 3 of them at a time. The most important thing is that they be done slowly. If feasible, do a different task for a while.

The exact movement or stretch you do may not be as important as the fact that you are stopping and moving something. If you have been under medical care and have been advised to do certain movements/stretches, then use those. If not under medical care, then do the exercises that seem to have some positive effect on the painful body part.

**IMPORTANT:** If you are currently under care of a doctor or therapist, you should follow their guidance regarding exercises. Check with them before doing any exercises they have not given you.
Binghamton University
CHEMICAL HYGIENE PLAN

The Occupational Safety and Health Administration (OSHA) regulation 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" mandates the development of a Chemical Hygiene Plan which is capable of protecting employees from health hazards associated with hazardous chemicals in the laboratory and capable of keeping exposures below OSHA Permissible Exposure Limits.

The Binghamton University Chemical Hygiene Plan is developed and coordinated by Environmental Health and Safety (EH&S). This Chemical Hygiene Plan is designed to supplement department and laboratory specific safety manuals and procedures that already address chemical safety in laboratories.

As per the OSHA Laboratory Standard, the following are elements of the Chemical Hygiene Plan:

1) Standard Operating Procedures

There are over three hundred laboratories at Binghamton University and most of these use hazardous chemicals. Every department should developed a comprehensive safety and health manual. These manuals should address specific safety rules, regulations and standard operating procedures for laboratory workers in the department or college. Most of the laboratories have referred to widely known and 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.

EH&S will assist laboratories in developing general and specific standard operating procedures for chemical use in laboratories. Due to the large variety of research and the number of laboratories involved, it will be the responsibility of each laboratory, department or college to ensure that their practices and procedures are adequate to protect their workers who use hazardous chemicals.

It will be up to the Principal Investigator 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. In many cases, standard operating procedures for laboratory safety have been developed and implemented for years and few changes will be necessary to comply with the OSHA Lab Standard. Existing standard operating procedures may need to be reevaluated to ensure that they address the health and safety requirements for the chemicals in use.

2) 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 Binghamton may include dilution ventilation, local exhaust ventilation (fume hoods), and proper storage facilities.

- **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.

- **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. These general procedures include guidelines on use of chemicals, accidents and spills, personal protection, use of fume hoods and other good laboratory practice information.

- **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.

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.

3) Fume Hoods and Other Protective Equipment

Fume hoods are tested annually by EH&S. EH&S will provide a list to Physical Facilities of fume hoods which are not working properly and they will facilitate repairs.

The proper functioning and maintenance of other protective equipment used in the lab is the responsibility of a variety of service groups. Periodic inspections and maintenance by these groups ensure proper functioning and adequate performance of the equipment.

It is the responsibility of the Department Chair to insure all safety equipment is working and checked accordingly.

4) Information and Training

Federal and state laws and Binghamton University policy require all laboratory workers to receive laboratory safety training and be informed of the potential health and safety risks that may be present in their workplace. Documentation must be maintained to demonstrate that such training was provided and received. In order to assist laboratory personnel comply with this requirement, laboratory safety training must be obtained either through EH&S or documented as having been received from an alternative source. Laboratory personnel who attend EH&S training classes will have documentation entered and maintained for them within EH&S.

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

EH&S will provide information to laboratories, including the Chemical Hygiene Plan, the Laboratory Safety Manual, MSDSs, OSHA Permissible Exposure Limits, and specific topical information from employee requests. EH&S personnel are available to answer questions and provide information to employees about chemical safety in laboratories.

Other sources of information and training may come from informal group or individual discussions with a supervisor, posted notices, fliers, web documents, and other written materials. Properly labeled containers, such as those using Right-To-Know labels, will give immediate warning information to workers about specific chemical hazards. Employees are encouraged to contact their Department Safety Representative and EH&S at 777-2211 for more information about safety in laboratories.

5) Prior Approval for High Hazard Work

EH&S can assist in identifying circumstances when there should be prior approval before implementation of a particular laboratory operation. Due to the large variety of research being conducted in laboratories at the University, it is impossible to apply one prior approval process that can apply to all laboratories. Instead, high hazard types of activities should be identified by the Principal Investigator or person responsible for the work, and any type of approval process should be addressed in the laboratory’s or department’s standard operating procedures.

EH&S will assist in providing information to researchers about work with select carcinogens, reproductive toxins, and acute toxins. General guidelines and recommendations for the safe handling, use and control of high hazard materials can be provided through MSDSs, and reference sources such as Prudent Practices in the Laboratory, Safety in Academic Chemistry Laboratories, and other resources.

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 or the Bio Safety Officer at 777-2211.

• Use of Radioactive Materials – contact the Radiation Safety Officer (RSO) at 777-4370.

Use of Human Subjects - contact the Institutional Review Board (IRB).

6) Medical Consultations and Medical Examinations

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.

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.

All records of medical consultations, examinations, tests, or written opinions shall be maintained at the health center in accordance with 29 CFR 1910.1020 - Access to employee exposure and medical records.
7) Personnel Responsible for the Chemical Hygiene Plan

EH&S will provide technical information and program support to assist laboratories comply with the OSHA Laboratory Standard. EH&S will maintain the campus Chemical Hygiene Plan (CHP) and the institutional Chemical Hygiene Officer responsibilities will reside within EH&S. However, it will be the responsibility of the Principal Investigator or individual supervisor, department or college to be in compliance with the components of the CHP.

Each college, center, department, or laboratory may adopt or modify this CHP or write their own chemical hygiene plan as long as the requirements of the OSHA Laboratory Standard are met. It is assumed if a college, center, department, or laboratory has not developed their own chemical hygiene plan, then that unit or laboratory has adopted the Binghamton University Chemical Hygiene Plan.

8) Provisions for Additional Employee Protection for Work with Particularly Hazardous Substances

The Chemical Hygiene Plan includes provisions for additional employee protection for work with particularly hazardous substances. Research involving the use of particularly hazardous substances, such as select carcinogens, reproductive toxins or acute toxins chemicals may require prior review to ensure adequate controls are in place which will protect the worker. EH&S will assist with the review and make recommendations for additional employee protection.

Additional employee protection may require the use of additional provisions such as:

- 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 provision for additional controls may require the expertise and recommendations of various groups throughout campus including EH&S. All additional provisions for work with particularly hazardous substances must be incorporated into the lab’s standard operation procedures for those materials.
APPENDIX B: DEPARTMENTS’ SAFETY MANUALS
APPENDIX C: COMPILED LAB SAFETY RESPONSIBILITIES

1) It is the responsibility of Principal Investigators and laboratory supervisors to ensure that personnel working in laboratories under their control are familiar with the contents and location of the Chemical Hygiene Plan, including any lab specific standard operating procedures and any department or college level laboratory safety manuals, policies, and procedures. (Section 1.1)

2) It is the responsibility of the Principal Investigator and individual supervisors (and individuals working under their supervision) to be in compliance with the components of the University Chemical Hygiene Plan, the University Health and Safety Policy, and any other department or University specific policies. (Section 1.2)

3) It is the responsibility of laboratory personnel to immediately report malfunctioning protective equipment, such as fume hoods, or mechanical problems to their Building Administrator as soon as any malfunctions are discovered. (Section 2.1)

4) Principal Investigators, laboratory supervisors, departments and colleges are free to set policies that establish minimum PPE requirements for personnel working in and entering their laboratories. Be sure to check with your DSR to see if there are any department or college specific requirements for PPE. (Section 2.2.1)

5) It is the responsibility of the Principal Investigator or laboratory supervisor to ensure laboratory staff have received the appropriate training on the selection and use of proper PPE, that proper PPE is available and in good condition, and laboratory personnel use proper PPE when working in laboratories under their supervision. (Section 2.2.1.1)

6) EH&S strongly encourages Principal Investigators and laboratory supervisors to make use of eye protection a mandatory requirement for all laboratory personnel, including visitors, working in or entering laboratories under their control. (Section 2.2.2)

7) EH&S strongly recommends that Principal Investigators and laboratory supervisors discourage the wearing of shorts and skirts in laboratories using hazardous materials (chemical, biological, and radiological) by laboratory personnel, including visitors, working in or entering laboratories under their supervision. (Section 2.2.4)
8) EH&S strongly encourages Principal Investigators and laboratory supervisors to require the use of closed toed shoes for all laboratory personnel, including visitors, working in or entering laboratories and laboratory support areas under their supervision. (Section 2.2.7)

9) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure written SOPs incorporating health and safety considerations are developed for work involving the use of hazardous chemicals in laboratories under their supervision and that PPE and engineering controls are adequate to prevent overexposure. In addition, Principal Investigators and laboratory supervisors must ensure that personnel working in laboratories under their supervision have been trained on those SOPs. (Section 2.3)

10) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that personnel working in laboratories under their supervision are informed and follow laboratory specific, departmental, and campus wide policies and procedures related to laboratory safety – such as the guidelines and requirements covered in this Laboratory Safety Manual. (Section 2.4)

11) It is the responsibility of Principal Investigators and laboratory supervisors to ensure laboratories under their supervision are maintained in a clean and orderly manner and personnel working in the lab practice good housekeeping. (Section 2.4.3)

12) It is the responsibility of Principal Investigators and laboratory supervisors to ensure procedures for working alone are developed and followed by personnel working in laboratories under their supervision. (Section 2.4.6)

13) It is the responsibility of Principal Investigators and laboratory supervisors to ensure procedures for unattended operations are developed and followed by personnel working in laboratories under their supervision. (Section 2.4.7)

14) It is the responsibility of the Department Chairperson, Principal Investigators, and laboratory supervisors to restrict access of visitors and children to areas under their supervision when potential health and physical hazards exist. (Section 2.4.8)
15) It is the responsibility of laboratory personnel to activate (flush) emergency showers and eyewash units on a regular basis. (Section 3.5.1)

16) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure all accidents and injuries are reported to University officials through the use of the Binghamton University injury reporting system. (Section 3.6)

17) It is the responsibility of Principal Investigators and laboratory supervisors to ensure personnel working in laboratories under their supervision have been provided with the proper training, have received information about the hazards in the laboratory they may encounter, and have been informed about ways they can protect themselves. (Section 4.0)

18) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students under their supervision are provided with adequate training and information specific to the hazards found within their laboratories. (Section 5.2.1)

19) 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 MSDSs (and other sources of information) for all hazardous chemicals used in laboratories under their supervision. (Section 5.2.2)

20) While EH&S can provide assistance in identifying circumstances when there should be prior approval before implementation of a particular laboratory operation, the ultimate responsibility of establishing prior approval procedures lies with the Principal Investigator or laboratory supervisor. (Section 6.3)

21) 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. (Section 7.1)

22) It is the responsibility of the Principal Investigator or laboratory supervisor to ensure any employee working under their supervision who ships or prepare shipments of hazardous materials have received the proper training. (Section 8.0)
23) The responsibility for ensuring that all work with pesticides at Binghamton is conducted properly and legally rests on the individual user. (Section 9.0)

24) When using pesticides in a non-dispersive manner in a laboratory setting, an individual must follow the safety rules outlined in the Binghamton University Laboratory Safety Manual. (Section 9.1.1)

25) It is the responsibility of the Principal Investigator or laboratory supervisor to ensure biological safety cabinets within laboratories under their supervision are certified annually. (Section 10.5.1)

26) It is the responsibility of the Principal Investigator or laboratory supervisor with class 3b or 4 LASERs in laboratories under their supervision to ensure the class 3b or 4 LASERs have been registered with EH&S and employees using these LASERs have received the appropriate training. (Section 12.0)

27) It is the responsibility of the Principal Investigator and laboratory supervisor to ensure that staff and students in laboratories under their supervision are provided with adequate training and information specific to the physical hazards found within their laboratories. (Section 13.0)
## APPENDIX D: GLOVE SELECTION FOR SPECIFIC CHEMICALS

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Incidental Contact</th>
<th>Extended Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>Nitrile</td>
<td>Neoprene, Butyl rubber</td>
</tr>
<tr>
<td>Acetic anhydride</td>
<td>Nitrile (8 mil), double glove</td>
<td>Butyl rubber, Neoprene</td>
</tr>
<tr>
<td>Acetone</td>
<td>Nitrile (Latex) (8 mil)</td>
<td>Butyl rubber</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>Nitrile</td>
<td>Butyl rubber, Polyvinyl acetate (PVA)</td>
</tr>
<tr>
<td>Acrylamide</td>
<td>Nitrile, or double Nitrile</td>
<td>Butyl rubber</td>
</tr>
<tr>
<td>bis-Acrylamide</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Alkali metals</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Ammonium hydroxide</td>
<td>Nitrile</td>
<td>Neoprene, Butyl rubber</td>
</tr>
<tr>
<td>Arsenic salts</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Benzotriazole, 1,2,3-</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Bismuth salts</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Butanol</td>
<td>Nitrile</td>
<td>Nitrile, Butyl rubber</td>
</tr>
<tr>
<td>Butyric acid</td>
<td>Nitrile</td>
<td>Butyl rubber, Neoprene</td>
</tr>
<tr>
<td>Cadmium salts</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Viton, Polyvinyl acetate (PVA)</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Viton</td>
</tr>
<tr>
<td>Catechol</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Viton, Polyvinyl acetate (PVA)</td>
</tr>
<tr>
<td>Chlorosulfuron</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Chromium salts</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Cobalt chloride</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Cobalt salts</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Copper (Cupric) sulfate</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Cyrogenic liquids</td>
<td>Cryogloves</td>
<td></td>
</tr>
<tr>
<td>3,3'-Diaminobenzidine (DAB)</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Diazomethane in Ether</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Norfoil</td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>Nitrile (8 mil), double glove</td>
<td>Polyvinyl acetate (PVA) or Viton</td>
</tr>
<tr>
<td>2,4-Dichlorophenoxy acetic acid</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Diethyl pyrocarbonate</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Dimethyl sulfoxide</td>
<td>Nitrile (15-18mil)</td>
<td>Butyl rubber</td>
</tr>
<tr>
<td>Substance</td>
<td>Gloves/Other Protection</td>
<td>Additional Information</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------</td>
<td>-------------------------------------------------------------</td>
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<tr>
<td>1,4-Dioxane</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Butyl rubber</td>
</tr>
<tr>
<td>Dithiothreitol</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Ethanol</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Ethidium bromide (EtBr)</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>Nitrile (8 mil), double glove</td>
<td>Butyl rubber, PVA</td>
</tr>
<tr>
<td>Ethyl ether</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Polyvinyl acetate (PVA)</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Formamide</td>
<td>Nitrile</td>
<td>Butyl rubber</td>
</tr>
<tr>
<td>Formic acid</td>
<td>Nitrile (8 mil), double glove</td>
<td>Butyl rubber, Neoprene (.28-.33mm)</td>
</tr>
<tr>
<td>Gallic acid</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Geneticin</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Glutaraldehyde</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Heavy metal salts</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Heptane</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Nitrile (35 mils or thicker), Viton, PVA</td>
</tr>
<tr>
<td>Hexamethylenediamine (1,6-Diaminohexane)</td>
<td>Nitrile (8 mil)</td>
<td>Neoprene</td>
</tr>
<tr>
<td>Hexane</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Nitrile (35 mils or thicker), Viton, PVA</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>Nitrile</td>
<td>Neoprene, Butyl rubber</td>
</tr>
<tr>
<td>Hydrofluoric acid (HF)</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Nitrile or Rubber sleeves</td>
</tr>
<tr>
<td>Hypophosphorous acid</td>
<td>Nitrile (4 mil), double glove or 8 mil or heavier</td>
<td></td>
</tr>
<tr>
<td>Isoamyl alcohol</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Isooctane</td>
<td>Nitrile</td>
<td>Heavy weight Nitrile</td>
</tr>
<tr>
<td>Isopropanol</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Kananmycin</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Lactic acid</td>
<td>Nitrile</td>
<td>Nitrile (double glove), or Neoprene or Butyl rubber</td>
</tr>
<tr>
<td>Laser dyes</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Lead acetate</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Lead salts</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Mercuric chloride</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Mercury</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Mercury salts</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Methanol (Methyl</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>Gloves Material</td>
<td>Compatibility</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Nitrile (8 mil), double glove</td>
<td>Polyvinyl acetate, Viton</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>Nitrile (8 mil), double glove</td>
<td>8 mil or heavier Nitrile</td>
</tr>
<tr>
<td>Methylphosphonic acid</td>
<td>Nitrile (4 mil), double glove</td>
<td>8 mil or heavier Nitrile</td>
</tr>
<tr>
<td>Methyl sulfinic acid, Ethyl ester (EMS) (Ethyl methanesulfonate)</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Monoethanolamine</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Nickel chloride</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Nickel salts</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>Nitrile (8 mil), double glove</td>
<td>Heavy weight (.28-.33mm) Butyl rubber or Neoprene</td>
</tr>
<tr>
<td>N-Methyllethanolamine</td>
<td>Nitrile (8 mil), double glove</td>
<td>Viton, Neoprene, Butyl rubber</td>
</tr>
<tr>
<td>Octane</td>
<td>Nitrile</td>
<td>Heavy weight Nitrile or Viton</td>
</tr>
<tr>
<td>Organophosphorous compounds</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Osmium salts</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Osmium tetroxide</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Parafomaldehyde</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Pentane</td>
<td>Nitrile (8mil), double glove</td>
<td>Heavy weight Neoprene, or Viton</td>
</tr>
<tr>
<td>Perchloroethylene (tetrachloroethylene)</td>
<td>Nitrile (8 mil), double glove</td>
<td>Nitrile (22 mil or heavier)</td>
</tr>
<tr>
<td>Pesticides</td>
<td>heavy weight, unlined Nitrile (8-20 mils), or glove specified by pesticide label.</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Petroleum ether</td>
<td>Nitrile</td>
<td>Heavy weight Nitrile or Viton</td>
</tr>
<tr>
<td>Phenol</td>
<td>Nitrile (8 mil), double glove</td>
<td>Neoprene, Butyl rubber</td>
</tr>
<tr>
<td>Phenol-Chloroform mixtures</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Viton</td>
</tr>
<tr>
<td>Phenylmethylsulfonyl fluoride (PMSF)</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Phosphonic acid</td>
<td>Nitrile (4 mil), double glove, or 8 mil or heavier single</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>Nitrile (4 mil), double glove, or 8 mil or heavier</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Picloram (4-amino-3,5,6-trichloropicolinic acid)</td>
<td>Nitrile</td>
<td>Nitrile</td>
</tr>
<tr>
<td>Substance</td>
<td>Glove Material</td>
<td>Safety Notes</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Polychlorinated Biphenyls (PCB’s)</td>
<td>Nitrile (8 mil) glove over a Neoprene glove</td>
<td>Neoprene (20 mil)</td>
</tr>
<tr>
<td>Polyoxyethylene-sorbitol-n-monolaurate (Tween 20)</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Potassium ferricyanide</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Potassium ferrocyanide</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Potassium permanganate</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Propanol</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Propionic acid</td>
<td>Nitrile</td>
<td>Neoprene or Butyl rubber</td>
</tr>
<tr>
<td>Propylene oxide</td>
<td>heaver weight (17 mil or greater) Butyl rubber or Neoprene</td>
<td>Norfoil</td>
</tr>
<tr>
<td>Psoralen</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Pump oil</td>
<td>Butyl rubber</td>
<td></td>
</tr>
<tr>
<td>Silane based silanization or derivatization compounds</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier single</td>
<td></td>
</tr>
<tr>
<td>Silver nitrate</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Silver salts</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Sodium dodecyl sulfate (SDS)</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Sodium azide</td>
<td>Nitrile, or double glove</td>
<td></td>
</tr>
<tr>
<td>Spermidine</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>Nitrile (8 mil)</td>
<td>Neoprene, Butyl rubber (20 mil or greater)</td>
</tr>
<tr>
<td>Tetrahydrofuran (THF)</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Norfoil</td>
</tr>
<tr>
<td>3,3’,5,5’-Tetramethylbenzidine (TMB)</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>N,N,N’,N’-Tetramethyl-ethylenediamine (TEMED)</td>
<td>Nitrile</td>
<td>Nitrile, double glove</td>
</tr>
<tr>
<td>Timetin</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>Nitrile (8 mil), double glove, or 15 mil or heavier</td>
<td>Viton, Polyvinyl acetate (PVA)</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>Nitrile (8 mil), double glove</td>
<td>Viton, Polyvinyl acetate (PVA)</td>
</tr>
<tr>
<td>Trichloromethyl chloroformate (diposphogene)</td>
<td>Nitrile (8 mil) over Butyl rubber glove</td>
<td>This material must be used in a glove box.</td>
</tr>
<tr>
<td>Substance</td>
<td>Material</td>
<td>Complementary Material</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Triton-X100</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Uranium salts</td>
<td>Nitrile</td>
<td>Nitrile, double gloves, or Neoprene or Butyl rubber</td>
</tr>
<tr>
<td>Valeric acid</td>
<td>Nitrile</td>
<td></td>
</tr>
<tr>
<td>Xylene</td>
<td>Nitrile</td>
<td>Polyvinyl acetate (PVA), Viton</td>
</tr>
</tbody>
</table>

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

**GLOVE SELECTION WEBSITES**

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

- Comprehensive Guide to Chemical Resistant Best Gloves from Best Manufacturing  

- Glove Selection Guide from the University of South Carolina EH&S  
  [http://ehs.sc.edu/gloves.htm](http://ehs.sc.edu/gloves.htm)

- Chemical Compatibility Guide for Gloves from Laboratory Safety Supply  

- Glove Selection Guide from Stanford University EH&S (also includes other links)  

- Glove Selection Links from Iowa State University EH&S  
Chemical manufacturers are required by law to supply "Material Safety Data Sheets" (OSHA Form 174 or its equivalent) upon request by their customers. These sheets have nine sections giving a variety of information about the chemical. Following is a section-by-section reproduction and explanation of a Material Safety Data Sheet (MSDS).

<table>
<thead>
<tr>
<th>U.S. DEPARTMENT OF LABOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>MATERIAL SAFETY DATA SHEET</td>
</tr>
<tr>
<td>Required For compliance with OSHA Act of 1970</td>
</tr>
<tr>
<td>Public Law 91-596 (CFR 1910)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECTION I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Name</td>
</tr>
<tr>
<td>Chemical Name</td>
</tr>
<tr>
<td>Formula</td>
</tr>
<tr>
<td>Manufacturer</td>
</tr>
<tr>
<td>Address</td>
</tr>
<tr>
<td>For Information on Health Hazards Call</td>
</tr>
<tr>
<td>For Other Information Call</td>
</tr>
<tr>
<td>Signature and date</td>
</tr>
</tbody>
</table>

This section gives the name and address of the manufacturer and an emergency phone number where questions about toxicity and chemical hazards can be directed. Large chemical manufacturers have 24-hour hotlines manned by chemical safety professionals who can answer questions regarding spills, leaks, chemical exposure, fire hazard, etc. Other information that may be contained in Section I include:

**Trade Name**: This is the manufacturer's name for the product.

**Chemical Name and Synonyms**: This refers to the generic or standard names for the chemical.

**Chemical Family**: This classification allows one to group the substance along with a class of similar substances, such as mineral dusts, acids, caustics, etc. The potential hazards of a substance can sometimes be gauged by experience with other chemicals of that hazard class.
SECTION II - HAZARDOUS INGREDIENTS OF MIXTURES

<table>
<thead>
<tr>
<th>Principal Hazardous component(s)</th>
<th>%</th>
<th>TVL (Units)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This section describes the percent composition of the substance, listing chemicals present in the mixture. It lists Threshold Limit Values for the different chemicals that are present.

Threshold Limit values (TLV’s) are values for airborne toxic materials that are used as guides in the control of health hazards. They represent concentrations to which nearly all workers (workers without special sensitivities) can be exposed to for long periods of time without harmful effect. TLV’s are usually expressed as parts per million (ppm), the parts of gas or vapor in each million parts of air. TLV’s are also expressed as mg/m³, the milligrams of dust or vapor per cubic meter of air.

SECTION III - PHYSICAL DATA

<table>
<thead>
<tr>
<th>Boiling Point (°F)</th>
<th>Specific Gravity (H₂O = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapor Pressure (mm Hg)</td>
<td>Percent Volatile By Volume (%)</td>
</tr>
<tr>
<td>Vapor Density (Air = 1)</td>
<td>Evaporation Rate (Butyl Acetate = 1)</td>
</tr>
</tbody>
</table>

| Solubility in Water |
| Appearance and Odor |

This section gives information about the physical characteristics of the chemical. This information can be very useful in determining how a chemical will behave in a spill situation and what appropriate steps should be taken.

**Vapor Pressure:** Vapor pressure (VP) can be used as a measure of how volatile a substance is...how quickly it evaporates. VP is measured in units of millimeters of mercury (mm Hg). For comparison, the VP of water (at 20° Centigrade) is 17.5 mm Hg. The VP of Vaseline (a nonvolatile substance) would be close to zero mm Hg, while the VP of diethyl ether (a very volatile substance) is 440 mm Hg.

**Vapor Density:** Vapor density describes whether the vapor is lighter or heavier than air. The density of air is 1.0. A density greater than 1.0 indicates a heavier vapor, a density less than 1.0 indicates a lighter vapor. Vapors heavier than air (gasoline vapor for instance) can flow along just
above the ground and can collect in depressions where they may pose a fire and explosion hazard.

**Specific Gravity:** Specific gravity describes whether the liquid is lighter or heavier than water. Water has a specific gravity of 1.0.

**Percent Volatile by Volume:** Describes how much of the substance will evaporate.

### SECTION IV - FIRE AND EXPLOSION HAZARD DATA

<table>
<thead>
<tr>
<th>Flash Point (°F)</th>
<th>Flammable Limits in Air (% by Vol.)</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extinguisher Media</td>
<td>Autoignition Temperature (°F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Fire Fighting Procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explosion Hazards</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This section gives information, which is important for preventing and extinguishing fires and explosions. If a fire does occur, this information should be made available to fire fighters.

**Flash Point:** Flash point is the lowest temperature at which a liquid gives off enough vapor to ignite when a source of ignition is present. A fire or explosion hazard may exist if the substance is at or above this temperature and used in the presence of spark or flame.

**Flammable Limits:** In order to be flammable, a substance must be mixed with a certain amount of air (as in an automobile carburetor). A mixture that is too "lean" (not enough chemical) or too "rich" (not enough air) will not ignite. The Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL) define the range of concentration in which combustion can occur. The wider the range between the LEL and UEL, the more flammable the substance is.

### SECTION V - HEALTH HAZARD DATA

<table>
<thead>
<tr>
<th>Threshold Limit Value</th>
<th>Effects of Overexposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Overexposure</td>
<td>Emergency and First Aid Procedures</td>
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<tr>
<td>Chronic Overexposure</td>
<td></td>
</tr>
<tr>
<td>Inhalation</td>
<td></td>
</tr>
<tr>
<td>Eyes</td>
<td></td>
</tr>
<tr>
<td>Skin</td>
<td></td>
</tr>
<tr>
<td>Ingestion</td>
<td></td>
</tr>
</tbody>
</table>
This section describes the potential health effects resulting from overexposure to the chemical and gives emergency and first aid procedures. The symptoms and effects listed are the effects of exposure at hazardous levels. Most chemicals are safe in normal use and the vast majority of workers never suffer toxic effects. However, any chemical can be toxic in high concentrations, and the precautions outlined in the MSDS should be followed.

The health hazards section often contains information on the toxicity of the substance. The data most often presented are the results of animal experiments. For example, "LD50 (mouse) = 250 mg/kg." The usual measure of toxicity is dose level expressed as weight of chemical per unit body weight of the animal-usually milligrams of chemical per kilogram of body weight (mg/kg). The LD50 describes the amount of chemical ingested or absorbed by the skin in test animals that causes death in 50% of test animals used during a toxicity test study. Another common term is LC50, which describes the amount of chemical inhaled by test animals that causes death in 50% of test animals used during a toxicity test study. The LD50 and LC50 values are then used to infer what dose is required to show a toxic effect on humans.

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

Health hazard information may also distinguish the effects of acute and chronic exposure. Acute toxicity is generally thought of as a single, short-term exposure where effects appear immediately and the effects are often reversible. Chronic toxicity is generally thought of as frequent exposures where effects may be delayed (even for years), and the effects are generally irreversible. Chronic toxicity can also result in acute exposures, with long term chronic effects.

<table>
<thead>
<tr>
<th>SECTION VI - REACTIVITY DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
</tr>
<tr>
<td>Unstable          Conditions to avoid</td>
</tr>
<tr>
<td>Stable</td>
</tr>
</tbody>
</table>

Incompatibility (Materials to Avoid)

Hazardous Decomposition Products
This section gives information on the reactivity of the chemical – with other chemicals, air, or water which is important when responding to a spill or fire. Chemical substances may be not only hazardous by themselves, but may also be hazardous when they decompose (break down into other substances) or when they react with other chemicals.

**Stability: Unstable** indicates that a chemical can decompose spontaneously under normal temperatures, pressures, and mechanical shocks. Rapid decomposition may be hazardous because it produces heat and may cause a fire or explosion. **Stable** compounds do not decompose under normal conditions.

**Incompatibility:** Certain chemicals should never be mixed because the mixture creates hazardous conditions. Incompatible chemicals should not be stored together where an accident could cause them to mix.

**Hazardous Decomposition Products:** Other chemical substances may be created when a chemical burns or decomposes.

**Hazardous Polymerization:** Some chemicals can undergo a type of chemical reaction (rapid polymerization) which may produce enough heat to cause containers to explode. Conditions to avoid are listed in this section.

<table>
<thead>
<tr>
<th>Hazardous Polymerization</th>
<th>Conditions to Avoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>May Occur</td>
<td>Will Not Occur</td>
</tr>
</tbody>
</table>

**SECTION VII - SPILL OR LEAK PROCEDURES**

Steps to be Taken in Case Material is Released or Spilled

<table>
<thead>
<tr>
<th>Waste Disposal Method</th>
</tr>
</thead>
</table>

This section can provide specific information about how to clean up a spill of the chemical and how the chemical should be properly disposed.

<table>
<thead>
<tr>
<th>SECTION VIII - SPECIAL PROTECTION INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Protection (Specify type)</td>
</tr>
<tr>
<td>Ventilation</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Protective Gloves</td>
</tr>
</tbody>
</table>
Other Protective clothing or Equipment

This section gives information for any special protection that needs to be taken when handling this chemical including ventilation requirements and the type of personal protective equipment that should be worn.

<table>
<thead>
<tr>
<th>SECTION IX - SPECIAL PRECAUTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precautions to be Taken in Handling and Storing</td>
</tr>
<tr>
<td>Other Precautions</td>
</tr>
</tbody>
</table>

This section describes other precautionary measures that may need to be taken. Some of the precautions presented are intended for large-scale users and may not be necessary for use with small quantities of the chemical. Any questions about precautions or health effects should be referred to EH&S at 777-2211.
APPENDIX F: HAZARDS OF FUNCTIONAL GROUPS

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

ALCOHOLS

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

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

ALDEHYDES

- Aldehydes are intermediate products in the conversion of primary alcohols to carboxylic acids or vice versa.
- The low molecular weight aldehydes are more toxic than the higher ones.
- Toxicity decreases with increase in the carbon chain length.
- Aromatic aldehydes are less toxic than low molecular weight aliphatic aldehydes.
- Low molecular weight aldehydes are highly flammable, with flammability decreasing with increasing carbon chain length.
- Low aromatic aldehydes are combustible or nonflammable liquids.
Examples: Acetaldehyde    Glutaraldehyde
          Acrolein     1-Hexanal
          Benzaldehyde Isobutyraldehyde
          Formaldehyde Propenal

ALIPHATIC AMINES

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

Examples: Aminocyclohexane    Methylamine
          Ethyleneimine   2-Propylamine

ALIPHATIC and ALICYCLIC HYDROCARBONS

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

Examples: Butane  Methane  
Cyclohexene  n-Pentane  
Cyclopentane

**ALKALI and OTHER REACTIVE METALS**

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

Examples: Aluminum  Magnesium  
Calcium  Potassium  
Lithium  Sodium

**ALKALIES**

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

- Compounds that contain one or more amino groups attached to an aromatic ring.
- These amines are similar in many respects to aliphatic amines.
- These amines are basic, but the basicity is lower to aliphatic amines.
- The health hazard from aromatic amines may arise in two ways:
  - Moderate to severe poisoning, with symptoms ranging from headache, dizziness, and ataxia to anemia, cyanosis, and reticulocytosis.
  - Carcinogenic, especially cancer of the bladder.
- Many amines are proven or suspected human carcinogens, among aromatic amines, ortho-isomers generally exhibit stronger carcinogenic properties than those of the para- and meta-isomers.
- Unlike aliphatic amines, the aromatic amines do not cause severe skin burn or corneal injury.
- The pure liquids (or solids) may produce mild to moderate irritation on the skin.
- Lower aromatic amines are combustible liquids and form explosive mixtures with air.
- Amines may react violently with strong oxidizing compounds.

Examples:
- Aniline
- o-Toluidine
- Benzidine

AROMATIC HYDROCARBONS

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

Examples:
- Benzene
- Toluene
AZIDES, FULMINATES, ACETYLIDES, and RELATED COMPOUNDS

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

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

CARBOXYLIC ACIDS

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

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

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

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

ESTERS

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

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

ETHERS

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

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

GLYCOL ETHERS

• Also known by the name Cellosolve.
• The toxic effects are mild, however, moderate to severe poisoning can occur from excessive dosage.
• The routes of exposure are inhalation, ingestion, and absorption through the skin.
• Compounds with high molecular weights and low vapor pressures do not manifest an inhalation hazard.
• Low molecular weight alkyl ethers are flammable or combustible liquids forming explosive mixtures with air.
• The reactivity of glycol ethers is low.
• There is no report of any violent explosive reactions.
• The high molecular weight compounds are noncombustible.

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

HALOETHERS

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

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

HALOGENATED HYDROCARBONS

• The flammability of these compounds shows a wide variation.
• Bromo compounds are less flammable than their Chloro- counterparts, the difference in flammability is not great though.
• An increase in the halosubstitutions in the molecule increases the flash point.
• The flammable hydrocarbons are stable compounds with low reactivity.
• These compounds, however, may react violently with alkali metals and their alloys or with finely divided metals.
• Violent reactions may occur with powerful oxidizers, especially upon heating.
• Volatile halocarbons may rupture glass containers due to simple pressure build up or to exothermic polymerization in a closed vessel.
• Halogenated hydrocarbons in general exhibit low acute toxicity.
• Inhalation toxicity is greater for gaseous or volatile liquid compounds.
• The health hazard from exposure to these compounds may be due to their anesthetic actions; damaging effects on liver and kidney; and in case of certain compounds, carcinogenicity.
• The toxic symptoms are drowsiness, lack of coordination, anesthesia, hepatitis, and necrosis of the liver.
• Vapors may cause irritation of the eyes and respiratory tract.
• Death may result from cardiac arrest due to prolonged exposure to high concentrations.
• Ingestion can produce nausea, vomiting, and liver injury.
• Fluorocarbons are less toxic than the chloro-, bromo-, and iodo-
  compounds, the toxicity increases with increase in the mass number
  of the halogen atoms.
• Some of the halogenated hydrocarbons cause cancer in humans.

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

HYDRIDES

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

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

INDUSTRIAL SOLVENTS

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

INORGANIC CYANIDES

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

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

KETONES

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

Examples:
Acetophenone    Mesityl oxide
Acetone         Methyl Ethyl Ketone
Ketene

MINERAL ACIDS

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

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

ORGANIC CYANIDES (NITRILES)

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

Examples:
- Acrylonitrile
- Butyronitrile
- Acetonitrile
- Cyanohydrin

ORGANIC ISOCYANATES

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

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

ORGANIC PEROXIDES

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

Examples: Benzoyl peroxide  Diisopropyl peroxydicarbonate
Cumene hydroperoxide  Hydroperoxyenthanol
Diacetyl peroxide

OXIDIZERS

- Include certain classes of inorganic compounds that are strong oxidizing agents, evolving oxygen on decomposition.
- These substances are rich in oxygen and decompose violently on heating.
- The explosion hazard arises when these substances come into contact with easily oxidizable compounds such as organics, metals, or metal hydrides.
- When the solid substances are finely divided and combined, the risk of explosion is enhanced.
- The unstable intermediate products, so formed, are sensitive to heat, shock, and percussion.
- The health hazard from the substances arises due to their strong corrosive action on the skin and eyes.
- The toxicity depends on the metal ions in these molecules.

Examples:
- Bromates
- Chlorites
- Dichromates
- Hypochlorites
- Iodates
- Inorganic peroxides
- Nitrates
- Perchlorates
- Periodates
- Permanganates

**PEROXACIDS**

- There are 2 types: Peroxycarboxylic acids and Peroxysulfonic acids.
- Peroxycarboxylic acids are weaker acids than the corresponding carboxylic acids.
- Lower peroxy acids are volatile liquids, soluble in water.
- Higher acids with greater than 7 carbons are solids and insoluble in water.
- These compounds are highly unstable and can decompose violently on heating.
- May react dangerously with organic matter and readily oxidizable compounds.
- Among organic peroxides, peroxy acids are the most powerful oxidizing compounds.
- The lower acids are also shock sensitive, but less than some organic peroxides.
- Health hazard primarily due to their irritant actions.

Examples:
- Peroxyacetic acid
- Peroxyformic acid
- Peroxybenzoic acid

**PHENOLS**
• Phenols are a class of organic compounds containing hydroxyl groups attached to aromatic rings.
• The hydroxyl group exhibits properties that are different from an alcoholic hydroxyl group.
• Phenols are weakly acidic, forming metal salts on reactions with caustic alkalies.
• In comparison, acid strengths of alcohols are negligibly small or several orders of magnitude lower than those of phenols.
• In comparison with many other classes of organic compounds, phenols show relatively greater toxicity.

Examples:  
Cresol  
2-Naphthol  
Resorcinol  
Pentachlorophenol

**PHTHALATE ESTERS**

• These are esters of Phthalic acid.
• They are noncombustible liquids.
• Some are EPA-listed priority pollutants.
• The acute toxicity is very low.
• High doses may produce somnolence, weight loss, dyspnea, and cyanosis.
• The pure liquids are mild irritants to the skin.
• These are relatively harmless and are among the least toxic organic industrial products.

Examples:  
Dibutyl phthalate  
Diethylhexyl Phthalate (DEHP)

Reference:  
## APPENDIX G: PEROXIDE FORMING CHEMICALS

### SAFE STORAGE PERIODS FOR PEROXIDE FORMERS

<table>
<thead>
<tr>
<th>Description</th>
<th>Storage Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unopened chemicals from manufacturer</td>
<td>18 months or (expiration date)</td>
</tr>
<tr>
<td><strong>Opened containers:</strong></td>
<td></td>
</tr>
<tr>
<td>Chemicals in Table A</td>
<td>3 months</td>
</tr>
<tr>
<td>Chemicals in Tables B and D</td>
<td>12 months</td>
</tr>
<tr>
<td>Uninhibited chemicals in Table C</td>
<td>24 hours</td>
</tr>
<tr>
<td>Inhibited chemicals in Table C (Do not store under an inert atmosphere)</td>
<td>12 months</td>
</tr>
</tbody>
</table>

### A. Chemicals that form explosive levels of peroxides without concentration

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Peroxide Forming Compound</th>
<th>Other Compound(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butadiene(^a)</td>
<td>Isopropyl ether</td>
<td>Sodium amide (sodamide)</td>
</tr>
<tr>
<td>Chloroprene(^a)</td>
<td>Potassium metal</td>
<td>Tetrafluoroethylene(^a)</td>
</tr>
<tr>
<td>Divinylacetylene</td>
<td>Potassium amide</td>
<td>Vinylidene chloride</td>
</tr>
</tbody>
</table>

### B. Chemicals that form explosive levels of peroxides on concentration

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Peroxide Forming Compound</th>
<th>Other Compound(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetal</td>
<td>Diethyl ether</td>
<td>4-Methyl-2-pentanol</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>Diethylene glycol dimethyl ether (diglyme)</td>
<td>2-Pentanol</td>
</tr>
<tr>
<td>Benzyl alcohol</td>
<td>Dioxanes</td>
<td>4-Penten-1-ol</td>
</tr>
<tr>
<td>2-Butanol</td>
<td>Ethylene glycol dimethyl ether (glyme)</td>
<td>1-Phenylethanol</td>
</tr>
<tr>
<td>Cumene</td>
<td>4-Heptanol</td>
<td>2-Phenylethanol</td>
</tr>
<tr>
<td>2-Cyclohexen-1-ol</td>
<td>2-Hexanol</td>
<td>2-Propanol</td>
</tr>
<tr>
<td>Cyclohexene</td>
<td>Methylacetylene</td>
<td>Tetrahydrofuran</td>
</tr>
<tr>
<td>Decahydronaphthalene</td>
<td>3-Methyl-1-butanol</td>
<td>Tetrahydronaphthalene</td>
</tr>
<tr>
<td>Diacetylene</td>
<td>Methylcyclopentane</td>
<td>Vinyl ethers</td>
</tr>
<tr>
<td>Dicyclopentadiene</td>
<td>Methyl isobutyl ketone</td>
<td>Other secondary alcohols</td>
</tr>
</tbody>
</table>

### C. Chemicals that may autopolymerize as a result of peroxide accumulation

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Peroxide Forming Compound</th>
<th>Other Compound(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylic acid(^b)</td>
<td>Methyl methacrylate(^b)</td>
<td>Vinyl chloride</td>
</tr>
<tr>
<td>Acrylonitrile(^b)</td>
<td>Styrene</td>
<td>Vinylpyridine</td>
</tr>
<tr>
<td>Butadiene(^c)</td>
<td>Tetrafluoroethylene(^c)</td>
<td>Vinyladiene chloride</td>
</tr>
<tr>
<td>Chloroprene(^c)</td>
<td>Vinyl acetate</td>
<td></td>
</tr>
<tr>
<td>Chlorotrifluoroethylene</td>
<td>Vinylacetylene</td>
<td></td>
</tr>
<tr>
<td>Chemicals</td>
<td>p-Chlorophenetole</td>
<td>4,5-Hexadien-2-yn-1-ol</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Allyl ether</td>
<td>Cyclooctene</td>
<td>n-Hexyl ether</td>
</tr>
<tr>
<td>Allyl ethyl ether</td>
<td>Cyclopentyl methyl ether</td>
<td>o,p-Iodophenetole</td>
</tr>
<tr>
<td>Allyl phenyl ether</td>
<td>Diallyl ether</td>
<td>Isomyl benzyl ether</td>
</tr>
<tr>
<td>p-(n-Amyloxy)benzoyl chloride</td>
<td>p-Di-n-butoxybenzene</td>
<td>Isomyl ether</td>
</tr>
<tr>
<td>n-Amyl ether</td>
<td>1,2-Dibenzyloxyethane</td>
<td>Isobutyl vinyl ether</td>
</tr>
<tr>
<td>Benzyl n-butyl ether</td>
<td>p-Dibenzyloxybenzene</td>
<td>Isophorone</td>
</tr>
<tr>
<td>Benzyl ethyl ether</td>
<td>1,2-Dichloroethyl ethyl ether</td>
<td>B-Isopropoxypropionitrile</td>
</tr>
<tr>
<td>Benzyl ethyl ether</td>
<td>2,4-Dichlorophenetole</td>
<td>Isopropyl 2,4,5-trichlorophenoxyacetate</td>
</tr>
<tr>
<td>Benzyl methyl ether</td>
<td>Diethoxymethane</td>
<td>Limonene</td>
</tr>
<tr>
<td>Benzyl 1-naphthyl ether</td>
<td>2,2-Diethoxypropane</td>
<td>1,5-p-Methadiene</td>
</tr>
<tr>
<td>1,2-Bis(2-chloroethoxy) Ethane</td>
<td>Diethyl ethoxymethylene Malonate</td>
<td>Methyl p-(n-amyl-oxy)-benzoate</td>
</tr>
<tr>
<td>Bis(2 ethoxyethyl)ether</td>
<td>Diethyl fumarate</td>
<td>4-Methyl-2-pentanone</td>
</tr>
<tr>
<td>Bis(2-(methoxyethoxy)-ethyl) ether</td>
<td>Diethyl acetal</td>
<td>n-Methylphenetole</td>
</tr>
<tr>
<td>Bis(2-chloroethyl)ether</td>
<td>Diethylketene</td>
<td>2-Methyltetrahydrofuran</td>
</tr>
<tr>
<td>Bis(2-ethoxyethyl)adipate</td>
<td>m,o,p-diethoxybenzene</td>
<td>3-Methoxy-1-butyl acetate</td>
</tr>
<tr>
<td>Bis(2-ethoxyethyl)phthalate</td>
<td>1,2-Diethoxyethane</td>
<td>2-Methoxyethanol</td>
</tr>
<tr>
<td>Bis(2-methoxyethyl)-Carbonate</td>
<td>Dimethoxymethane</td>
<td>3-Methoxyethyl acetate</td>
</tr>
<tr>
<td>Bis(2-methoxyethyl) ether</td>
<td>1,1-Dimethoxymethane</td>
<td>2-Methoxyethyl vinyl ether</td>
</tr>
<tr>
<td>Bis(2-methoxyethyl) Phthalate</td>
<td>Dimethylethylene</td>
<td>Methoxy-1,3,5,7-cycloocta-tetraene</td>
</tr>
<tr>
<td>Bis(2-methoxymethyl) Adipate</td>
<td>3,3-Dimethoxypropene</td>
<td>B-Methoxypropionitrile</td>
</tr>
<tr>
<td>Bis(2-n-butoxyethyl) Phthalate</td>
<td>2,4-Dinitrophenetole</td>
<td>m-Nitrophenetole</td>
</tr>
<tr>
<td>Bis(2-phenoxyethyl) ether</td>
<td>1,3-Dioxepane</td>
<td>1-Octene</td>
</tr>
<tr>
<td>Bis(4-chlorobutyl) ether</td>
<td>Di(1-propynyl)ether</td>
<td>Oxybis(2-ethyl acetate)</td>
</tr>
<tr>
<td>Bis(chloromethyl) ether</td>
<td>Di(2-propynyl)ether</td>
<td>Oxybis(2-ethyl benzoate)</td>
</tr>
<tr>
<td>2-Bromomethyl ethyl ether</td>
<td>Di-n-propoxymethane</td>
<td>B,B-oxypyronepropionitrile</td>
</tr>
<tr>
<td>B-Bromophenetole</td>
<td>1,2-Epoxy-3-isoproxypropene</td>
<td>1-Pentene</td>
</tr>
<tr>
<td>o-Bromophenetole</td>
<td>1,2-Epoxy-3-phenoxypropene</td>
<td>Phenoyacetyl chloride</td>
</tr>
<tr>
<td>p-Bromophenetole</td>
<td>p-Ethoxycetophenone</td>
<td>a-Phenoypropionyl chloride</td>
</tr>
<tr>
<td>3-Bromopropyl phenyl ether</td>
<td>2-Ethoxyethyl acetate</td>
<td>Phenyl o-propyl ether</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Monomers</td>
<td>Properties</td>
</tr>
<tr>
<td>-----------</td>
<td>----------</td>
<td>------------</td>
</tr>
<tr>
<td>1,3-Butadiyne</td>
<td>(2-Ethoxyethyl)-o-benzoylbenzoate</td>
<td>p-Phenylphenetone</td>
</tr>
<tr>
<td>Buten-3-yn</td>
<td>1-(2-Ethoxyethoxy)ethyl acetate</td>
<td>n-Propyl ether</td>
</tr>
<tr>
<td>tert-Butyl ethyl ether</td>
<td>1-Ethoxynaphthalene</td>
<td>n-Propyl isopropyl ether</td>
</tr>
<tr>
<td>tert-Butyl methyl ether</td>
<td>o,p-Ethoxyphenyl isocyanate</td>
<td>Sodium 8,11,14-eicosa-tetraenoate</td>
</tr>
<tr>
<td>n-Butyl phenyl ether</td>
<td>1-Ethoxy-2-propyne</td>
<td>Sodium ethoxyacetylide</td>
</tr>
<tr>
<td>n-Butyl vinyl ether</td>
<td>3-Ethoxypropionitrile</td>
<td>Tetrahydrofuran</td>
</tr>
<tr>
<td>Chloroacetaldehyde diethylacetal</td>
<td>2-Ethylacrylaldehyde oxide</td>
<td>Triethylene glycol diacetate</td>
</tr>
<tr>
<td>2-Chlorobutadiene</td>
<td>2-Ethylbutanol</td>
<td>Triethylene glycol dipropionate</td>
</tr>
<tr>
<td>1-(2-Chloroethoxy)-2-phen-oxyethane</td>
<td>Ethyl B-ethoxypropionate</td>
<td>1,3,3-Trimethoxypropene</td>
</tr>
<tr>
<td>Chloroethylene</td>
<td>2-Ethylhexanal</td>
<td>1,1,2,3-Tetrachloro-1,3-butadiene</td>
</tr>
<tr>
<td>Chloromethyl methyl ether</td>
<td>Ethyl vinyl ether</td>
<td>4-Vinyl cyclohexene</td>
</tr>
<tr>
<td>B-Chlorophenetole</td>
<td>Furan</td>
<td>Vinylene carbonate</td>
</tr>
<tr>
<td>o-Chlorophenetole</td>
<td>2,5-Hexadiyn-1-ol</td>
<td>Vinylene chloride</td>
</tr>
</tbody>
</table>

**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.

References:


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

<table>
<thead>
<tr>
<th>Substances in the left-hand column</th>
<th>Reactivity in the right-hand column</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaline and alkaline earth metals, such as Sodium, Potassium, Cesium, Lithium, Magnesium, Calcium</td>
<td>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.</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>Chromic acid, Nitric acid, hydroxyl compounds, Ethylene glycol, Perchloric acid, peroxides, permanganates.</td>
</tr>
<tr>
<td>Acetic anhydride</td>
<td>Chromic acid, Nitric acid, hydroxyl-containing compounds, Ethylene glycol, Perchloric acid, peroxides and permanganates.</td>
</tr>
<tr>
<td>Acetone</td>
<td>Concentrated Nitric and Sulfuric acid mixtures.</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Copper, Silver, Mercury and halogens, Fluorine, Chlorine, Bromine.</td>
</tr>
<tr>
<td>Alkali &amp; alkaline earth metals (such as powdered Aluminum or Magnesium, Calcium, Lithium, Sodium, Potassium)</td>
<td>Water, Carbon tetrachloride or other chlorinated hydrocarbons, Carbon dioxide, and halogens.</td>
</tr>
<tr>
<td>Aluminum alkyls</td>
<td>Halogenated hydrocarbons, water.</td>
</tr>
<tr>
<td>Ammonia (anhydrous)</td>
<td>Silver, Mercury, Chlorine, Calcium hypochlorite, Iodine, Bromine, Hydrogen fluoride, Chlorine dioxide, Hydrofluoric acid (anhydrous).</td>
</tr>
<tr>
<td>Material</td>
<td>Reactants</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>Acids, metal powders, flammable liquids, chlorates, nitrites, Sulfur, finely divided organics or combustibles.</td>
</tr>
<tr>
<td>Aniline</td>
<td>Nitric acid, Hydrogen peroxide.</td>
</tr>
<tr>
<td>Arsenical materials</td>
<td>Any reducing agent.</td>
</tr>
<tr>
<td>Azides</td>
<td>Acids.</td>
</tr>
<tr>
<td>Benzoyl peroxide</td>
<td>Chloroform, organic materials.</td>
</tr>
<tr>
<td>Bromine</td>
<td>Ammonia, Acetylene, Butadiene, Butane and other petroleum gases, Sodium carbide, Turpentine, Benzene and finely divided metals, Methane, Propane, Hydrogen.</td>
</tr>
<tr>
<td>Calcium carbide</td>
<td>Water (see also Acetylene).</td>
</tr>
<tr>
<td>Calcium hypochlorite</td>
<td>Methyl carbitol, Phenol, Glycerol, Nitromethane, Iron oxide, Ammonia, activated carbon.</td>
</tr>
<tr>
<td>Calcium oxide</td>
<td>Water.</td>
</tr>
<tr>
<td>Carbon, activated</td>
<td>Calcium hypochlorite, all oxidizing agents.</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>Sodium.</td>
</tr>
<tr>
<td>Chlorates</td>
<td>Ammonium salts, acids, metal powders, Sulfur, finely divided organics or combustibles.</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Ammonia, Acetylene, Butadiene, Butane, Propane, and other petroleum gases, Hydrogen, Sodium carbide, Turpentine, Benzene and finely divided metals, Methane.</td>
</tr>
<tr>
<td>Chlorine dioxide</td>
<td>Ammonia, Methane, Phosphine and Hydrogen sulfide.</td>
</tr>
<tr>
<td>Chlorosulfonic acid</td>
<td>Organic materials, water, powdered metals.</td>
</tr>
<tr>
<td>Substance</td>
<td>Reactants</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Chromic acid &amp; Chromium trioxide</td>
<td>Acetic acid, Naphthalene, Camphor, Glycerin, Turpentine, alcohol and other flammable liquids, paper or cellulose.</td>
</tr>
<tr>
<td>Copper</td>
<td>Acetylene, Hydrogen peroxide, Ethylene oxide.</td>
</tr>
<tr>
<td>Cumene hydroperoxide</td>
<td>Acids, organic or mineral.</td>
</tr>
<tr>
<td>Cyanides</td>
<td>Acids.</td>
</tr>
<tr>
<td>Ethylene oxide</td>
<td>Acids, bases, Copper, Magnesium perchlorate.</td>
</tr>
<tr>
<td>Flammable liquids</td>
<td>Ammonium nitrate, Chromic acid, Hydrogen peroxide, Nitric acid, Sodium peroxide, halogens.</td>
</tr>
<tr>
<td>Fluorine</td>
<td>Almost all oxidizable substances.</td>
</tr>
<tr>
<td>Hydrocarbons (such as Bromine, Butane)</td>
<td>Fluorine, Chlorine, Chromic acid, Sodium peroxide.</td>
</tr>
<tr>
<td>Hydrocyanic acid</td>
<td>Nitric acid, alkalis.</td>
</tr>
<tr>
<td>Hydrofluoric acid (anhydrous)</td>
<td>Ammonia (aqueous or anhydrous).</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>Copper, Chromium, Iron, most metals or their salts, any flammable liquid, combustible materials, Aniline, Nitromethane, alcohols, Acetone, organic materials, Aniline.</td>
</tr>
<tr>
<td>Hydrides</td>
<td>Water, air, Carbon dioxide, chlorinated hydrocarbons.</td>
</tr>
<tr>
<td>Hydrofluoric acid, anhydrous (Hydrogen fluoride)</td>
<td>Ammonia (anhydrous or aqueous), organic peroxides.</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>Fuming Nitric acid, oxidizing gases.</td>
</tr>
<tr>
<td>Hydrocarbons (Benzene, Butane,</td>
<td>Fluorine, Chlorine, Bromine, Chromic acid,</td>
</tr>
<tr>
<td>Compound</td>
<td>Reactants</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Propane, Gasoline, Turpentine, etc.)</td>
<td>Sodium peroxide, fuming Nitric acid.</td>
</tr>
<tr>
<td>Hydroxylamine</td>
<td>Barium oxide, Lead dioxide, Phosphorus pentachloride and trichloride, Zinc, Potassium dichromate.</td>
</tr>
<tr>
<td>Hypochlorites</td>
<td>Acids, activated Carbon.</td>
</tr>
<tr>
<td>Iodine</td>
<td>Acetylene, Ammonia (anhydrous or aqueous), Hydrogen.</td>
</tr>
<tr>
<td>Maleic anhydride</td>
<td>Sodium hydroxide, Pyridine and other tertiary amines.</td>
</tr>
<tr>
<td>Mercury</td>
<td>Acetylene, Fulminic acid, Ammonia, Oxalic acid.</td>
</tr>
<tr>
<td>Nitrates</td>
<td>Acids, metal powders, flammable liquids, chlorates, sulfur, finely divided organics or combustibles, Sulfuric acid.</td>
</tr>
<tr>
<td>Nitric acid (concentrated)</td>
<td>Acetic acid, Aniline, Chromic acid, Hydrocyanic acid, Hydrogen sulfide, flammable liquids, flammable gases, nitratable substances, organic peroxides, chlorates, Copper, brass, any heavy metals.</td>
</tr>
<tr>
<td>Nitroparaffins</td>
<td>Inorganic bases, amines.</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Oil, grease, Hydrogen, flammable liquids, solids, or gases.</td>
</tr>
<tr>
<td>Oxalic acid</td>
<td>Silver, mercury, organic peroxides.</td>
</tr>
<tr>
<td>Perchlorates</td>
<td>Acids.</td>
</tr>
<tr>
<td>Perchloric acid</td>
<td>Acetic anhydride, Bismuth and its alloys, alcohol, paper, wood, grease, oil, organic amines or antioxidants.</td>
</tr>
<tr>
<td>Peroxides, organic</td>
<td>Acids (organic or mineral); avoid friction, store cold.</td>
</tr>
<tr>
<td>Substance</td>
<td>Reactants</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Phosphorus (white)</td>
<td>Air, Oxygen, alkalis, reducing agents.</td>
</tr>
<tr>
<td>Phosphorus pentoxide</td>
<td>Propargyl alcohol.</td>
</tr>
<tr>
<td>Potassium</td>
<td>Carbon tetrachloride, Carbon dioxide, water.</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>Acids, Sulfuric acid (see also chlorates).</td>
</tr>
<tr>
<td>Potassium perchlorate</td>
<td>Sulfuric &amp; other acids (see also Perchloric acid, &amp; chlorates).</td>
</tr>
<tr>
<td>Potassium permanganate</td>
<td>Glycerin, Ethylene glycol, Benzaldehyde, any free acid, Sulfuric acid.</td>
</tr>
<tr>
<td>Selenides</td>
<td>Reducing agents.</td>
</tr>
<tr>
<td>Silver</td>
<td>Acetylene, Oxalic acid, Tartaric acid, Fulminic acid, ammonium compounds.</td>
</tr>
<tr>
<td>Sodium</td>
<td>Carbon tetrachloride, Carbon dioxide, water. See alkaline metals (above).</td>
</tr>
<tr>
<td>Sodium amide</td>
<td>Air, water.</td>
</tr>
<tr>
<td>Sodium nitrate</td>
<td>Ammonium nitrate and other ammonium salts.</td>
</tr>
<tr>
<td>Sodium oxide</td>
<td>Water, any free acid.</td>
</tr>
<tr>
<td>Sodium peroxide</td>
<td>Any oxidizable substance, such as Ethanol, Methanol, glacial Acetic acid, Acetic anhydride, Benzaldehyde, Carbon disulfide, Glycerine, Ethylene glycol, Ethyl acetate, Methyl acetate and Furfural.</td>
</tr>
<tr>
<td>Sulfides</td>
<td>Acids.</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>Chlorates, perchlorates, permanganates, organic peroxides. Potassium chlorate, Potassium perchlorate, Potassium permanganate (similar compounds of light metals, such as Sodium, Lithium).</td>
</tr>
<tr>
<td>Compound</td>
<td>Firefighting Procedures</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Tellurides</td>
<td>Reducing agents.</td>
</tr>
<tr>
<td>UDMH (1,1-Dimethylhydrazine)</td>
<td>Oxidizing agents such as Hydrogen peroxide and fuming Nitric acid.</td>
</tr>
<tr>
<td>Zirconium</td>
<td>Prohibit water, Carbon tetrachloride, foam and dry chemical on zirconium fires.</td>
</tr>
</tbody>
</table>
APPENDIX I: EH&S SEGREGATION SCHEME

EH&S CHEMICAL SEGREGATION PROCEDURE

KEY

Hazard Class # – All Hazard Classes must be segregated from other Hazard Classes
  • Class – must segregate from other Classes within Hazard Class
    o Group – recommend to segregate from other groups within Class

Hazard Class 1 - Explosives (potentially explosive)

Hazard Class 2 - Compressed Gases / Lecture Bottles
  • Class 2.1 - Flammable gases
  • Class 2.2 - Non-Flammable gases
  • Class 2.3 - Poisonous gases
  • Oxidizing gases (separate from everything)
  • Corrosive – acids
  • Corrosive – bases
  • Cryogenics
  • Pyrophorics

Hazard Class 3 - Flammable liquids
  • Combustible liquids (that do not have another hazard)

Hazard Class 4 - Flammable solids
  • Class 4.1 - Flammable solids
  • Class 4.2 - Spontaneously combustible
  • Class 4.3 - Dangerous When Wet

Hazard Class 5 - Oxidizers
  • Class 5.1 - Oxidizers
Class 5.2 - Organic peroxides

Hazard Class 6 - Poisons
- Class 6.1 - Poisons
  o Liquids
  o Solids
  o Carcinogens
  o Reproductive hazards (Teratogens, Mutagens)
  o Irritants
  o Organic acids, solid
  o Nonhazardous chemicals

- Poison Inhalation Hazards (PIH)
- Cyanides
- Controlled substances
- Class 6.2 - Biohazards – Infectious agents
  o CDC Select agents

Hazard Class 7 - Radioactives

Hazard Class 8 - Corrosives
- Inorganic acids
- Oxidizing acids (Nitric acid and Perchloric acid)
- Hydrofluoric acid
- Organic acids, liquid (can store in flammable cabinet)

- Bases
  o Liquids
  o Solids
Prior Approval for Highly Hazardous Operations

PI or supervisor: __________________________ Location: __________________________

Name of chemical(s) or operation: ________________________________________________

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

- Are aware of the hazards the chemical(s) or operation(s) pose?
- Has read the Standard Operating Procedures for this process?
- Knows the first aid procedure in case of an exposure?
- Knows what to do in the event of a spill or other emergency?
- Has received any specific training needed above the standard lab safety training (i.e.: radiation, hazardous waste)

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# APPENDIX K: LASER REGISTRATION FORM

## REGISTRATION OF CLASS 3b AND CLASS 4 LASERS

Department: ____________________________

Professor/authority: __________________

<table>
<thead>
<tr>
<th>Laser Type</th>
<th>Production Type</th>
<th>Laser Class</th>
<th>Wavelength</th>
<th>Power</th>
<th>Building/Room Number</th>
<th>Contact Person</th>
<th>Use</th>
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Laser Type: CO₂, Nd:YAG, He-Ne, Diode, etc  
Production Class: Commercial, modified, "home-built"  
Class: 3b or 4  
Use: Research, medical or therapeutic application, undergraduate teaching, outside user etc.

Please return completed form to EH&S

-- Page ____ of ____ --
APPENDIX L: REFERENCE MATERIALS

1) Reference materials identified in the OSHA Lab Standard


American Red Cross CPR Workbook, American Red Cross, 1988.

American Red Cross Multimedia Standard First Aid, American Red Cross.


Carson, George A., *The American Conference of Governmental Industrial*


Claton, George D., Patty’s Industrial Hygiene And Toxicology, Volume 2A, 2B, 2C and 3, John Wiley & Sons Inc, Canada, 1981.


Collins George R., editor, Manual for Laboratory Animal Technicians, American Association for Laboratory Animal Science, IL.


Control of Biohazards in the Research Laboratory Course Manual, Office of Environmental Health & Safety, Department of Environmental Health Sciences, Baltimore MD.


Cox, Doye B, editor, Hazardous Materials Management, Institute of


Drury, Peter, Guidelines for Laboratory Safety, Canadian Society of Laboratory Technologists, Canada, 1996.


Ebert, Michael, Radiation Effects In Physics, Chemistry and Biology, North Holland Publishing Co., 1963.


Environmental Radiation Measurements, National Council on Radiation
Protection and Measurements, 1976.


Gray, Joel E., *Quality Control in Diagnostic Imaging*, Mayo Foundation,


*Guidelines for the Selection of Chemical Protective Clothing, Volume 1 and 2*, American Conference of Governmental Industrial Hygienists, 1983.


*Health Physics at Research Reactor*, Health Physics, Conference, 1996.


Laboratory Decontamination and Destruction of Aflatoxins B1, B2, G1, G2 In Laboratory Wastes, International Agency for Research on Cancer, Lyon


Protection Against Radiation From Brachytherapy Sources, National Council on Radiation Protection and Measurements, 1972.


Radiation Protection for Medical and Allied Health Personal, National Council on Radiation Protection and Measurements, 1989.

Radiation Protection in Educational Institutions, National Council on Radiation Protection and Measurements, 1996.


Tatken, Rodger L., *Registry of Toxic Effects of Chemical Substances, Volume 1, 2 and 3*, U.S. Department of Health And Human Services, Cincinnati, 1983.


*The Medical NBC Battlebook*, US Army Center for Health Promotion and Preventive Medicine, 2002.

The Safe Handling of Chemical Carcinogens, Division of Safety, National Institutes of Health, U.S.A.


TLV’s and BEI’s: Threshold Limit Values for Chemical Substances and Physical Agents. Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, 1999.

Tracy, Tony M., Clinical Toxicology of Commercial Products, Williams Wilkins U.S.A., 1984.


Veterinary and Human Toxicology, Veterinary and Human Toxicology U.S, 1981.

Video Display Terminals, Bell Laboratories, Bell Telephones, 1983.


Emergency handling of radiation exposure or radioactive contamination cases should not be feared. The handling of these cases is a matter involving common sense, cleanliness and good housekeeping.

Radiation can be detected and measured by a simple instrument--a survey meter. Radiation accident problems have parallels in other conditions handled more frequently by University Police and Ambulance personnel. Since you may become involved with such accidents, there are a few things you should know about radiation.

There are four types of radiation accident patients. The individual who has received whole or partial body external radiation may have received a lethal dose of radiation but he is no hazard to rescue personnel or the environment. He is no different than the patient that has just received diagnostic x-rays or radiation therapy.

Another type is the individual who has received internal contamination by inhalation or ingestion. He also is no hazard to rescue personnel or the environment. However, the environment may be a hazard if the radioactive particles are still airborne in the work area. Following cleansing of minor amounts of contaminated material deposited on the body surface during airborne exposure, he is similar to the chemical poisoning case. All body wastes should be collected and saved for measurements of the amount of radiation to assist the hospital in determining appropriate therapy.

External contamination of body surface and/or clothing by radioactive liquids or dirt particles presents a third type, with problems similar to vermin infestation. Surgical isolation technique to protect rescue personnel and cleansing to protect the environment must be taken to confine and remove a potential hazard.

When external contamination is complicated by a wound, care must be taken not to cross-contaminate surrounding surfaces. The wound and surrounding surfaces are cleansed separately and sealed off when clean. When crushed dirty tissue is involved, early wet cleansing following wound irrigation may be indicated. Further cleansing, debridement, and definite therapy can await sophisticated measurement and hospital care.

To properly deal with radiation accidents, many experts may be necessary. The initial emergency work performed on campus by law enforcement officers, safety personnel, and ambulance personnel will be supplemented later by physicians, nurses, Health Department personnel and other
specialists when the patient is received at the hospital. To assure continuity in the flow of work, it is necessary that each specialist knows what is expected of him as well as a general familiarity of what is expected of others during the radiation emergency.

It is the responsibility of rescue personnel to:

**For the patient:**

1. Give life saving emergency assistance if needed.

2. Secure pertinent information including estimate of radiation exposure from those present at the scene.

3. Determine if physical injury or open wounds are involved. Cover wounds with clean dressings; use elastic bandage to hold wound covers in place; do not use adhesive tape.

4. Cover stretcher, including pillow, with open blanket; wrap patient to limit spread of contamination.

5. Notify hospital by radio or telephone of available information before arrival at the hospital.

**For rescue personnel:**

1. To have performed surveys of clothing, ambulance, etc., before undertaking further assignments.

2. If contaminated, place clothing in plastic bag and store in container marked "Radioactive Do Not Discard." A container is located in Building 133, the radiation section. Cleanse self by washing in appropriate sinks marked for radioactive use. (If no marked sink is near, use any sink and then label for later contamination survey).

3. If in contaminated area, all personnel must be surveyed by radiation survey meter; measurements must be recorded. Survey meters are available in most labs where radioactive materials are used and in Room 506 or 507 of Science Building II. Cleansing must continue until the Radiation Safety Officer or responsible physician indicates person is "clean" and may leave.

In addition, University Police and/or Safety personnel must be responsible for carrying out the following procedures:

1. If notified of an emergency involving either radioactive material or the exposure of people to radiation from sources such as radioactive material or X-rays, immediately verify the location and nature of the event, and whether or not people may have been injured or exposed to radioactivity. Then report the facts to the Safety Coordinator and the Radiation Safety Officer. In cases of emergency when the above two people cannot be reached, the incident should be reported to the Broome County Health Department.
2. University Police and Safety officers are briefed annually by the Radiation Safety Officer and must know where alpha and beta-gamma radiation monitoring equipment is located. It is necessary that monitoring equipment accompany the patient to the hospital since most hospitals are not equipped with radiation monitoring equipment. Additional equipment, other than that located on campus, may be obtained from the Broome County Civil Defense office.

3. When called to the scene of an accident and the presence of radioactive material is known or suspected, the names and addresses of all people located in the immediate area affected must be obtained. In addition, the names and addresses of all rescue personnel must be recorded for further survey follow up to assure that all personnel are "clean" of radioactive contamination.

4. When ambulance personnel arrive, they must be informed of the known or suspected presence of radioactive material.

5. If it is necessary for University Police officers to transport the patient in a patrol vehicle, the patient must be wrapped in a blanket to prevent the spread of radioactive material contamination onto the transporting vehicle and onto those persons handling the injured. The vehicle must be surveyed after use.

6. Keep bystanders away from the incident area. Detour vehicular and pedestrian traffic as for a major fire. Permit access only to those persons identified with an emergency organization--Harpur's Ferry, Civil Defense, Health Department, etc. and to those who can prove that they have an official responsibility for the site, buildings, equipment or material affected by the emergency. Remember, the names and addresses of all personnel exposed to the radioactive material must be recorded.

7. If it is known or believed that a radioactive material container has been damaged, it must be assumed that some radioactive material has been released and personnel and property have been contaminated.

8. University Police and Safety officers can determine that:

   a) There is or is not alpha, beta, or gamma radiation present.
   b) The radiation is low level (e.g. the readings do not exceed the maximum range of the survey meter on lowest scale).
   c) The radiation is moderate level (exceeds range of meter on lowest scale).
   d) The radioactive material is or is not scattered around the area and has or has not contaminated shoes, clothing, uncovered head, arms, legs, equipment, corridors or vehicles.

**Additional information helpful for rescue personnel:**

Radiation Safety Officer - James D. Brownridge  
Associate Director, Health & Safety - Connie E. Corey
Office Phone: 607-777-2211 (x7-2211) / Home Phone: 607-724-8306

Radiological Safety Committee:

Susan Bane, Chair - Office Phone: 607-777-2927 (x7-2927) / Home Phone: 607-772-9549

Broome County Health Department, Division of Environmental Health -
Telephone: 607-778-2887

Broome County Office of Emergency Services
Telephone: 607-778-2170

NYS Department of Health
Telephone: 518-402-7590

Location of survey equipment:
Alpha Survey Meter - SC II, 507 or 506
Beta-Gamma Survey Meter - SC II, 507 or 506

Contaminated waste-can location:
Chemical and Radioactive Storage Building, 133
607-777-3956
General Policy

1. It is the policy of Binghamton University to maintain an environment for its faculty, staff, students, and visitors that will not subject them to avoidable risk of injury.

2. The applicable health and safety standards are contained in rules and regulations promulgated by Federal and State agencies which must be followed in establishing campus safety policies. In addition, the published standards of nationally recognized professional health and safety organizations serve as guidelines in areas not covered by the government standards, rules and regulations.

Environmental Health and Safety Responsibility

1. Management

The President of the University is legally responsible for campus health and safety and must ensure that appropriate health and safety policies are established for environmental protection and the prevention of health and safety hazards. These responsibilities are delegated to all levels of supervision in order to ensure that campus health and safety objectives are met.

2. Role of Department Chairs/Directors

The chairs or directors of each department are responsible for the health and safety of all students, faculty, staff and visitors in their area. They have the obligation and authority to prevent or stop any operation they consider unsafe. They are also expected to obtain whatever assistance they may need from the Department of Environmental Health and Safety in order to develop and implement a departmental health and safety program. The chair/director may delegate all or part of these obligations to a departmental safety coordinator. Ideally, the safety coordinator should be a faculty member in an academic department. However, such delegation in no way relieves the chair or director of their responsibility in matters of departmental health and safety.
3. Supervisors

Each supervisor must develop initiatives that will maintain a safe work place and also develop training for employees and students regarding safe work practices. This training must ensure that employees and students know:

- All the potentially hazardous conditions associated with departmental operations, and methods established to control them.
- All applicable safety regulations for the area of operation.
- That they are expected to help all persons unfamiliar with the area to comply with applicable safety regulations.

The goal is for employees and students to develop awareness and responsibility for safety so they will act in a safe manner when faced with situations not covered by established rules or regulations.

4. Individuals

Many injuries are caused by unsafe acts rather than unsafe conditions. It is incumbent upon each individual to provide constant vigilance necessary to avoid unsafe acts. Thinking "safety" is a part of everyone's job. Each person has an obligation to take all reasonable precautions to prevent injury to themself or their fellow employee or student. Individuals are expected to learn and follow all health and safety policies and standards which apply to their activities and to check with their supervisor when there are doubts concerning potential hazards.

5. Department of Environmental Health and Safety

The University's Department of Environmental Health and Safety provides guidance and services to campus personnel so that the goals and objectives of the campus environmental health and safety policy may be attained. The responsibility requires the Department of Environmental Health and Safety to:

- Provide the President, or their designee, the information needed to formulate campus health and safety policies.
- Investigate and report health and safety incidents involving campus personnel or visitors.
• Assist campus personnel to plan, establish, and maintain safe work practices and a safe work environment in compliance with the Public Employees Safety and Health act of 1980.

Policy Title:

BU 808 - Chemical Waste Management and Disposal

Introduction

Chemical waste at Binghamton University is generally defined as any unwanted chemical, residual, or unusable by-product from any process, service operation, classroom activity or laboratory where chemical substances are used. Activities include, but are not limited to: classroom and research laboratories, maintenance functions, physical facilities operations, printing facilities, photographic chemicals from darkrooms, and miscellaneous chemicals from art departments.

Chemical waste that is declared a hazardous waste (HW) must be disposed of in accordance with New York State Department of Environmental Conservation (NYSDEC) regulations (Ref: 6 NYCRR Part 370 series) and Federal Regulations (40CFR). Binghamton University is identified by NYSDEC as a HW generator facility and has been issued an Environmental Protection Agency (EPA) hazardous waste generator ID number. This designation prohibits the following activities by Binghamton University:

1. In-house disposal of any HW;

2. In-house treatment of HW (other than elementary neutralization); and

3. Storage of HW beyond the limitations stated in current Part 370 series regulations.
Off-site transportation and disposal of HW must be provided by approved companies licensed by the EPA.

A program of waste minimization is supported. Practices include: buying only the volume of chemicals necessary to complete the intended task (buying in bulk is considerably more expensive when the cost of disposal is factored in), properly storing and disposing of unwanted chemicals in a timely manner to prevent chemical containers from degrading, substituting non-hazardous or less hazardous chemicals for hazardous ones, using recycled chemicals when possible, elementary neutralizations of acids and bases in the laboratory, and investigating micro-scale activities. When wastes are declared as hazardous wastes, primary methods of disposal focus on reclamation, destruction and/or treatment, thereby minimizing the overall impact to the environment.

Objectives

The objectives of the chemical waste management program (CWM Program) are to:

1. provide an effective method for removing unwanted chemicals from campus locations;

2. minimize the volume of chemical waste generated on campus using a variety of methods; and

3. temporarily store and arrange off-site transportation and disposal of all declared hazardous waste in accordance with current NYSDEC regulations.

Responsibilities

The majority of chemical waste generated at Binghamton University is declared hazardous waste. In light of the complexity of and frequent changes that occur in applicable NYSDEC regulations, chemical waste management activities must be limited to a single office. Environmental Health and Safety (EH&S) administers the CWM Program and is responsible for ensuring compliance with standard operating procedures, supervising the transport and storage of waste chemicals, record keeping for all waste chemicals accepted by the program, and contracting for disposal of all hazardous waste generated by Binghamton University.
Any and all persons generating a chemical waste have a moral and legal obligation to certify that their waste has been properly disposed. Improper disposal can result in injury to human health and the environment and may be punishable by a prison sentence, a monetary fine, or both.

Individuals that generate chemical waste are responsible for following established collection and storage procedures. The policy for collection and storage procedures for chemicals can be found in the Binghamton University *Hazardous Waste Management Guide* (available on-line at [https://ehs.binghamton.edu](https://ehs.binghamton.edu)). Although every effort will be made by EH&S to assist individuals in complying with these procedures, the generator must:

1. Read the Binghamton University *Hazardous Waste Management Guide* and follow the procedures outlined.

2. Properly label all chemical containers with all known or suspected chemical constituents and their approximate concentrations. The chemical name must be written out. Chemical structures, formulas, or abbreviations are not acceptable. Unknown chemicals cannot be accepted by the CWM Program. EH&S will assist generators in identifying methods and/or private laboratories that will identify unknown chemicals.

3. Segregate and store chemicals in compatibility classes such as acids, bases, flammables, oxidizers, poisons, etc.

4. Properly tag all waste chemicals with a Hazardous Chemical Waste Tag.

5. Properly package and containerize waste chemicals for transport.

**Procedures**

Chemical waste pick up schedule can be seen on our website at [http://ehs.binghamton.edu](http://ehs.binghamton.edu). Generators need to call 7-6835 or 7-5799 or send an e-mail to hazwaste@binghamton.edu to place a request for disposal. Requests for disposal need to be made before the scheduled pick up day. When calling or e-mailing a request for disposal, the following information must be included:

- name

- phone number
-building and room number

-type and amount of waste to be picked up (# of bottles)

-location of the waste

Generators need not be present when the waste is picked up. All waste must be properly labeled and tagged. The waste will be picked up at the lab or room on the scheduled day. A list of the scheduled pick up dates is available by contacting the Hazardous Waste Manager at 7-5799 or on the EHS website at http://ehs.binghamton.edu.

More detailed information can be found in the Binghamton University Hazardous Waste Management Guide. Copies of the guide can be obtained by contacting the Hazardous Waste Manager at 7-5799.

**Note:** All radioactive wastes are handled by radiation safety. Contact the radiation safety officer at 7-4370. Regulated medical waste is handled in accordance with Management Procedure No. 819 or contact Bob Snyder at 7-4905.

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**Policy Title:**

**BU 810 – Laser Safety Procedures**

**GENERAL**
The laser is a light source that produces a monochromatic coherent beam of relatively high energy. In addition to the potential hazards of eye or body exposure to the laser beam and its reflections, potentially harmful radiation may be generated. Ozone may be produced and toxic materials may be generated in the target area. Precautions are also required to protect against exposure to high voltages and the possibility of fire. (toxic gases are often used in laser)
This procedure outlines basic safety considerations for laser operations. The procedure is based on but is not as inclusive as the American National Standards Institute (ANSI) Standard Z136.1 - 1972 and the New York Labor Department Code Rule 50. It is recommended that faculty and staff working with lasers be thoroughly familiar with these two codes.

EXPOSURE CRITERIA

Because the energy level and output frequency or wavelength depend upon the type of laser used and its method of operation, the radiant intensity of each laser beam and of its reflections shall be determined by direct measurement or by calculations. Control measures shall be taken to keep the possible exposure of personnel well within the maximum permissible exposure (MPE) levels stated in ANSI Z136.1 and Code Rule 50.

NOTIFICATION

The University Radiological Safety Committee must be notified prior to the procurement, construction, or initial operation of laser equipment. The Committee shall review all equipment, installations, and operating prior to initial operations. The department owning and operating the laser shall notify the Environmental Health and Safety (EHS) Office of such installations and will ensure that governmental agencies are notified and maintain required records.

The EHS Office must be notified when a laser operation is discontinued or dismantled.

INVENTORY

The individual offices shall maintain a current inventory of all laser devices. The inventory shall include the manufacturer’s name, model number, type, serial number, SUNY inventory number, wavelength, power and/or energy, beam geometry, location (building and room), responsible faculty, and users. A copy of this inventory must be sent to EH&S and updated annually.

TRAINING

Faculty, staff, and students that operate or assist in the operation of laser equipment shall be thoroughly trained. The training shall include
an explanation of potential hazards of the laser beam and its reflected energy, safety requirements, use of personal protective equipment, emergency procedures, and any other information operators need to know in order to protect themselves and others. Each operator should be given a copy of the operating procedures. All faculty, staff, and students shall receive the required training prior to operating the laser. Copies of emergency procedures will be sent to the EHS Office for safety and security personnel training.

**EYE PROTECTION**

Appropriate eye protection shall be used whenever the possibility exists for eye exposure in excess of maximum permissible limits. It shall be capable of attenuating the maximum possible exposure to within acceptable limits. All eye protection devices shall be clearly marked to identify the optical density at the wavelength they will protect against. The owner of the equipment shall conduct periodic inspections of this equipment including inspection of attenuator material for pitting, crazing, cracking, etc., and of frames for mechanical integrity and light leaks. There shall be a sufficient number of eye protection devices located in each laboratory containing a laser for all persons required to be in the laboratory at any one time.

**LABORATORY FACILITIES**

Laser operations shall be confined to fully enclosed rooms, isolated from other non-laser operations, unless the laser equipment protects personnel from levels of radiation above the MPE’s indicated in ANSI Z136.1 and Code Rule 50. If more than one laser is within a single room, effective optical and physical barriers shall be provided between them to prevent personnel from inadvertently viewing or intercepting beam paths. The use of door interlocks and/or signal lights prevent entrance while a laser is in operation shall be considered.

Laser beams shall not be projected beyond the confines of the controlled area without prior written approval of the University Radiological Safety Committee and the EHS Office.

**WARNING SIGNS**

Laser warning signs shall be used in accordance with ANSI Z136.1 and Code Rule 50. The presence of warning signs should be checked daily by the owner/operator.

**VENTILATION**
Ventilation shall be sufficient to remove any hazardous gases which may escape from sealed systems of continuous flow gas lasers or to safely controlled cryogenic liquids and gases used to purge and cool lasers.

Forced ventilation shall be provided for pumping sources such as mercury or xenon lamps, which may produce ozone in hazardous quantities. Forced ventilation will also be required in the area of the target when toxic materials, such as evaporated metals or decomposed materials are present.

Physical Facilities staff will be consulted in all cases where additional forced ventilation is required so as to assure adequate makeup air.

**FIRE PREVENTION**

Combustible and flammable material will be kept to a minimum and placed so it will not be accidentally exposed to high power laser beams. The EHS Office will assist in the placement of appropriate fire extinguishers.

**ACCIDENT REPORTS**

Accidents involving exposure to a laser beam shall be immediately reported to both the University Health Physicist and the EHS Office. A written accident report shall be completed by the injured person's supervisor and forwarded to the EHS Office within five days.

All students receiving accidental exposures must seek medical care immediately.

The following constitutes accidental exposure:

1. A person who suspects he has had accidental eye exposure or who suffers persistent after-image or abnormal effect shall report to a medical facility for examination.
2. A person who receives skin exposure from a laser resulting in discomfort or which produces a reddening of the exposed area shall report to a medical facility for examination. Any delayed, persistent, or progressive change in any area of the skin shall be reported.

**OTHER REQUIREMENTS**

1. All laser installations shall meet requirements set forth in the

2. High voltage laser circuits shall be protected by interlocked covers. When the removal of interlocked covers becomes necessary for work, such work, such as maintenance, adjustment or experimental tryout, there must be a written procedure. The procedure will outline the steps to be taken, precautionary measures, protective equipment and type and placement of shielding and must be approved by the faculty member responsible for the laser. A copy of such procedure will be sent to the EHS Office.

3. Capacitors shall be equipped with positive discharge devices and the capacitor bank will be provided with adequate shielding for protection in the event of rupture.

4. Cables between the power supply and the laser head must be corona-free and they must have adequate dielectric strength. Periodic inspection will be made to determine these capabilities. If a cable shows the presence of corona, it will be replaced immediately.

5. Layout of all auxiliary equipment such as meters and instruments will be made to minimize the hazards to the operators. For example, operators will not be required to face the direction of the laser beam during charging or firing in order to use the above instruments.

6. High voltage vacuum tubes in power supplies rated over 10KV will be surveyed on a regular basis for possible X-ray emission by the owner/operator.

7. The beam path shall be enclosed wherever possible to avoid accidental skin or eye exposure.
Most chemical spills are the result of casual handling of chemicals and a lack of preplanning. Before conducting any experiments, READ the Material Safety Data Sheets (MSDS) for the chemicals you plan to use. MSDS’s contain useful information relating to the chemical and physical properties, physical and health hazards, safe handling precautions (including proper personal protective equipment), spill response, and emergency and first aid procedures.

If a spill does occur, follow the procedure outlined below. Keep in mind that the responsibility for cleaning up a minor chemical spill rests with the individual that caused it. The Environmental Health & Safety Department (x7-2211) is available for advice on cleaning up minor chemical spills and for conducting major spill clean up.

**Chemical Spills**

When spills occur, it is necessary to take prompt and appropriate action. Appropriate action will depend upon the severity of the hazards associated with the particular chemical involved.

**Minor Spill**

*Only attempt to clean up a spill if it is minor, a known material, and presents limited risk.* Begin the cleanup immediately by using the proper personal protective equipment (PPE) such as gloves, goggles, etc.

Spill control usually begins by stopping the flow of the spill by tipping the container or placing in secondary containment. Clean up the spill by spreading appropriate absorbent material for the chemical spilled (i.e., absorbent clay for oil and most aqueous and organic liquid spills, calcium carbonate for acid spills, citric acid for base spills, and Hg Absorb Powder [found in the Mercury kit] for mercury spills). Be sure to check the MSDS sheets of the chemicals you are using BEFORE you begin an experiment to ensure you have the correct type of spill absorbent on hand. This is of particular importance when working with highly reactive or toxic chemicals such as sodium metal, mercury, and hydrofluoric acid.

After allowing the chemical to absorb, scoop up the material and deposit into an appropriate container, usually a one or five gallon
plastic container. Wipe up the contaminated surface with soapy water and a sponge and then place everything into the container for disposal. Seal the container and label it with a Hazardous Chemical Spill Cleanup "Hazardous Chemical Waste Tag" and dispose of the material through the Hazardous Waste Program. Report the spill to your supervisor. Also notify the Environmental Health & Safety department at 7-2211 about all spills involving mercury so that adequate cleanup may be confirmed with mercury detection equipment.

Major Spills

If the spill involves a large quantity of chemicals or a material unknown in chemical composition, or is potentially dangerous (explosive, toxic fumes), evacuate the room, floor, and/or building as necessary, report the spill (DIAL 911), limit access to the area, and stand by in a safe place until help arrives.

When reporting a spill, you will be asked for the following information:

- your name
- where the spill occurred (building and room number)
- the materials involved (SPELL CLEARLY and SLOWLY)
- the amount spilled
- any immediate actions you took
- how the spill occurred (if you know or can guess)
- who first observed the spill and at what time
- are there any injuries
- a call back number (if available) and contact name

Prevention: Most chemical spills can be avoided by following these safety precautions.

1. Before transporting or using a chemical, read the precautionary (or warning) panel of the product label and the Material Safety Data Sheet.
2. When transporting glass bottles of liquid chemicals, use secondary containers, such as safety pails or acid buckets. Do not use containers such as plastic bags or cardboard boxes.

3. When using laboratory carts or dollies, be aware of recessed floor drains or other objects lying on the floor that may force the wheels to swivel, jarring the cart, and causing a bottle to tip or fall off.

4. When hazardous chemicals must be transported on an elevator, do not allow passengers to ride with you.

5. Order the minimum amount of chemicals that you need. Keep quantities of hazardous chemicals at a minimum to reduce the fire and explosion hazard associated with these materials.

6. An annual cleaning of classrooms, laboratories, and storage rooms should be conducted to remove old, unwanted, or excess chemicals.

7. Incompatible chemicals must be stored separately to reduce the possibility of accidental contact. For assistance with this, please contact EH&S at 7-2211.

8. Use safety cans for storing flammable liquids.

9. Dispose of any waste or unwanted chemicals as outlined in Management Procedure #808.
Many departments on campus have the occasion to use apparatus that produce ultraviolet radiation. This management procedure should be used as a guide so that necessary precaution will be taken to avoid UV radiation exposure.

Ultraviolet (UV) radiation is an invisible radiant energy produced naturally by the sun, and artificially by arcs operating at high temperatures. Artificial sources commonly found on campus include germicidal and black light lamps, carbon arcs, welding and cutting torches, electric arc furnaces, and other laboratory equipment.

Since the eyes and skin readily absorb UV radiation, they are particularly vulnerable to injury. The severity of radiation injury depends on factors which include exposure time, intensity of the radiation source, distance from the source, wavelength, sensitivity of the individual, and presence of sensitizing agents.

Sunburn is a common example of the effect of UV radiation on the skin. Since UV radiation is not visible, the person exposed to UV may not be aware of the hazard at the time of exposure.

Absorption of the radiation by the mucous membranes of the eye and eyelids can cause conjunctivitis. Lesions may also be formed on the cornea at high exposure levels. Such injuries usually manifest themselves 6 to 12 hours after exposure.

Protective measures are essential for persons exposed to high intensity UV sources. Goggles, face shields, and masks provide protection for the eyes; protective clothing and barrier creams minimize skin exposure. Shiny metal surfaces reflect UV radiation, and, when possible, should be removed from the work area. Reflections from lamp housings, walls, ceilings, and other surfaces may be reduced by coating these surfaces with a pigmented paint to low UV reflectance. Very high levels of UV should be enclosed, so as to shield those in the area.

Exposure to UV may be a cause of skin cancer. The following facts are known concerning UV radiation carcinogenesis:*

1. The incidence and prevalence of skin cancer correlate with decreasing geographic latitude, hence with the degree of insulation.
2. Over 90% of skin cancers occur in parts of the body exposed to sunlight.

3. The amount of pigmentation affects the incidence and prevalence of skin cancers.

4. Skin cancer is more prevalent in people who spend more time out of doors.

At this time, the relationship between UV radiation and the incidence of skin cancer is inconclusive. However, many studies substantiate the hypothesis that exposure to UV is related to the development of skin cancer.

**Policy Title:**

**BU 815 – Hazardcommunication Standard & NYS Right-to-Know**

The Occupational Safety and Health Administration's (OSHA) hazard communication standard (29 CFR 1910.1200) was expanded to include non-manufacturing employers on August 24, 1987. The date for compliance was May 23, 1988. The new Federal standard preempts the New York State Right-to-Know law, however not in its entirety. Therefore, the Binghamton University hazard communication plan has been designed to meet the requirements of both regulations.

The objective of the hazard communication standard, as stated in section 1910.1200(b), is: *"to provide information to employees about the hazardous chemicals to which they are exposed, by means of a hazard communications program, labels, and other forms of warning, material safety data sheets, and information and training."*

To comply with the hazard communication standard the university has:

1) Prepared a written hazard communications plan. The plan is available for any employee, or their bargaining unit representative, to review in the Department of Public Safety, Office of Environmental Health and Safety.

2) Developed an on-going inventory (list) of all chemicals and chemical products located on the Binghamton University campus, obtained a Material Safety Data Sheet (MSDS) for each, and will make available, for any employee, access to such information for those chemicals they may be required to work with. (see attached "Right-to-Know" law, employee information request form)

3) Established a labeling policy that assures that all chemical containers are properly labeled.

4) Provided employee training which includes informing employees of their rights under the standard, the location of the written plan, how to understand MSDS's, and understanding the labeling policy.

The posting of signs and the access to information within 24 hours, presently a part of the Right-to-Know law, will remain in effect until the law is revised or rescinded.
Questions concerning the Hazard Communications Standard or the written communications plan should be directed to Environmental Health and Safety, x7-2211.

*Printable "Right To Know Law" Employee Information Request Form:*

[MS document](#) or [pdf format](#)*

*pdf format requires Adobe Reader to view and print. To download a free reader, [click here](#).*
Policy Title:

BU 817 – Respiratory Protection

Article 2, Section 27-a of the New York State Labor Law (Public Employees Safety and Health Act, or PESHA) adopted the Occupational Safety and Health Administration (OSHA) safety and health standards effective December 29, 1980. Part 1910.134 of the OSHA standards, Respiratory Protection, states that engineering control measures will be used in the control of those occupational diseases caused by breathing contaminated air. The main objective of this standard is to prevent atmospheric contamination. When effective engineering controls are not feasible while those controls are being instituted, or in emergencies, appropriate respirators shall be provided and used pursuant to OSHA standards.

Responsibility

The Environmental Health and Safety Department (EH&S) will coordinate respiratory protection program activities that include the purchasing, maintenance, training, and record keeping. These activities are based on the requirements set forth in OSHA 29 CFR 1910.134. Although EH&S is responsible for administration of the program, Management Procedure Number 807 identifies those positions having the responsibility and authority for achieving program objectives.

Each department head is obligated and authorized to stop any unsafe activity that involves a student, a faculty or staff member, or a visitor under his/her cognizance. This includes the improper use or (non-use) of respiratory protection devices. The department head is expected to obtain assistance from EH&S in providing this program for his/her department.

Supervisors must be familiar with and inform his/her employees and students of hazardous and potentially hazardous air contaminants associated with an operation. If a supervisor cannot provide this information, or if a special assessment of an area or operation must be made, assistance can be requested through EH&S. The supervisor must also be able to assure that those persons understand and participate in the Respiratory Protection Program i.e., receive training, properly use and maintain respirators, keep records.

Individuals participating in the Respiratory Protection Program must properly wear their respirators wherever the threat to health and
safety from airborne contaminants exists. Participants must also maintain his/her equipment as directed.

Respirator Program

1. Written standard operating procedures (SOPs) will be developed by the Environmental Health and Safety Department (EH&S) and will be used in the selection, use, and maintenance of respiratory equipment at Binghamton University. These procedures may only be amended by EH&S.

2. Only Mine Safety and Health Administration/National Institute for Occupational Safety and Health (MSHA/NIOSH)-certified respirators will be selected and used. The selection will be based on the hazard(s) to which the worker will be exposed.

3. All users will be instructed in respiratory protection and trained in the proper selections, use, and maintenance of a respirator. Instruction and training will include: rights and responsibilities; types of respirators and their operation; hands-on orientation with a respirator type; fitting instructions and practice; testing the face-to-face piece seal; wearing it in normal air for a long familiarity period; and wearing it in a test atmosphere. Instruction and training will be provided to both supervisors and workers by EH&S annually.

4. Persons with beard growth, long sideburns, a skullcap that projects under the face piece, temple pieces on glasses, or any other condition that prevents a good face seal should not be allowed to use a respirator.

5. To assure proper protection, the user will check the face piece fit every time the respirator is put on.

6. Respirators will be regularly cleaned and disinfected. Those assigned to individuals will be cleaned after each day’s use, at minimum.

7. A routine inspection of the respirator will be made. Worn, damaged, or deteriorated parts identified during inspection must be corrected before the equipment is used again. Respirators used frequently may be inspected during cleaning. Emergency equipment,
such as SCBA’s or respirators stored for long periods should be inspected monthly and after each use.

8. All respirators will be sealed in a protective container to prevent equipment damage and contamination.

9. Department heads and/or supervisors should request the surveillance of work area conditions and degree of employee exposure or stress. Surveillance requests can be made to EH&S and a report will be provided with recommendations.

10. This program will be evaluated regularly by EH&S and may include inspections of respirators used, maintenance records, and real-time industrial hygiene sampling.

11. Persons will not be assigned to tasks requiring the use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. An occupational physician will make this determination and will include a physical examination, pulmonary function test (spirometry), work history, and if deemed necessary, a baseline chest x-ray.

12. Persons who voluntarily use a respirator (where not required) for personal comfort shall be informed of their rights and the limitations of respirators according to appendix D of the Resp. Std.1910.B4.
Policy Title: **BU 818 – Chemical Labeling**

The Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard (29 CFR 1910.1200) requires the University to establish a chemical labeling policy. Because it is the policy of Binghamton University to comply with all Federal, State and local regulations, all containers of hazardous chemicals must be properly labeled in accordance with section 1910.1200(f) of the Hazard Communication Standard.

A hazardous chemical is any chemical or mixture of chemicals having properties capable of producing adverse effects on the health & safety of human beings and/or the environment. It is recommended that containers of non-hazardous materials also be labeled when those containers are stored or used around other hazardous materials (e.g.: a water bottle in a chemistry lab).

It is the responsibility of all employees to assure that labels are properly attached and legible. Any labels that are not legible, are degraded, or are missing must be replaced. This is necessary to prevent the generation of unknown compounds which present health & safety hazards and require additional costs for identification before final disposal.

When it is necessary for chemical products to be transferred to other containers, it is the responsibility of the employee making such transfers to assure a proper label is attached that contains at a minimum, the name of the chemical written out. Structures, formulas or abbreviations are not acceptable. It also requires that any special hazards also be identified on the container label. Examples include, but are not limited to, carcinogens, mutagens, teratogens, highly toxic, explosives, etc. Preprinted labels for this purpose are available at Science Stores.

In addition, it is also recommended that all chemicals be given a “Date Received,” “Date Opened,” and/or “Expiration Date.” This policy is mandatory for peroxide forming compounds such as ether, dioxane, tetrahydrofuran, etc. The Binghamton University Hazardous Waste Management Guide (available on-line at [http://ehs.binghamton.edu](http://ehs.binghamton.edu)) lists specific examples and procedures for dealing with peroxide forming compounds. This policy is necessary to prevent peroxide forming compounds from becoming unstable and potentially explosive over time which requires special handling and disposal at a cost of $1000 or more PER container.
Questions concerning chemical labeling should be directed to the Hazardous Waste Manager at 7-5799.

Policy Title:

**BU 819 – Procedure of Disposal of Regulated Medical Waste**

Chapter 438 of the Laws of 1993 amended both the Environmental Conservation Law (ECL) and the Public Health Law (PHL) concerning regulated medical waste (RMW). To address changes resulting from the enactment of Chapter 438, the New York State Department of Health (DOH) collaborated with the New York State Department of Environmental Conservation (DEC) on RMW issues and developed guidelines entitled, "Managing Regulated Medical Waste, Interpretive Guidelines for Implementing Revisions to PHL 1389AA-GG" (December 1995). In addition, Federal regulations govern RMW management and disposal, including the federal Occupational Safety and Health Administration (OSHA) Exposure to Bloodborne Pathogens regulations at 29 CFR Part 1910.1030 and federal Department of Transportation (DOT) regulation in 49 CFR Parts 171, 172, 173, and 178. These regulations require the University to manage the handling and disposal of RMW.

Regulated Medical Waste is defined as: any waste which is generated in the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals, when listed by the Department of Environmental Conservation, provided, however, that regulated medical waste shall not include any hazardous waste identified or listed by the Department of Environmental Conservation, or any household waste defined by the Department of Environmental Conservation and shall include the following:

1) Cultures and stocks (those that require biosafety level II-IV containment) in the CDC/NIH Manual for Biosafety in microbiological and Biomedical Laboratories (3rd edition, May 1993) and also contagious agents listed in Section 2.1 of the New York State Sanitary Code and assorted biologicals, including cultures from medical and pathological laboratories, cultures and stocks of infectious agents from research laboratories, wastes from the production of biologicals, discarded live and attenuated vaccines, and culture dishes used to transfer, inoculate, and mix cultures;
2) Human pathological waste, including tissues, organs, body parts and body fluids that are removed during surgery or autopsy or other medical procedures, and specimens of body fluids and their containers;

3) Waste human blood and products of blood, including serum, plasma, and other blood components and their containers;

4) Sharps that have been used in animal or human patient care or in clinical laboratories, including hypodermic needles, syringes, pasteur pipettes, broken glassware and scalpel blades, blood vials, test tubes, needles with attached tubing, and such unused sharps that have been discarded;

5) Contaminated animal carcasses, body parts, and bedding of animals that were known to have been exposed to infectious agents during research, production of biologicals, or testing of pharmaceuticals;

6) Wastes from surgery or autopsy that were in contact with infectious agents, including soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves;

7) Cell lines - human, primate, and any other animal (mammalian) cell lines, even in the absence of overt contamination, may contain latent viruses and/or other opportunistic pathogens or zoonotic agents (capable of transmitting disease from animals to humans). Therefore these materials must be disposed of as RMW in New York state.

8) Laboratory wastes from clinical laboratories that were in contact with infectious agents, including slides and cover slips, disposable gloves, laboratory coats and aprons;

9) Dialysis waste that were in contact with the blood of patients undergoing hemodialysis or renal dialysis, including contaminated disposable equipment and supplies such as tubing, filters, disposable sheets, towels, gloves, aprons and laboratory coats;

10) Biological waste and discarded materials contaminated with blood, excretion, exudates or secretion from human beings or animals who are isolated to protect others from highly communicable diseases; and
11) Any other waste material designated by the administrator of the U.S. Environmental Protection Agency as a "regulated medical waste."

**Laboratory Procedure**

All regulated medical waste must be collected in a manner and location which affords protection from the environment and limits exposure to others.

Regulated medical waste shall be separated from all other wastes in the laboratory.

Regulated medical waste, except for discarded sharps, shall be contained in bags which are impervious to moisture and have strength and sufficient to resist ripping, tearing or bursting under normal conditions of usage and of handling. The bags shall be secured so as to prevent leakage during storage, handling or transport. All bags used for containment and disposal of regulated medical waste shall be red in color. Red bags shall not be used for any other use. All such bags shall have affixed a label indicating the word "biohazard," or the universal biohazard symbol/the generators name and telephone number.

All discarded sharps shall be contained for disposal in leak proof, rigid, puncture-resistant containers which are secured to preclude loss of the contents. Such containers shall be red in color and labeled with the word "biohazard" or the universal biohazard symbol/the generators name and telephone number.

All medical waste shall be stored in containers which shall be marked with prominent warning signs on the containers with the word "biohazard" or the universal biohazard symbol.

Regulated medical waste shall be transferred to the regulated medical waste holding area in accordance with procedures distributed by applicable administrative offices.

**Regulated Medical Waste Holding Area Procedure**

The regulated medical waste holding area will be located in Science III, room B-27A. The area will be equipped with an appropriate sign, prevent unauthorized access, protect wastes from the elements and prevent access by vermin.
Containers used for the containment of regulated medical waste shall be marked with prominent warning signs on the containers with the word "biohazard" or the universal biohazard symbol.

Regulated medical waste exceeding 50 pounds in any month shall not be stored on the premises for more than 30 days.

Transportation of regulated medical waste from the University to off-site treatment, storage or disposal facilities shall be in accordance with the regulations of the Department of Environmental Conservation as set forth in Part 364 of Title 6 of the New York State Codes, Rules and Regulations.

Only authorized regulated medical waste haulers will transport regulated medical waste to off-site facilities.

All off-site shipments will be documented with appropriate manifests. The signed and dated initiation copy (copy 5) will be retained by the RMW manager. A final destination copy (copy 1) will be returned to the RMW manager indicating disposal. Both copies will be maintained as a part of the permanent record for a minimum of three years.

Appropriate records must be maintained.

**Record Keeping**

All generators of regulated medical waste are required to maintain a record of the quantity of regulated medical waste generated, and the disposition of such wastes.
Policy Title:

**BU 820 - OSHA/PESHA Laboratory Standard [Chemcial Hygiene Plan]**

OSHA’s/PESHA laboratory standard (29 CFR 1910.1450) applies to all laboratories that use hazardous chemicals. It supersedes the provisions in all other health standards with the exception of permissible exposure limits (PELs) for the approximately 600 air contaminants in OSHA’s subpart Z and for the 26 substances covered by individual standards. Hazardous chemicals include any chemical meeting the definition of hazardous chemical with respect to health hazards as defined in OSHA’s Hazard Communication Standard.

The standard requires every laboratory supervisor to formulate and implement a chemical hygiene program which must include the necessary work procedures and policies that will be used to ensure that laboratory employees are protected from all potentially hazardous chemicals used in their work areas.

Among other requirements, the standard provides for employee training and information, hazard identification, respirator use, record keeping, and when appropriate, medical consultation and examinations.

In order to comply with the requirements of the laboratory standard, the University has established a comprehensive chemical hygiene plan. Laboratories supervisors are encouraged to adopt this plan as their program for compliance. However, individual departments or laboratory supervisors may change, modify, or revise the chemical hygiene plan to meet their individual needs as long as the program in effect meets the requirements of 29 CFR 1910.1450. When departments and/or laboratory supervisors choose to use an alternate plan, a copy of their chemical hygiene plan, including a list of laboratories for which it applies, must be forwarded to Environmental Health & Safety.

All laboratory chemical hygiene programs must be in writing. A program in its simplest form may be a memorandum adopting the University’s chemical hygiene plan as the laboratory’s program.

It is recommended that laboratory supervisors purchase a copy of the latest edition of the National Academy of Science’s *Prudent Practices for Handling Hazardous Chemicals in Laboratories*. The University’s chemical hygiene plan is based on the criteria found in this reference book.
The standard also requires laboratory supervisors to provide information and training in both physical and health hazards associated with the chemicals used in the laboratory. Employees must receive training before assignments involving hazardous chemicals or prior to assignments involving new exposure situations. Appropriate training records must be maintained. In addition to the training provided by laboratory supervisors as required by the University’s chemical hygiene plan, all laboratory employees must attend ANNUAL lab safety training provided by Environmental Health & Safety.

Environmental Health & Safety will audit laboratory compliance biannually (two times per year), with follow up audits occurring as necessary. All noted safety violations must be corrected. Detailed procedures for laboratory audits can be found in the University’s chemical hygiene plan or at EH&S’s website http://ehs.binghamton.edu. Laboratory supervisors must notify Environmental Health & Safety when they suspect that exposure levels to a chemical may routinely exceed the action levels or PEL. In such cases, personal monitoring will be required to assure worker safety.

Copies of the laboratory standard and laboratory requirements are contained in the University’s chemical hygiene plan. Copies of chemical hygiene plan are located in science department offices and in the Environmental Health & Safety office.

For further information, contact the Chemical Hygiene Officer at 7-5799.
This country generates approximately 200 million tons of hazardous waste each year. The American people, increasingly concerned about the disposal of these wastes, have demanded a reduction in the quantity and toxicity of hazardous waste that is generated. The Resource Conservation and Recovery Act (RCRA) requires Binghamton University, as a large quantity generator of hazardous waste, to certify that we have programs in place to reduce the quantity and toxicity of the waste generated here on campus.

Policy

This Management Procedure is to remind all schools, departments, offices and individuals that it is university policy to comply with all applicable federal, state, and local environmental health and safety regulations. Generators of hazardous waste must continually review their procedures for purchasing, receiving, handling, storage, use, and disposal of hazardous chemicals with the goal of reducing the quantity and toxicity of waste generated. There are a number of techniques that can be used to help minimize the amount of hazardous waste generated. In addition to minimizing hazardous waste, many of these techniques are accomplished by good housekeeping and following safe laboratory practices.

Waste Minimization Techniques

1. The first step to effectively minimize the amount of hazardous waste generated is to maintain a current inventory of all chemicals being used and stored in your lab or work area. Properly label all chemicals to prevent the generation of unknowns and use older chemicals first before they degrade or become contaminated. Use the chemicals you have on hand before ordering new chemicals.

2. Only order the amount of chemicals that you will need in the immediate future. Although chemicals appear cheaper when purchased in large quantities, when the actual usage, storage, and disposal is factored in, the cost savings diminish significantly.

3. Properly store your current chemical inventory. Improper storage of chemicals can result in containers degrading and chemicals becoming contaminated, labels that degrade and result in
the generation of unknowns, and chemicals becoming unstable and/or potentially explosive.

4. Chemical containers should be dated when first opened. This is useful for verifying chemicals that are past their expiration date and should be disposed of.

5. Substitute less hazardous or non-hazardous chemicals for hazardous ones when feasible. There are a number of substitutes available for commonly used chemicals and procedures. When purchasing thermometers, select non-mercury containing ones.

6. Use recycled chemicals whenever possible. There is an on-going recycling program for usable but unwanted chemicals. All recycled chemicals are in their original containers and many still have their factory seals. See the *Hazardous Waste Management Guide* for more information or call 7-5799.

7. When using lecture bottles and cylinders, determine if the manufacturer will take back the empty cylinders/lecture bottles before you place an order. If at all possible, order only from manufacturers who will accept empty cylinder and lecture bottles for return.

8. Investigate converting to micro-scale activities, which result in less chemicals needed for experiments and less hazardous waste generated.


10. Dispose of unwanted or waste chemicals in a timely manner. If you no longer plan to use chemicals that you have on hand, or the containers are very old, properly dispose of the chemicals according to Management Procedure #808. General rule of thumb: If you have not used a chemical in four (4) semesters, consider recycling or disposing of it.

If you have any questions regarding waste minimization techniques, contact the Hazardous Waste Manager at 7-5799.
Policy Title:
BU 826 – Lab Close out, Transfer, or Temporary Shutdown Procedures

Purpose/Background
Throughout the University, principal investigators (PI)/faculty members leave, relocate labs and/or go on sabbatical. This document will provide general guidelines to address requirements that must be met prior to any of these actions taking place.

Scope:
This policy applies to all labs, darkrooms, animal rooms, and workshops throughout Binghamton University or other space where regulated waste may be present.

Applicability
This policy applies to all students, principal investigators, faculty, staff, and department chairs.

Objective
To maintain a safe working environment, reduce hazardous waste generation and to comply with all applicable regulations.

ROLES AND RESPONSIBILITY

Environmental Health and Safety (EH&S) - Will provide guidance for lab close out, decontamination, relocation and other issues that may arise. Waste disposal will be coordinated through EH&S.

Radiation Safety Officer (RSO) - Must survey and sign off on close out procedure form for all rooms where radioactive materials were in use. Will assist with and confirm proper disposal of radioactive materials. Decontamination of a lab may not take place until RSO has signed off on form.

Biosafety Officer (BSO) - Will provide direction on proper decontamination methods for equipment and exposed materials. Assure proper disposal of regulated medical waste and sharps in lab.
Department Chairperson - Must assure all work is complete. If work is not completed, it is the department's responsibility to do so. Upon departure of PI or faculty member, department chairperson will assume full responsibility for the lab until a new lab occupant is assigned.

Faculty Member or Principal Investigator (PI) - Responsible for following these guidelines in order to assure lab is left in appropriate condition.

PROCEDURES

Faculty Member or PI Leaving University
Notification must be sent to EH&S as soon as occupant is aware of their pending departure from the University. Prior to leaving the University, principal investigator or faculty member must complete a Lab Close Out Checklist form and send it to EH&S. Laboratories cannot be reoccupied, nor work done by Physical Facilities, until EH&S has verified that the close out procedure has been completed.

NOTE: THIS PROCESS CAN BE TIME INTENSIVE AND SHOULD BE INITIATED AS EARLY AS POSSIBLE. IT MUST BE COMPLETED PRIOR TO LEAVING THE UNIVERSITY.

Radioactive Materials

- All radioactive material must be removed from lab (lead pigs, lead bricks, sheeting, and radioactive sources).
- All radioactive equipment must be unplugged and locked down to avoid unauthorized use.
- Radioactive waste must be removed from lab. For information regarding disposal of radioactive waste, please contact the Radiation Safety Officer (RSO) at 7-4370.
- Area must be surveyed by RSO to assure that all radioactive source has been removed and area is free of contamination.
- Radiation Safety Officer must sign off on Lab Close Out Checklist form.

Biological Materials
In a lab where biohazardous materials were present, the area must be decontaminated. Wipe down all areas with a 10% bleach solution or 70% alcohol with water solution. Allow solution to sit on surfaces for 30 minutes prior to wiping up.

- Place all sharps (syringes, Pasteur pipettes, serological pipettes, razor blades, etc.) in a sharps container and dispose of through the University Regulated Medical Waste Program.
- Dispose of all solid media, supplies and all other potentially biohazardous waste from the laboratory in red bags as red bag waste, per University Regulated Medical Waste guidelines.
- Decontaminate all liquid media and non-regulated medical waste by autoclaving or by treating for 30 minutes with bleach solution (final concentration to be 10%) before drain disposal.
- For disposal of Regulated Medical Waste, please contact Bob Snyder at 7-4905.

**Biological Safety Cabinets (BSC)**

- Remove all contents.
- Disconnect tissue culture media vacuum flask.
- Decontaminate all accessible surfaces with appropriate disinfectant.
- If a BSC is being relocated to another building, it must be decontaminated by a certified contractor before being moved. Please contact the Biosafety Officer at 7-2211 regarding decontamination.
- Biological safety cabinets must be recertified before being placed back in service.

**Specimens**

- Specimens cannot be disposed of down the drain or in regular trash.
- Specimens must be separated from formaldehyde or formalin solution.
- Solutions must be disposed of through Hazardous Waste Program (7-2211)
- Animal specimens must be double bagged and thrown in the trash in an outside dumpster (do not use red bags).
- Human specimens must be disposed of as regulated medical waste.

**Compressed Gas Cylinders**

- Remove regulators.
- Replace cap.
- Return to company (preferred method) or dispose of through Hazardous Waste Program (7-2211).
- Do not roll cylinders; use hand carts designed for cylinders.
Freezers/Refrigerators

- Inventory all chemicals using Binghamton University online chemical inventory form. The completed inventory forms must be typed. The chemical inventory form can be accessed through our website at http://ehs.binghamton.edu/index.html
- Dispose of unwanted chemicals through the Hazardous Waste Program (7-2211).
- Defrost.
- Clean all spills and residues.
- Wipe down door and handle.
- Leave plugged in.

Chemicals

- Offer unwanted chemicals to other faculty and staff first.
- Inventory all chemicals (refrigerator, flammable cabinets, acid cabinets, etc.). Be sure to include location, bottle size, and CAS number on the online chemical inventory form. The completed inventory form must be typed. The chemical inventory form can be accessed through our website at http://ehs.binghamton.edu/index.html
- Identify location of all chemical storage areas.
- Check all chemicals and samples for proper labeling (chemical name is legible, no chemical formulas, labels are not degrading, no chemical structures, labels are facing out, etc.)
- NO chemicals should be stored in drawers.
- Dispose of expired chemicals through the Hazardous Waste Program (7-2211).
- Dispose of all unstable chemicals i.e. peroxide formers and reactive chemicals.
- Do not transport chemicals in vehicles or outside of building. If transporting chemicals outside building, please contact EH&S for guidance.

Chemical Waste Disposal

EH&S is able to remove small amounts of unwanted chemicals from a lab. Due to time and labor constraints, we are unable to handle large amounts of chemicals. Therefore, if you have large amounts of unwanted chemicals, please contact EH&S as soon as possible so we can facilitate disposal through an outside vendor.

- Store all waste in a central location.
• Inventory all waste. Include chemical name, bottle size, CAS number, and amount in container using the online chemical inventory form. The completed inventory form must be typed. The chemical inventory form can be accessed through our website at http://ehs.binghamton.edu/index.html
• Try to indentify all unknowns.
• Waste must be compatible with container.
• Waste containers must be closed with appropriate top, which will prevent material from spilling.
• Label all waste with hazardous waste sticker.
• All bottles need a completed hazardous waste tag (chemical formulas and structures are not accepted).

**Glassware**

Glassware with substantial residue that cannot be removed should be disposed of through the Hazardous Waste Program.

• Clean all glassware with appropriate solvent.
• Store glassware in boxes, drawers, and cabinets.
• Dispose of broken glassware in box designated for broken glassware. Boxes may be purchased through Science Stores, located in the basement of Science II.

**Equipment**

• Shut off.
• Unplug.
• Decontaminate with solution of soap and water.
• Store in appropriate location.

**Keys**

Must be accounted for and turned in to department chairperson upon completion of lab clean out procedures and before final departure from Binghamton University.

**General Laboratory Cleanup**

All laboratory areas must be thoroughly cleaned to assure removal of all hazardous residues. All surfaces where hazardous chemicals have been used or stored must be washed down with a solution of soap and water. This includes fume hoods, bench tops, cabinets, drawers, walls, floors, etc.
EHS Inspection

When all work has been completed and checked off per the lab close out checklist, send original to department head. Department head will insure all work is complete, sign off on form, and send to EH&S. Upon receiving Lab Close Out Checklist form from department head, EH&S will conduct an inspection to confirm completion.
Binghamton University

HAZARDOUS WASTE MANAGEMENT GUIDE
PURPOSE OF THIS MANUAL

This manual has been designed to assist all Binghamton University faculty, staff, and graduate assistants in the safe and economical management of hazardous wastes generated on campus. The hazardous waste manager coordinates the hazardous waste management program including the identification of hazardous wastes, compliance with state and federal regulatory requirements, hazardous waste storage and disposal, spill response, and hazardous waste minimization.

The role of the hazardous waste manager is to act in the capacity of a consultant for the Binghamton University campus and to provide customer service oriented programs that help achieve compliance with various state and federal hazardous waste regulations. The input and cooperation of chemical users is an important part in the overall success of the hazardous waste management program.

This manual discusses the vital role YOU play in this management effort.

This revised guide includes a number of additional sections to better assist the campus community in managing hazardous waste. Please read the guide carefully and call the hazardous waste manager at 777-2211 if you have any questions. Your comments and suggestions are always appreciated!
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Special Thanks go to:
The Indiana University Department of Environmental Health & Safety for the format and basic information of this document.
1.0 INTRODUCTION

It is a policy of Binghamton University “to maintain an environment for its faculty, staff, students, and visitors that will not adversely affect their health and safety nor subject them to avoidable risk of injury”. The Environmental Health and Safety Office (EH&S) was established in 1974 to provide guidance and services needed by campus personnel to attain the goals and objectives of the campus environmental health and safety policy.

Environmental Health and Safety Mission Statement

“Environmental Health & Safety (EH&S) promotes and supports a safe and environmentally conscious campus community through professional consultation, education, training, customer service and comprehensive programs.”

The following are programs and initiatives developed by your EH&S professional and technical staff:

Asbestos Awareness  
Bloodborne Pathogens  
Chemical Spill Response  
Disaster Planning  
Fire and Safety Code Compliance  
Hazard Communication  
Hazardous Waste Management  
Hazardous Work Permits  
Incident and Hazard Reports  
Industrial Hygiene  
Laboratory Safety  
Regulated/Infectious Medical Waste  
Respiratory Protection  
Safety Consultation

If you would like more information or want to receive a copy of our brochure detailing these programs, contact the Environmental Health and Safety office at 777-2211.
2.0 YOUR RESPONSIBILITIES

As a chemical user, YOU have a legal and moral responsibility to ensure the proper disposal of any hazardous waste you generate. There are various state and federal regulations that govern the disposal of chemical wastes. There are also criminal and civil penalties that can result from improper disposal of these wastes. In addition to potential citations, fines, and imprisonment; improper waste disposal can also result in national media attention and damage to the University’s reputation.

YOU CAN BE PERSONALLY HELD LIABLE FOR “WILLFULLY AND KNOWINGLY” VIOLATING THESE REGULATIONS.

You also have a moral responsibility to properly dispose of chemicals that can pose a present or potential hazard to human health or the environment. This includes accident and injury prevention to students, coworkers, and the campus community.

The Binghamton University management procedure for the policy on environmental health and safety can be found in Appendix A.

3.0 HAZARDOUS WASTE MINIMIZATION

Disposal of hazardous waste is regulated by the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (DEC) under the Resource Conservation and Recovery Act (RCRA). The Act makes it illegal to mismanage hazardous wastes. The Act’s emphasis is on waste reduction and recycling. You can help reduce the expenditure of University funds (and ultimately your department’s funds) on waste disposal and material procurement by practicing waste minimization.

3.1 Plan Your Experiment

Include waste minimization practices when you are planning for an experiment. Consider the chemicals you will be using and whether or not they will become hazardous waste. Only mix the amount of reagents and stock solutions that you need for the experiment and will be able to use. Do not make excess solutions for potential later use. Know in advance how you will be handling any hazardous waste. Read Material Safety Data Sheets (MSDS) BEFORE working with chemicals to understand any hazards and special handling precautions. Allow for time at the end of each day to clean up, and always practice good housekeeping.
3.2 Maintain a Current Inventory

The first step to effectively minimizing the amount of hazardous waste you generate is to maintain a current inventory of all chemicals being used and stored in your lab or work area. You should check your inventory first before ordering any new chemicals. It may also be possible to borrow small amounts of chemicals from other labs. Please take the time to check with your colleagues.

3.3 Use Recycled Chemicals

There is an on-going program of recycling usable but unwanted chemicals. All recycled chemicals are in their original containers and many still have their factory seals. You can also put in a special request for a particular chemical. Once you have submitted a request, EH&S will look for the requested items(s) in the chemicals that are sent through the hazardous waste management program.

If you would like to be included on the e-mail distribution list for surplus chemicals or would like to request a particular chemical(s), contact EH&S at 7-2211.

3.4 Purchasing Chemicals

When ordering new chemicals, only order the amount of chemical that you need for the experiment you are conducting. Do not order a larger size container for an experiment that will only last a semester or for an experiment that may occur in the future. Although chemicals usually cost less per unit when purchased in large containers, when the actual usage, storage, and disposal are factored in, the cost savings diminish significantly and in some cases result in higher costs overall.

In addition, chemicals in large containers that are not used frequently can be rendered useless over time by contamination or degradation. In general you should only order the minimum quantity of a chemical that you need for the experiment, or one year’s worth of stock at the absolute most.

3.5 Nonhazardous Substitutes

There are many nonhazardous substitutes for hazardous chemicals used in laboratories. Hazardous chemicals that should be substituted with nonhazardous alternatives in particular include those chemicals that are
highly toxic, reactive, contain heavy metals, and are known or suspected carcinogens, mutagens, or teratogens.

Examples of nonhazardous chemical substitutes can be found in reference materials such as Prudent Practices in the Laboratory (see Appendix I). If you are using a specific hazardous chemical on a routine basis, EH&S can research possible alternatives for you.

3.6 Appropriate Storage Practices

Storing chemicals properly promotes safer and healthier working conditions and extends the usefulness of chemicals. Improperly stored chemicals can result in:

degraded containers that allow chemicals to become contaminated
degraded containers that can release hazardous vapors that are detrimental to the health of lab workers
degraded containers that can release vapors that can affect the integrity of nearby containers
degraded labels that can result in the generation of unknowns
chemicals becoming unstable and/or potentially explosive

3.6.1 General Storage Guidelines

1) Chemical containers should be dated when they arrive and should be checked regularly and disposed of if the chemical is past its expiration date. NOTE: Peroxide forming chemicals are required to be dated (see Section 8.16).

2) Large chemical bottles should be stored towards the back of a storage cabinet and smaller bottles should be stored up front where they are visible. Labels should be turned so they can be easily read.

3) 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 older chemicals to get used up first and helps to minimize the number of chemical containers in the storage area.

4) All chemical containers MUST be labeled. Labels must include the name of the chemical constituent(s) and any hazards present. You should check chemical containers regularly and be sure to replace any labels that are deteriorating BEFORE the chemical becomes an unknown.
5) Flammable liquids in excess of the quantities for the specific classes listed below must be stored in approved flammable liquid storage cabinets.

   a) Class IA  (flashpoint < 73°F, boiling point < 100°F)  1 pint
   b) Class IB  (flashpoint < 73°F, boiling point > 100°F)  1 quart
   c) Class IC  (flashpoint > 73°F, boiling point > 100°F)  1 gallon
   d) Class II  (140°F > flashpoint > 100°F)  1 gallon

6) Do not store corrosive chemicals 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.

7) Do not store flammable liquids in a non-explosion-proof refrigerator. This can result in the flammable vapors being ignited by the electrical components of the refrigerator. Only store flammable liquids in explosion-proof (or flammable storage) refrigerators. Explosion-proof refrigerators have protected electrical components and are designed to store flammable liquids.

8) Highly toxic chemicals such as inorganic cyanides should be stored in locked storage cabinets.

3.7 Chemical Storage Classes

Chemicals should be stored according to compatibility groups, they should not be stored alphabetically (or otherwise) until they have first been segregated by hazard class. In general, chemicals should first be separated into their organic and inorganic families and then segregated according to hazard class groups. The basic hazard class groups, which are based on the Department of Transportation (DOT) hazard classes, include:

- Flammable liquids (Class 3)
- Spontaneously combustible (Class 4.2)
- Oxidizers (Class 5.1)
- Poisons (Class 6.1)
- Bases
- Inorganic acids

- Flammable solids (Class 4.1)
- Dangerous when wet (Class 4.3)
- Organic peroxides (Class 5.2)
- Cyanides
- Organic acids
- Other

Be sure to check Material Safety Data Sheets (MSDS) for any special storage requirements. There are a number of storage patterns and systems that are recommended by various manufacturers.
EH&S has a customized label maker and hazard class stickers for labeling your chemical storage areas and can provide assistance in segregating your chemicals for you. If you would like to take advantage of these services, contact the hazardous waste manager at 7-6835.

3.8 Cylinder and Lecture Bottles

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 and lecture bottles for return.

3.9 Microscale Activities

If possible, consider switching to microscale experiments. Benefits include:

- reduced costs in chemical purchases and hazardous waste disposal
- shorter analysis times
- significantly less glassware breakage
- compatibility with macro-scale equipment
- less hazardous chemical exposure to employees and students
- minimized potential for fires and explosions
- less space required for chemical and hazardous waste storage

For more information and training on microscale activities, check out The National Microscale Chemistry Center located at Merrimack College at:

http://www.silvertech.com/microscale/index.html
http://www.microscale.org
4.0 DISPOSAL OF NONHAZARDOUS WASTE

Some of the chemical products used at Binghamton University may be disposed of safely and legally in the normal trash and sanitary sewer. However, in general it is not advisable to dispose of questionable chemicals by either method. Although a chemical may not be regulated today, the generator of chemical wastes can still be held liable in the future if a particular chemical becomes regulated. This is referred to as “retroactive liability” under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), i.e. “Superfund”. A good example of this is the disposal of PCBs before they were regulated. There are numerous sites across the country that are now Superfund sites because of past disposal practices of PCBs – even though the disposal practices were acceptable at the time. Many institutions, including universities, that followed these accepted disposal practices are now being asked to fund the cleanup of these Superfund sites.

It is also important to keep in mind the stigma attached with the disposal of chemicals in the normal trash. This is especially true when chemicals are discovered in the trash by other members of the campus community who may not have the technical knowledge needed to identify and evaluate those chemicals. This type of situation can quickly escalate into unwarranted attention from the media and regulatory agencies. Please be aware of the concerns people have with regard to their health and safety when discovering strange and unknown chemicals in the trash.

In an effort to minimize any potential incidents, Environmental Health and Safety recommends disposing of all chemical wastes through the hazardous waste management program.

In general, nonhazardous waste chemicals are those that have relatively low toxicity, contain no toxic metals, and have no positive determination of carcinogenicity, mutagenicity, or teratogenicity. Chemicals that may be disposed of in the sanitary sewer include chemicals that are NOT regulated as hazardous waste, but ARE water soluble, biodegradable, and of low toxicity. Examples include: sugars, amino acids, simple proteins, aqueous salt solutions, and neutral aqueous solutions. Solid chemicals of this type can be disposed of in the sanitary sewer if they are first dissolved in water. All chemicals poured into the sewer must be followed by at least 20 parts of water.

Please keep in mind that improper disposal of hazardous wastes can result in fires, chemical reactions, release of toxic or noxious gases and vapors, corrosion of the plumbing system, and can result in other environmental problems at the sewage treatment plant.
NOTE: Dilution is not allowed as a treatment method for hazardous waste.

4.1 Treatment Plant Prohibitions

The following is an abbreviated list from the Binghamton-Johnson City Joint Sewage Treatment Plant regulations. The following wastes are PROHIBITED from being discharge into the sanitary sewer:

any liquids or solids that can cause fires or explosions or be injurious to the treatment works or employees of the treatment works either alone or by interaction with other substances

flammable liquids (flashpoint < 140° F)

solid or viscous substances which may cause obstruction to the flow in a sewer or interference with the operations of the treatment plant

any wastewater having a pH less than 6.0 or higher than 10.0, or wastewater having any other corrosive property

toxic pollutants (either singly or by interaction with other pollutants)

any noxious or malodorous liquids, gases, or solids which either singly or by interaction with other wastes are sufficient to create a public nuisance or hazard to life or are sufficient to prevent entry into the sewers for their maintenance and repair

any heated wastewater which exceeds 150°F or in such quantities that the temperature of wastewater at the POTW treatment plant exceeds 104° F

Please see Appendix F for an excerpt of regulations concerning the Binghamton-Johnson City Joint Sewage Treatment Plant, including examples of the above items.

Complete copies of the Rules and Regulations relating to the use of the Binghamton-Johnson City Joint Sewage Treatment Plant can be obtained from the Physical Facilities Supervising Plumber or from Environmental Health and Safety.

When in doubt, dispose of chemical wastes through the hazardous waste management program.
5.0 THE HAZARDOUS WASTE MANAGEMENT PROGRAM

There is a large variety of chemical waste generated at Binghamton University. Nearly all facets of the campus community generate some form of hazardous waste. Examples include:

flammable, corrosive, reactive, and toxic laboratory waste
waste solvents from vehicle maintenance, printing, and painting operations
corrosive wastes from cleaning operations
waste fixer and photographic chemicals from darkrooms
paints, thinners, corrosives, and metal containing wastes from art studios
other miscellaneous wastes from across campus

The management of hazardous waste generated on campus includes:

information on safe chemical handling, storage, use, and disposal
hazardous waste collection and disposal
laboratory and work area cleanouts
spill response

The first step in the hazardous waste management program is for you to recognize your responsibilities as a chemical user according to the hazardous waste regulations, understand the hazardous waste management system, and implement the procedures described in this guide. You are also responsible for making every technical and economically feasible effort to minimize the volume of surplus chemicals and the amount of hazardous waste that you generate.

5.1 Hazardous Waste Regulations

Hazardous waste is regulated by the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (DEC) under the Resource Conservation and Recovery Act (RCRA). Binghamton University is regulated as a Large Quantity Generator (LQG) of hazardous wastes. This guide is intended to provide an overview of managing hazardous wastes on a university campus. The complete regulations and additional environmental compliance assistance information for colleges and universities can be found at the DEC and EPA www sites:

http://www.dec.ny.gov/Regs/4390.html
6.0 MANAGING HAZARDOUS WASTE

As a generator of hazardous waste, there are specific requirements that must be followed in order to properly handle, store, and dispose of hazardous wastes. These requirements include:

Make a determination as to whether the chemical wastes you are generating are considered hazardous (see Section 6.1).

Follow Satellite Accumulation Area requirements (see Section 7.0).

Follow proper hazardous waste storage and disposal procedures (see Sections 8 and 9).

6.1 Hazardous Waste Determination (What is Hazardous Waste)

The U.S EPA and New York DEC consider a waste to be hazardous if it:

is a Listed hazardous waste (see Section 6.2)
OR
exhibits certain hazardous characteristics (see Section 6.3)

In addition to the two criteria above, Environmental Health and Safety also considers chemical waste to be hazardous if it:

has an oral Lethal Dose (LD50) for a rat of less than 500 mg/kg
OR
if the original container identifies the chemical as toxic or poisonous
OR
if the chemical is a known or suspected carcinogen, mutagen, or teratogen

To summarize, a chemical waste exhibiting any one of these five criteria is to be considered as hazardous waste and must be managed accordingly.

When in doubt, dispose of chemical waste through the hazardous waste management program.
Listed Hazardous Wastes (F, U, and P lists)

The EPA and DEC have several lists of chemical wastes that are regulated as hazardous wastes. Three of the lists that apply to Binghamton University are the F-list, U-list, and P-list.

6.2.1 F-Listed Waste

Chemical wastes found on the F-list are hazardous wastes from nonspecific sources. Although there are 39 listings (F001–F039), the most common F-listed wastes generated on campus are F001, F002, F003, F004, and F005. The chemicals listed are primarily both halogenated and nonhalogenated organic solvents. See Appendix B for a description of the chemicals on the F-list.

Some common examples of F-listed hazardous wastes include:

A graduate student working in a science laboratory uses Acetone as a final rinse for cleaning glassware, the Acetone waste that results is considered a F003 listed hazardous waste. This Acetone rinse cannot be disposed of down the drain and must be managed as a hazardous waste.

A maintenance worker uses a 10% solution by volume (or greater) of Methylene chloride as a degreasing agent. The waste that results is considered a F001 listed hazardous waste and must be disposed of through the hazardous waste management program.

A person working in a Fine Arts department uses a trade name paint brush cleaner that contains 10% or more (by volume) of Toluene. The waste that results is considered a F005 listed hazardous waste and must be managed accordingly.

6.2.2 U and P Listed Waste

The EPA and DEC regulate certain chemical wastes as being Toxic Wastes (U-list) and Acutely Hazardous Wastes (P-list). The U and P codes are assigned to chemicals that are discarded commercial chemical products, off-specification species, and container residues. The EPA and DEC also regulate any residue or contaminated soil, water, or other debris resulting from the cleanup of a spill involving a U or P listed chemical as hazardous waste. It is also EH&S policy that any mixture of chemicals that contain ANY concentration of U or P listed chemicals is considered to be hazardous
waste and must be disposed of through the hazardous waste management program. The U and P lists of chemicals can be found in Appendix C. A number of commonly used chemicals can be found on the U and P lists. Some examples include:

<table>
<thead>
<tr>
<th>U-listed</th>
<th>P-listed</th>
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<tbody>
<tr>
<td>Acrylamide</td>
<td>Mercury</td>
</tr>
<tr>
<td>Chloroform</td>
<td>Methanol</td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>Phenol</td>
</tr>
<tr>
<td>Formic acid</td>
<td>Xylene</td>
</tr>
<tr>
<td>Osmium tetroxide</td>
<td>Potassium cyanide</td>
</tr>
<tr>
<td>Potassium cyanide</td>
<td>Sodium azide</td>
</tr>
<tr>
<td>Sodium cyanide</td>
<td></td>
</tr>
</tbody>
</table>

Please note that if you spill a chemical found on the U or P lists, the resulting cleanup debris is still considered a hazardous waste. For example, if you spill a 100ml bottle of Chloroform, the speedi-dry or paper towels used to clean up the spill are considered as hazardous waste and must be disposed of through the hazardous waste management program.

6.2.3 Polychlorinated Biphenyls (PCBs)

PCBs and PCB contaminated materials are regulated by the DEC as hazardous waste. PCBs and all waste chemicals and contaminated debris containing 50 ppm (parts per million) or greater of PCBs are a New York State listed hazardous waste. Oils in or from electrical equipment whose PCB concentration is unknown or not otherwise clearly marked as “No PCBs”, must be assumed to contain between 50 and 500 ppm of PCBs and must be disposed of through the hazardous waste management program.

Due to the high cost for disposal of PCB waste, it is very important to keep PCB waste clearly identified and separated from other wastes. If PCB waste is added to a container of non-PCB waste, the resulting mixture will have to be treated as PCB waste. Please make every attempt to minimize the amount of PCB waste that you generate.

6.3 Characteristic Waste

In addition to listed hazardous wastes, the EPA and DEC regulate any chemical wastes as hazardous waste if the waste exhibits any one or more of the following characteristics: Ignitability, Corrosivity, Reactivity, and Toxicity.
6.3.1 Ignitability

Ignitable wastes are those that are capable of causing or intensifying a fire during routine handling. Ignitable wastes carry the EPA waste code D001. A waste exhibits the characteristic of ignitability if it has ANY of the following properties:

A liquid, other than an aqueous solution containing less than 24% alcohol by volume, and has a flash point less than 140° F (60° C)

Is not a liquid and is capable under standard temperature and pressure of causing fire through friction, absorption of moisture, or spontaneous chemical changes, and when ignited burns so vigorously and persistently that it creates a hazard

Is an ignitable compressed gas

Is an oxidizer

Examples include most organic solvents such as:

- Acetone
- Ethyl ether
- Paint
- Benzene
- Heptane
- Paint thinner
- Ethanol
- Hexane
- Toluene
- Ethyl acetate
- Methanol
- Xylene

6.3.2 Corrosivity

Corrosive wastes include highly acidic or highly alkaline chemicals. Corrosive wastes carry the EPA waste code D002. A waste exhibits the characteristic of corrosivity if it has ANY of the following properties:

Is an aqueous waste that has a pH less than or equal to 2 OR a pH greater than or equal to 12.5

Is a liquid that corrodes steel at a rate greater than 6.35mm (0.25 inches) per year

Please note: It is EH&S policy to treat solid chemicals as corrosive hazardous wastes if; when the solid chemical is added to water and results in an aqueous solution with a pH less than or equal to 2 OR a pH greater than or equal to 12.5. Additionally, if the original chemical container identifies the contents as corrosive, then the chemical waste must be disposed of through the hazardous waste management program.
Examples of corrosive hazardous wastes include:

<table>
<thead>
<tr>
<th>Corrosive Waste</th>
<th>Corrosive Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>Sodium hydroxide</td>
</tr>
<tr>
<td>(Muriatic acid)</td>
<td>solution</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>Sodium hydroxide pellets</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>Ammonium hydroxide solution</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>Potassium hydroxide flakes</td>
</tr>
<tr>
<td>Thionyl chloride</td>
<td>Calcium hydroxide solution</td>
</tr>
</tbody>
</table>

6.3.3 Reactivity

Reactive wastes include highly reactive and/or unstable chemicals. Reactive wastes carry the EPA waste code D003. A waste exhibits the characteristic of reactivity if it has ANY of the following properties:

- It is normally unstable and readily undergoes violent change without detonating
- It reacts violently with water
- It forms potentially explosive mixtures with water
- 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
- It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment
- Is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement
- It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure
- It is a forbidden explosive or a Class A or Class B explosive

Examples of reactive hazardous wastes include:

<table>
<thead>
<tr>
<th>Reactive Waste</th>
<th>Reactive Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium sulfide</td>
<td>Picric acid (dry)</td>
</tr>
<tr>
<td>Benzoyl peroxide (dry)</td>
<td>Sodium cyanide</td>
</tr>
</tbody>
</table>
tert-Butyllithium in solvent  Sodium metal

6.3.4 Toxicity

Toxicity is determined by a laboratory test which measures the concentration of the toxic material which would most likely leach into the ground water if that waste is improperly managed. The test is known as the "Toxicity Characteristic Leachate Procedure," or TCLP. Toxic wastes carry the EPA waste codes D004-D043. The list of TCLP contaminants can be found in Appendix D.

Any chemical waste that has concentrations greater than or equal to the regulatory limits listed in Appendix D must be disposed of through the hazardous waste management program.

NOTE: Dilution is not allowed as a treatment method for hazardous waste.

Examples of toxic contaminants include:

- Barium
- Benzene
- Chloroform
- Chromium
- Lead
- Mercury
- Pyridine
- Silver
6.3.5 The Mixture Rule

According to EPA and DEC regulations, the Mixture Rule defines whether a mixture of nonhazardous and hazardous waste results in a hazardous waste. The Mixture Rule states:

If ANY amount of a nonhazardous waste is mixed with ANY amount of a listed hazardous waste (see Section 6.2), then the resulting mixture is considered to be a hazardous waste.

If ANY amount of a nonhazardous waste is mixed with ANY amount of characteristically hazardous waste (see Section 6.3), then the resulting mixture is not considered to be hazardous if the resulting mixture no longer exhibits one of the hazardous characteristics.

For example:

If you have a container of waste Sodium choride solution (nonhazardous) and a container of waste Phenol (listed hazardous waste) and mix both chemicals in a larger waste container, the resulting mixture is considered to be a hazardous waste and must be disposed of through the hazardous waste management program.

If you have a container of dilute Sodium hydroxide solution with a pH= 10 (nonhazardous) and a container of Hydrochloric acid solution with a pH= 2 (characteristic hazardous waste – corrosive) and mix both chemicals in a larger waste container and the resulting pH of that mixture is greater than 2 or less than 12, then the mixture no longer exhibits the hazardous characteristic of corrosivity and therefore is not considered a hazardous waste.

7.0 SATELLITE ACCUMULATION AREAS

Satellite Accumulation Area is the name given to the area where hazardous wastes are generated and stored before being moved to the campus 90-day central storage area. Satellite Accumulation Areas can be thought of as the individual rooms, work areas, art studios, and laboratories where hazardous waste is generated.

Hazardous waste can be accumulated in a Satellite Accumulation Area if the following requirements are met:
A generator can accumulate up to 55 gallons of hazardous waste or one quart of acutely hazardous waste (P-listed), before having to be removed to the 90-day central storage area.

Hazardous waste must be stored at or near the point of generation and under the control of the person who generated the waste.

Hazardous waste must be kept in the same room, lab, work area, or art studio that it is generated. Under the hazardous waste regulations, you cannot move a container of hazardous waste from one room to another room, down a hallway, to another building, etc.

According to how the regulations are written, by moving hazardous waste from one room to another room or building, you are no longer storing waste under Satellite Accumulation Area rules, you are essentially creating another 90-day central storage area and must comply with all applicable storage requirements. To avoid this, keep hazardous waste stored at or near the point of generation.

A general rule of thumb is to follow the “Frisbee Rule”: You should be able to throw a Frisbee to your hazardous waste containers in your Satellite Accumulation Area. You can’t throw a Frisbee through walls, out doors, around corners, down hallways, etc. and still reach your hazardous waste containers. Keep your hazardous waste containers in the same room in which the hazardous waste was generated!

NOTE: Satellite Accumulation Area rules DO NOT apply to chemicals that are still in use and therefore not considered hazardous waste. Satellite Accumulation Area rules only apply to hazardous waste containers.

Hazardous waste must be properly labeled. ALL containers of hazardous waste MUST be labeled with the words “Hazardous Waste” and with other words identifying the contents and any hazards present.

EH&S has distributed rolls of stickers that say “Hazardous Waste” for this purpose. The Hazardous Chemical Waste Tag (see Section 9.1) can also be used for this purpose. Additional rolls of hazardous waste stickers or Hazardous Chemical Waste Tags can be obtained by contacting EH&S at 7-2211.

ALL containers of hazardous waste MUST be kept closed except when adding removing waste.

Hazardous waste must be stored in containers that are compatible with the waste being stored and be free of cracks and leaks. If a container is leaking
or in poor condition, then place the degraded container into an “overpack” container such as a 1 gallon plastic jar. Science Stores carries a variety of different types and sizes of containers (see Appendix H).

Hazardous waste containers must be marked with the date the container becomes full. This date can be written on the Hazardous Chemical Waste Tag (see Section 9.1).

After a hazardous waste container becomes full, contact EH&S to schedule a waste pick up (see Section 9.0). It is recommended that hazardous waste be accumulated in containers large enough to hold the waste being generated, yet small enough so the container can be filled quickly and then removed by EH&S. Do not accumulate full waste containers. Hazardous waste pickups are held once every two weeks.

Hazardous waste must be disposed of properly, do not dispose of hazardous waste down sink drains, in the normal trash, or by evaporation in fume hoods > > > all constitute illegal disposal.

Do not store hazardous waste containers in or around sinks, including cup sinks in hoods, without using some form of secondary containment.

Hazardous waste containers should be stored in plastic trays labeled “Satellite Accumulation Area”. You can obtain one of these specially labeled trays by contacting EH&S at 7-2211.

Please note: These specially labeled trays are for storage of hazardous waste containers only. Do not use them for general purpose storage. Science Stores carries a variety of storage trays and containers (see Appendix H).

8.0 MANAGEMENT PROCEDURES FOR SPECIFIC WASTE TYPES

The following procedures and requirements are for the management of specific types of hazardous waste. Please adhere to these guidelines. If you are routinely generating a large quantity of a particular chemical or waste stream, contact EH&S at 7-2211 and special disposal arrangements can be made to accommodate you.

8.1 Concentrated Solutions of Acids and Bases

Concentrated solutions of acids and bases can be disposed of through the hazardous waste management program OR as a means of waste minimization, can be neutralized first and then disposed of down the drain.
Please note that concentrated solutions of acids and bases that contain other chemicals such as heavy metals cannot be disposed of down the drain.

THESE PROCEDURES SHOULD ONLY BE PERFORMED BY TECHNICALLY QUALIFIED AND FULLY TRAINED PERSONNEL.

8.1.1 Neutralization Procedures

Do not attempt to neutralize strong oxidizing acids such as Perchloric acid and Chromic acid.

If you choose to neutralize and dispose of these materials yourself, please follow these guidelines:

Only perform these procedures in a fully functioning fume hood in a well-ventilated area and behind a safety shield. Always wear splash goggles, face shield, gloves, and splash apron for protection. CAUTION: Vapors and heat are generated during neutralization.

Keep containers cool while neutralizing and perform all steps slowly.

Solutions should be neutralized to a pH range of 6 to 10, and then flushed down the drain with at least 20 parts of water.

8.1.2 Acid Neutralization

Highly concentrated acids should first be diluted with cold water (always add the acid to the water) to a concentration below 10%. While stirring, add the dilute acid solution to large amounts of an ice water solution of base such as Sodium carbonate, Calcium hydroxide, or 8M Sodium hydroxide for concentrated acids. When a pH between 6 and 10 has been achieved, the solution can be flushed down the drain followed by 20 parts water.

8.1.3 Base Neutralization

Highly concentrated bases should first be diluted with cold water (always add the base to the water) to a concentration below 10%. Add the dilute solution to a large container of ice water. While stirring, slowly add a 1M solution of Hydrochloric acid. When a pH between 6 and 10 has been achieved, the solution can be flushed down the drain followed by 20 parts water.
8.1.4 Chromic acid

Chromic acid is a powerful oxidizing agent that is both toxic and corrosive and can explode on contact with organic materials. Chromium (VI) is also classified as a carcinogen. Accidents involving Chromic acid cleaning solutions can result in burns to both skin and clothing.

Chromic acid cleaning solutions leave a residue of Chromium (VI) on the glass surface, which is difficult to remove. This residue has been known to interfere with certain research procedures since the material can leach into solution. EH&S highly recommends that you consider using Chromic acid alternatives such as "No Chromix", "Alconox", or similar type products which can be ordered through Science Stores (see Appendix H).

8.1.5 Hydrofluoric acid

Hydrofluoric acid is a strong corrosive and highly toxic chemical that causes severe burns from dilute solutions and can be fatal upon exposure of concentrated solutions. Benchtop use of Hydrofluoric acid is not permitted, it must only be used in a fume hood.

Because of Hydrofluoric acid’s ability to etch glass, the chemical and waste must be stored in plastic containers. As a safety precaution, EH&S recommends that Calcium hydroxide be added to any mixtures or dilute solutions of Hydrofluoric acid waste.

Anyone using Hydrofluoric acid should contact EH&S and request a tube of Calcium gluconate gel, which is used as an initial response to skin exposure of Hydrofluoric acid. The quantities of Hydrofluoric acid that is used and stored should be kept to an absolute minimum.

8.1.6 Perchloric acid

Perchloric acid is a strong oxidizer and corrosive acid. Perchloric acid can also react with metal to form shock sensitive metal perchlorates. This can occur when Perchloric acid is used in a regular (non-Perchloric acid) fume hood.

Because of this high hazard, Perchloric acid must only be used in a special Perchloric acid fume hood, which has a wash down function. Contact EH&S at 7-2211 if you plan to use Perchloric acid so arrangements can be made for the experiment to be conducted in a special Perchloric acid fume hood.
8.2 Organic Solvents

Organic solvents should be collected in special flammable liquid safety cans. This is a requirement for laboratories that generate more than 2 gallons of flammable solvents within a two week period. Safety cans come in 2.5 gallon and 5 gallon sizes and can be purchased at Science Stores (see Appendix H). Science Stores also carries replacement flame arrestor screens for safety cans.

Do not dispose of organic solvents down the drain. Generators of organic solvents should keep nonhalogenated waste solvents separated from halogenated waste solvents to the fullest extent possible. EH&S bulks organic solvents into 55 gallon metal drums for fuels blending. It costs approximately three times as much to dispose of a drum of halogenated waste solvents versus a drum of nonhalogenated waste solvents.

Safety cans should only be used for the storage of waste organic solvents. Other wastes are inappropriate for fuels blending, can have a detrimental effect on the integrity of the metal 55 gallons drums used, and represent a serious health and safety issue to EH&S staff.

The following wastes must NOT be collected in safety cans:

- strong acid or base solutions (a pH between 4 and 11 is acceptable)
- aqueous solutions of toxic organic chemicals
- heavy metals (Lead, Mercury, Silver, Chromium, Barium, etc.)
- vacuum pump oil
- sulfides or inorganic cyanides
- strong oxidizers or reducers
- water reactive substances
- PCB waste
- unknowns

Be sure to include approximate percentages of all waste solvents placed in safety cans. Do not rely on your memory to label solvents, keep a running list of solvents that you add to the safety can.

8.3 Aqueous Solutions of Toxic Chemicals

Aqueous solutions containing heavy metals and chemicals found in Appendix C and Appendix D must be disposed of through the hazardous waste management program. Do not dispose of this type of waste down the drain.
8.4 Oil

Uncontaminated oil, such as vacuum pump oil, is not considered hazardous waste and can be collected and recycled. Do not mix other chemical wastes with used oil. If a hazardous waste, such as flammable solvents or heavy metals, is added to used oil, then the resulting mixture cannot be recycled and must be handled as hazardous waste. Be sure to note any contaminants on the Hazardous Chemical Waste Tag when disposing of contaminated used oil.

If you remove oil from a piece of electrical equipment, verify whether or not the oil contains PCBs. EH&S has the capability to do a quick test to determine if oil contains PCBs. When in doubt, contact EH&S at 7-2211.

8.5 Asbestos

Asbestos is a fibrous material that was once widely used in a number of products that can still be found in laboratories and throughout other buildings. Products that can contain asbestos include: electrical equipment insulation (ovens, heating mantles, heating pads, and wires), older vinyl floor tiles and mastic, pipe fittings, pipe insulation, caulking compounds, fireproofing, and transite (cement-like) panels such as those found in and under fume hoods.

Asbestos is a known human carcinogen and must be disposed of properly. The hazard of asbestos is greatest when the asbestos product becomes “frangible” – able to be pulverized from finger pressure – and when the asbestos becomes airborne. For older vinyl asbestos tile (VAT), an additional slipping hazard occurs when these tiles “pop” out of the floor.

If you find any of the above items deteriorating and suspect they may contain asbestos, or you are considering disposing of old electrical equipment with insulation, or if vinyl tiles have “popped” out of the floor, contact the asbestos coordinator at 7-4018 for more information.

8.6 Silica Gel

Silica gel contaminated with solvents, heavy metals, or other toxic chemicals should be accumulated in leak proof containers such as one gallon plastic wide mouth containers or a five gallon bucket lined with a heavy duty plastic bag. Contact the EH&S at 7-2211 for these supplies.
When labeling Silica gel waste, be sure to list all of the contaminants, including solvents, and the approximate percentages on the Hazardous Chemical Waste Tag.

8.7 Chemically Contaminated Items

In general, Chemically Contaminated Items (CCIs) can only be put into the normal trash if they are nonhazardous, nonignitable, nonreactive, noncarcinogenic, nonmutagenic, noninfectious, nonradioactive, and the contaminant is not highly toxic. “Labware” includes disposable items such as gloves, benchtop coverings, pipets, test tubes, etc.

If you feel that the normal trash is not an appropriate disposal route for your CCIs, then package them in a leakproof container or plastic bag and label with a Hazardous Chemical Waste Tag as “Chemically Contaminated Items” and the name and approximate percentage of chemical contaminants.

8.8 Mercury

Effective December 2002, metallic mercury must managed and disposed as a hazardous waste through the hazardous waste management program. It should be packaged in a tightly sealed and leak-free container such as a bottle or vial with a screw top lid. Place broken mercury thermometers in a leak proof container or a secured plastic bag. When collecting metallic mercury, DO NOT mix with other chemicals or waste if at all possible. Label all waste containers of metallic mercury a Hazardous Waste and include approximate percentages of the waste constituents on the Hazardous Chemical Waste Tag.

Do not use the past practice of adding sulfur, nitric acid, or water in an attempt to contain vapors. This only results in more hazardous waste being generated. However, the use of commercial ‘Hg Absorb’ powder found in mercury spill kits is acceptable.

Mercury is a highly toxic chemical and ALL mercury spills, including broken thermometers, must be cleaned up and the spill debris must be disposed of through the hazardous waste management program. Commercial mercury spill kits can be found in the 5-gallon ‘Spill Buckets’ (see Appendix G) and are also available through many safety supply companies. Never use a regular vacuum cleaner to clean up a mercury spill, this will only cause the mercury to vaporize and disperse into the air. Environmental Health & Safety has a special mercury vacuum designed for cleaning up mercury spills and a
mercury “sniffer” to determine if all mercury has been cleaned up from a spill. Contact EH&S at 7-2211.

8.9 Fluorescent Tubes

Fluorescent tubes and other mercury bearing lamps such as high pressure sodium lamps, mercury vapor, and metal halide lamps must be disposed of properly. These items cannot be placed in the normal trash. Broken fluorescent tubes must be handled as hazardous waste. If a bulb breaks, ventilate the area immediately. Every attempt should be made to keep these items intact and to prevent breakage.

There is a program in place to manage fluorescent tubes and other mercury bearing lamps. Contact EH&S at 7-2211 for more information.

8.10 Batteries

There is a program in place to recycle batteries (Alkaline, Ni-Cad, Lithium, Lead-acid, Mercury, and button batteries). There are a number of battery collection containers around campus. If you would like to request a battery collection container for your building/work area or if a battery collection container is full, contact the recycling coordinator at 7-4335.

8.11 Computer Equipment

There is a program in place to recycle computer equipment. There are heavy and precious metals in many components of computers. Old computer equipment cannot be disposed of in the normal trash. If you are planning on disposing of these items, contact the recycling coordinator at 7-4335.

8.12 Aerosol Cans and Cylinders

Aerosol cans and small Propane cylinders can contain flammable, corrosive, and toxic chemicals and propellants. There is a program in place to collect aerosol cans and small Propane cylinders. These items will be emptied of their contents, depressurized, and then recycled for scrap metal. Aerosol cans and small Propane cylinders are collected during regular hazardous waste pickups (see Section 9.0)

If you find a large (2 or 4 foot) high-pressure gas cylinder and would like to have it removed, contact EH&S at 7-2211.
8.13 Paint, Paint Thinner, Adhesives, and Printshop Chemicals

Paint (oil-based), Paint thinner, Adhesives, and many Printshop chemicals are flammable and are regulated as hazardous waste. These items cannot be poured down the drain or left out to evaporate. They must be disposed of through the hazardous waste management program. Latex paint that has solidified completely can be placed in the normal trash.

8.14 Photographic Chemicals

Photographic chemicals can contain heavy metals such as Silver, Chromium, and Selenium that may be above regulatory levels and must be handled as hazardous waste. Used photographic fixer contains Silver above regulatory levels and cannot be poured down the drain, however, some photographic chemicals may be disposed of down the drain depending on the chemical constituents. EH&S collects photographic chemicals during regular hazardous waste pick ups and can make special arrangements to return collection containers back to darkroom users. For more information on disposal of photographic chemical disposal, contact EH&S at 7-2211.

8.15 Reactive and Potentially Explosive Chemicals

Reactive chemicals such as strong oxidizers and reducers, and air/water reactive chemicals must be disposed of through the hazardous waste management program. Because of their reactive nature, it is important to minimize the quantity of reactive chemicals in storage. If the integrity of the container appears to be compromised, then dispose of the chemicals promptly. Never dispose of reactive chemicals, such as Sodium metal, regardless of the quantity, down the drain or in the normal trash. Such practices can result in fires, toxic vapors and gases being released, and injury to people. When disposing of these compounds, please note any special hazards on the Hazardous Chemical Waste Tag.

Some of these compounds can also become unstable and potentially explosive over time due to contamination with air, water, other material, or when the chemical dries out. If you come across any chemical that you suspect could be potentially explosive, do not attempt to move the container as some of these compounds are shock, heat, and friction sensitive. Be sure to let others in the lab or work area know the chemical exists and the potential explosion hazard. Contact EH&S at 7-2211 for more assistance.

Examples of potentially explosive chemicals include:
Benzoyl peroxide (dry)    Peroxide forming compounds
Diazo compounds        Picric acid (dry)
2,4-Dinitrophenyl hydrazine (dry)     Sodium amide
Nitrocellulose              Trinitro- compounds

8.16 Peroxide Forming Chemicals

Many commonly used chemicals, organic solvents in particular, can form shock, heat, and friction sensitive peroxides upon exposure to oxygen through concentration, evaporation, and distillation. Due to the serious fire and explosion hazards these chemicals can present, the following guidelines must be followed when using peroxide forming chemicals.

See Appendix E for a listing of common peroxide forming chemicals. Please note this list is not all-inclusive, there are numerous other chemicals that can form peroxides. Check Material Safety Data Sheets (MSDS) or contact EH&S for more reference sources.

All peroxide forming chemicals MUST be dated when received and dated when opened. Chemicals designated as Class III compounds (in Appendix E) should be disposed of within 3 months of opening and Class I and Class II compounds should be disposed of within 12 months of opening. All peroxidizable compounds should be stored away from heat and light. Sunlight is an especially good promoter of peroxidation.

Refrigeration does not prevent peroxide formation.

As is the case with all hazardous chemicals, and in particular with peroxide forming chemicals, only order the amount of chemical that you need. Do not order excess chemicals that will not be used right away.

Be sure to tightly close containers after use. Loose or leaky closures may allow for evaporation of the chemical which can result in peroxide formation.

There are a number of inhibitors that can be used to help prevent peroxide formation. Examples include Hydroquinone, Alkyl phenols, and Aromatic amines. Check with the chemical manufacturer to determine which inhibitor is the best to use.

Never distill peroxide forming solvents unless they are known to be free of peroxides. Peroxides concentrated in still residue can be a serious explosion hazard.
Science Stores carries peroxide test strips that can be used to test for peroxides (see Appendix H). EH&S also has a number of references that list various methods for testing peroxides. While no definitive amount of peroxide concentration is given in the literature, a concentration of 50 ppm should be considered dangerous and a concentration > 100 ppm should be disposed of immediately.

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. Make other people working in your area aware of the potential explosion hazard and contact EH&S immediately at 7-2211.

Due to the extremely high cost of remote openings, special handling, and disposal of chemicals that are considered potentially explosive (> $1000 per container), users of peroxide forming chemicals must follow the guidelines listed above. If a particular container requires special handling or remote opening by an outside environmental company as a result of improper handling and storage by laboratory personnel and failure to follow the guidelines listed above, then all costs associated with the special handling will be charged back to the faculty member responsible for the laboratory.

8.17 Unknowns

You must make every effort to provide an accurate description of all chemicals that you dispose of through the hazardous waste management program. Without an accurate description, the chemical cannot be handled or disposed of safely. Waste disposal companies will not accept unknown chemical waste without an analysis, which can be very expensive.

Many unknown chemicals are generated due to a lack of good housekeeping and good laboratory safety practices. ALL containers used to store chemicals must be labeled. Containers in which the labels are degrading or falling off should be given a new label. There are numerous reference materials with methods and procedures that can be used in identifying unknown chemicals (see Appendix I). Every effort should be made to prevent the occurrence of unknown chemicals and to properly identify any unknowns that are discovered.

8.18 Household Hazardous Waste

Binghamton University cannot accept household hazardous waste for disposal. However, for Broome and Tioga county residents, a program is in
place to collect household hazardous waste throughout the year. Typical wastes accepted at the facility are:

- auto fluids and oil filters
- paints and solvents
- varnishes, shellacs, and stains
- adhesives, coatings, and sealers
- pesticides and fertilizers
- photo, pool, and lab chemicals
- cleaners and aerosols
- household batteries

Please see website for collection dates:
http://gobroomcounty.com/dpw/DPWhazardouswaste.php

9.0 HAZARDOUS WASTE DISPOSAL PROCEDURES

Generators should call or email a request for disposal of hazardous waste. The waste will be picked up at your lab or work area on a scheduled pickup day. See the most recent hazardous waste disposal flier for the current scheduled pickup dates.

When calling or emailing a request for disposal, please include the following information:

- name
- phone number
- building and room number
- type and amount of waste to be picked up (# of bottles)
- location of the waste

Generators need not be present during the pickup as long as the above information is provided. Requests need to be made BEFORE the scheduled pickup dates.

Please keep in mind that ALL waste must have a completed Hazardous Chemical Waste Tag attached to each container. Hazardous Chemical Waste Tags must be signed and dated when the container is full. Information on filling out Hazardous Chemical Waste Tags can be found in Section 9.1. Hazardous Chemical Waste Tags can be obtained at Science Stores or from Environmental Health & Safety.

Full waste containers should not be accumulated in labs for longer than 2 weeks.
PLEASE NOTE: Containers that do not have a completed, signed, and dated Hazardous Chemical Waste Tag attached will NOT be picked up. A note will be left indicating the generator needs to attach a Hazardous Chemical Waste Tag and to call and reschedule to have the waste picked up.

Pickups will be held twice a month, no specific time can be given as to when the chemicals will be picked up. To schedule a waste pickup or to request a copy of the current flier with scheduled pickup dates, contact EH&S at 7-2211. (leave voice mail) or email hazwaste@binghamton.edu.

9.1 The Hazardous Chemical Waste Tag

The Hazardous Chemical Waste Tag serves many important functions in the proper disposal of chemicals. The obvious function is identifying what exactly is in the container. Often bottles are used for waste collection and the original label on the container does not accurately describe its contents. Be sure to deface any container label that does not accurately describe its contents. The Hazardous Chemical Waste Tag is also used to create an inventory log of hazardous waste generated on campus.

The tag must be filled out completely and attached to the container. Please be sure to read the directions on the back and completely fill out the front of each tag. Hazardous Chemical Waste Tags can be obtained at Science Stores or from Environmental Health & Safety.
9.2 Completing the Hazardous Chemical Waste Tag

HAZARDOUS CHEMICAL WASTE TAG
(see directions on reverse side)
Print Your Name:____________________________
Building and Room Number:______________ Phone:______________
Total Amount in Container:________________ Container Size:______________
Generation Code:________________
COMPLETE CHEMICAL COMPOSITION: (List approximate % of each constituent including water/solvent)
1. __________________________________________ % 5. ____________________________________%
2. __________________________________________ % 6. ____________________________________%
3. __________________________________________ % 7. ____________________________________%
4. __________________________________________ % 8. ____________________________________%
Check if applicable: | I certify this information is true and that I have done
___ Flammable?      | my best to reduce the volume and toxicity of this waste.
___ Corrosive?  pH       |
___ Oxidizer?     |
___ Highly Toxic?   | Sign Name:__________________________ Date:___________
___ Reactive/Explosive?|
___ Stench?     |

PRINT YOUR NAME: This should be the person generating the waste or someone who has knowledge about the waste in case additional information is needed.

BUILDING AND ROOM NUMBER: Where the waste was generated.

PHONE #: This is important in case additional information is needed.

TOTAL AMOUNT IN CONTAINER: Approximate amount of waste present in the container.

CONTAINER SIZE: The size of the container holding the waste.

COMPLETE CHEMICAL COMPOSITION: It is important that ALL chemical names be written out and the approximate percentages of EACH constituent be listed. Chemicals in amounts of < 1% can be written as “trace”. Also include the percentage of water or solvent present. Final reaction products should be listed instead of chemical equations. Chemical structures, formulas, abbreviations, or acronyms are NOT acceptable. Chemical names MUST be written out.

GENERATION CODE: The type of program under which the waste was generated.
F= Funded Research   I= Instructional   M= Maintenance   O= Other
**APPLICABLE HAZARDS:** While this can be helpful, if you are unsure or do not know, then leave this section blank. In the case of mixed waste, make sure that all reactions are complete before checking the pH as this can change over a short period of time.

**CERTIFICATION:** The hazardous waste regulations require that generators of hazardous waste certify that they are practicing waste minimization. In addition, by signing the certification you are assuming the responsibility that the waste generated is accurately described in the chemical composition section. The generator of the waste must sign and date when the container is full.

Please keep in mind that the hazardous waste management program collects waste throughout the ENTIRE Binghamton campus. Your cooperation in completely and legibly filling out Hazardous Chemical Waste Tags is greatly appreciated.

**10.0 WHAT HAPPENS TO THE HAZARDOUS WASTE GENERATED ON CAMPUS**

After a chemical waste has been generated, determined to be hazardous, and sent through the hazardous waste management program, there are 4 primary ways in which the waste is handled: bulk drums, lab pack drums, recycling/reclamation, and drain/trash disposal.

**10.1 Bulk Drums**

Certain categories of liquid chemicals can be bulked and combined into drums. Bulking waste (as opposed to lab packing) can result in significant cost savings for the University and ultimately your department. Bulking first involves segregating chemicals according to hazard class. Then a small amount of chemical from each container is mixed in a 1-gallon size container to minimize any potential fire or explosions. If no reactions occur, then the rest of the chemical is poured into a 30- or 55-gallon drum. Accurately labeling chemicals helps to avoid potential reactions, fires, or explosions when chemicals are bulked. Examples of waste streams that may be bulked into separate drums are as follows:
- Flammable solvents (non-halogenated)
- Flammable solvents (halogenated)
- Acids
- Bases
- Aqueous waste (i.e., photochemical waste)
10.2 Lab Pack Drums

Chemicals that cannot be bulked are lab packed. Lab packing first involves segregating chemicals according to hazard class. Chemicals in the same hazard class are placed into various size drums (55-gallon is the most common), then a packing material, such as vermiculite, is added to prevent the containers from breaking during transportation.

10.3 Recycling/Reclamation

Chemicals such as oil and silver from photographic fixer may be sent for recycling/reclamation. Photographic fixer may be collected and run through a filtration media to collect the silver. It is important to minimize the amount of other material that is mixed in with these items. The addition of chemicals or other solid waste to these items can result in the material being unable to be reclaimed and having to be disposed as hazardous waste instead.

10.4 Drain/Trash Disposal

Some chemicals are safe to dispose of via the sanitary sewer or normal trash. If solid chemicals that are received through the hazardous waste management program are determined to be nonhazardous and nonregulated, they are placed in containers that clearly identifies this and then disposed in the normal trash.

10.5 Ultimate Disposal

There are a variety of treatment/destruction methods that environmental companies use after they receive the waste generated on campus. Some wastes (bulk flammable liquid drums) are used as a secondary fuel source at cement kilns. Wastes such as acids/bases and oxidizers/reducers can be treated at a facility to render the waste nonhazardous. Most waste will be sent to a hazardous waste incinerator. Any resulting ash from the incineration process is stabilized and then placed into a hazardous waste landfill. While there are other methods that can be utilized, the hazardous waste generated at Binghamton University will generally be handled using the above technologies.
As part of the OSHA (NY PESH) Hazard Communication Standard, employers are required to have Material Safety Data Sheets (MSDS) available to any employee working with hazardous chemicals. The regulations state that the standard is based on the concept "that employees have both a need and a right to know the hazards and identities of the chemicals they are exposed to when working. They also need to know what protective measures are available to prevent adverse effects from occurring."

Information that can be found in a MSDS includes:

- the identity of the chemical substance
- physical and chemical characteristics
- physical and health hazards
- primary routes of entry
- OSHA Permissible Exposure Limits (PELs)
- carcinogenic status
- precautions for safe handling and use (including personal protective equipment)
- spill response
- emergency and first aid procedures
- date of the MSDS

Although not required, it is highly recommended that you maintain a file of MSDS sheets for all of the chemicals used in your lab/work area. A central campus file is maintained at the EH&S office.

Any chemical shipment received should be accompanied by an MSDS. Please send a copy to EH&S to help keep our files up to date and current. If you do not receive a MSDS with a shipment or would like to request a MSDS for a previously purchased chemical, contact EH&S at 7-2211.

**11.1 MSDSs on The WWW**

Material Safety Data Sheets can also be accessed through a number of WWW sites. Some useful sites are:

1) Interactive Learning Paradigms, Inc

http://www.ilpi.com/msds/index.html
This site has 85 links to search for MSDSs and other related information including:

- general and miscellaneous sites
- government agencies
- chemical manufacturers and suppliers
- agricultural pesticides and herbicides

2) University of Vermont – MSDS Site
http://www.siri.org

12.0 CHEMICAL SPILLS

Many chemical spills can be avoided by good housekeeping and best management practices. Plan out your experiments ahead of time and think about where your apparatus and glassware will be located in relation to where you will be using chemicals. If at all possible, work with chemicals over some form of secondary containment (ie. plastic trays or buckets) and store chemicals in secondary containment. Always read the MSDS BEFORE working with a chemical so you are familiar with the chemical hazards, any precautions to take, and what you will need in the event of a spill.

When a spill does occur, 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. Only attempt to clean up minor spills.

12.1 Minor Spills

A minor spill consists of:

- a small quantity of chemical involved – a rule of thumb is less than 1 liter, this quantity can be less if the chemical is particularly hazardous
- a known chemical of limited danger
- there are no gases or vapors present
- you have the Proper Personal Protective (PPE) equipment on hand
the spill can be easily cleaned up by the chemical user

12.1.1 Minor Spill Cleanup Procedures

Notify other people in the area that a spill has occurred. Prevent others from coming in contact with the spill (ie. walking through the spilled chemical).

If working in a science laboratory, spill cleanup supplies can be found in the 5-gallon Spill Buckets (see Appendix G for a list of supplies). If you do not work in a science laboratory and would like assistance in making a Spill Bucket for your work area, contact EH&S at 7-2211.

Wear the Proper Personal Protective Equipment (PPE) such as goggles, gloves, etc. before beginning cleanup.

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.

Use the appropriate absorbent material for liquid spills:

- Calcium carbonate for Acid spills
- Citric acid for Base spills
- Hg Absorb powder (found in Mercury kit) for Mercury spills
- Absorbent clay for oils and most aqueous and organic liquid spills

Slowly add the absorbent material on and around the spill and allow the chemical to absorb.

Sweep up the absorbed spill from the outside towards the middle.

Scoop up and deposit in a leak-proof container.

Label the container and dispose of through the hazardous waste management program.

Wash the contaminated surface with soapy water.

Report the spill to your supervisor.

Remember to restock any supplies that you use from the Spill Bucket. Supplies can be obtained from EH&S by contacting EH&S at 7-2211.
12.2 Major Spills

A major spill consists of:

- a large quantity of chemical or several chemicals are involved
- highly toxic or unknown chemicals
- gases or vapors are present
- the spill is not confined to the immediate area
- the spill involves a radioactive material

12.2.1 Major Spill Cleanup Procedures

Evacuate the room, floor, or building as necessary. In the event of a major situation, do not hesitate to pull the fire alarm to evacuate the building.

Report the major spill by DIALING 911 or by using one of the emergency hallway phones found in some buildings.

Limit access to the area.

Stand by until help arrives while keeping yourself away from danger. This could mean standing outside of the room or in the case of a building evacuation, standing by an outside door waiting for the University Police to arrive.

When you report a spill, the University Police will ask for the following information:

- where the spill occurred (building and room number)
- the materials involved (SPELL CLEARLY and SLOWLY)
- the amount of material spilled
- any immediate actions you took
- how the spill occurred (if you know or can guess)
- who first observed the spill and at what time
- are there any injuries
- a call back number (if available)
If the spill appears to be heading towards a waterway (sink, cup sinks, and floor drains inside and storm drains outside), try to prevent the spilled material from entering waterways by building a dike around access points with absorbent material ONLY if you can do so from a safe distance. DO NOT put yourself in danger, but if possible, try to protect waterways.

12.3 Fire Alarms

If you hear a fire alarm, the most important thing to do is **GET OUT!!!** Do not assume the fire alarm is just a drill...if you hear an alarm, get out of the building immediately.

When evacuating the building, only use the stairs. Do not use the elevators. During a fire alarm and an actual emergency, power to elevators may be lost and can result in people getting trapped inside.

After you have evacuated the building, remain outside until an “All Clear” is given by the University Police. Do not attempt to reenter the building for any reason until the fire alarms have been turned off and the University Police give an “All Clear”. There are NO exceptions to this policy.
Management Procedure Number 807

General Policy

1) It is the policy of Binghamton University to maintain an environment for its faculty, staff, students, and visitors that will not adversely affect their health and safety nor subject them to avoidable risk of injury.

2) The applicable health and safety standards are contained in rules and regulations promulgated by Federal and State agencies which must be followed in establishing campus safety policies. In addition, the published standards of nationally recognized professional health and safety organizations serve as guidelines in areas not covered by the government standards, rules, and regulations.

Environmental Health and Safety Responsibility

1) Management

The President of the University is legally responsible for campus health and safety and must ensure that appropriate health and safety policies are established for environmental protection and prevention of health and safety standards. These responsibilities are delegated to all levels of supervision in order to ensure that campus health and safety objectives are met.

2) Role of Department Chairs/Directors

The chairs or directors of each department are responsible for the health and safety of all students, faculty, staff, and visitors in their area. They have the obligation and authority to prevent or stop any operation they consider unsafe. They are also expected to obtain whatever assistance they may need from the Department of Environmental Health and Safety in order to develop and implement a departmental health and safety program. The chair/director may delegate all or part of these obligations to a departmental safety coordinator. Ideally, the safety coordinator should be a faculty member in an academic department. However, such delegation in
no way relieves the chair or director of their responsibility in matters of departmental health and safety.

3) Supervisors

Each supervisor must develop initiatives that will maintain a safe work place and also develop training employees and students regarding safe work practices. The training must ensure that employees and students know:

- All the potentially hazardous conditions associated with departmental operations, and methods to control them.
- All applicable safety regulations for the area of operation.
- That they are expected to help all persons unfamiliar with the area to comply with applicable safety regulations.

The goal is for employees and students to develop awareness and responsibility for safety so they will act in a safe manner when faced with situations not covered by established rules or regulations.

4) Individuals

The University’s Department of Environmental Health and Safety provides guidance and services to campus personnel so that the goals and objectives of the campus environmental health and safety policy may be attained. The responsibility requires the Department of Environmental Health and Safety to:

- Provide the President, or their designee, the information needed to formulate campus health and safety policies.
- Investigate and report health and safety incidents involving campus personnel or visitors.
- Assist campus personnel to plan, establish, and maintain safe work practices and a safe work environment in compliance with the Public Employees Safety and Health Act of 1980.
APPENDIX 2: F-List

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.

F002: The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane and 1,1,2-trichloroethane; 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.

F003: The following spent non-halogenated 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 non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated 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.

F004: The following spent non-halogenated 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 non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F005: The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2- nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004; and
still bottoms from the recovery of these spent solvents and spent solvent mixtures.

### APPENDIX 3: U and P List

<table>
<thead>
<tr>
<th>Hazardous Waste No.</th>
<th>Chemical Abstracts No.</th>
<th>Substance</th>
</tr>
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<tbody>
<tr>
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<td>30558-43-1</td>
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<tr>
<td>U001</td>
<td>75-07-0</td>
<td>Acetaldehyde</td>
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<td>Acetaldehyde, trichloro-</td>
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<td>U187</td>
<td>62-44-2</td>
<td>Acetamide, N-(4-ethoxyphenyl)-</td>
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<tr>
<td>U005</td>
<td>53-96-3</td>
<td>Acetamide, N-9H-fluoren-2-yl-</td>
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<td>U240</td>
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<td>Acetic acid, (2,4-dichlorophenoxy)-, salts &amp; esters</td>
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<td>U112</td>
<td>141-78-6</td>
<td>Acetic acid ethyl ester</td>
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<td>301-04-2</td>
<td>Acetic acid, lead(2+) salt</td>
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<tr>
<td>U214</td>
<td>563-68-8</td>
<td>Acetic acid, thallium(1+) salt</td>
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<td>see F027</td>
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<td>Azaserine</td>
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<td>Benzenamine, 4,4'-carbonimidoylbis[N,N-dimethyl-</td>
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<td>Benzenamine, 4-chloro-2-methyl-, hydrochloride</td>
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<td>Benzenamine, N,N-dimethyl-4- (phenylazo)-</td>
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<td>U248</td>
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<td>p-Benzquinone</td>
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2-Naphthalenamine
Naphthalenamine, N,N'-bis(2-chloroethyl)-
Naphthalene
Naphthalene, 2-chloro-
1,4-Naphthalenedione
2,7-Naphthalenedisulfonic acid, 3,3'-(3,3'-dimethyl[1,1']-biphenyl)-4,4'-diyl)bis(azo)bis[5-amino-4-hydroxy]-, tetrasodium salt
1-Naphthalenol, methylcarbamate
1,4-Naphthoquinone
alpha-Naphthylamine
beta-Naphthylamine
Nitric acid, thallium(1+) salt
Nitrobenzene
p-Nitrophenol
2-Nitropropane
N-Nitrosodi-n-butylamine
N-Nitrosodiethanolamine
N-Nitrosodiethylamine
N-Nitroso-N-ethylurea
N-Nitroso-N-methylurethane
N-Nitrosopiperidine
N-Nitrosopyrrolidine
5-Nitro-o-toluidine
1,2-Oxathiolane, 2,2-dioxide
2H-1,3,2-Oxazaphosphorin-2-amine, N,N-bis(2-chloroethyl)tetrahydro-2-oxide
Oxirane
Oxirane, (chloromethyl)-
Paraldehyde
Pentachlorobenzene
Pentachloroethane
Pentachloronitrobenzene (PCNB)
Pentachlorophenol
Pentanol, 4-methyl-
1,3-Pentadiene
Phenacetin
Phenol
Phenol, 2-chloro-
Phenol, 4-chloro-3-methyl-
Phenol, 2,4-dichloro-
Phenol, 2,6-dichloro-
Phenol, 4,4':(1,2-diethyl-1,2-ethenediyl)bis-, 
Phenol, 2,4-dimethyl-
Phenol, methyl-
Phenol, 2,2'-methylenebis[3,4,6-trichloro-
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U205  7488-56-4  Selenium sulfide SeS2
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U206  18883-66-4  Streptozotocin
U103  77-78-1  Sulfuric acid, dimethyl ester
U189  1314-80-3  Sulfur phosphide
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
U214  563-68-8  Thallium(I) acetate
U215  6533-73-9  Thallium(I) carbonate
U216  7791-12-0  Thallium(I) chloride
U217  10102-45-1  Thallium(I) nitrate
U218  62-55-5  Thioacetamide
U410  59669-26-0  Thiodicarb
U153  74-93-1  Thiourea
U219  62-56-6  Thiourea
U244  137-26-8  Thioperxydicarbonic 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 disocyanate
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
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  81-81-2  Warfarin, & salts, when present at concentrations of less 0.3% or
U239  1330-20-7  Xylene
U200  50-55-5  Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-
trimethoxybenzoyl(oxy) -, methyl ester, (3beta,16beta, 17alpha,18beta,20alpha) -

U249  1314-84-7  Zinc phosphide Zn3P2, when present at
concentrations of
10% or less

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3,4,5,6,9,9-Dimethanonaphth [2,3-b]oxirene, hexachloro-1,2,2a,3,6,6a,7,7a-octahydro-, (1αααα, 2ββββ, 2αααα, 3αααα, 6αααα, 6αββββ, 7ββββ, 7αααα) - & metabolites

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<td>P102</td>
<td>107-19-7</td>
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<td>57-47-6</td>
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<td>P114</td>
<td>12039-52-0</td>
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<td>P103</td>
<td>630-10-4</td>
</tr>
<tr>
<td>P104</td>
<td>506-64-9</td>
</tr>
</tbody>
</table>
P105  26628-22-8  Sodium azide
P106  143-33-9  Sodium cyanide
P106  143-33-9  Sodium cyanide Na(CN)
P108  1 57-24-9  Strychnidin-10-one, & salts
P018  357-57-3  Strychnidin-10-one, 2,3-dimethoxy-
P108  57-24-9  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
P062  757-58-4  Tetraphosphoric acid, hexaethyl ester
P113  1314-32-5  Thallic oxide
P113  1314-32-5  Thallium oxide Ti2 O3
P114  2039-52-0  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 [(H2 N)C(S)]2 NH
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  314-62-1  Vanadium oxide V2 O5
P120  1314-62-1  Vanadium pentoxide
P084  4549-40-0  Vinylamine, N-methyl-N-nitroso-
P001  1 81-81-2  Warfarin, & salts, when present at concentrations greater than 0.3%
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 Zn3 P2 , when present at concentrations greater than 10%
P205  137-30-4  Ziram
### APPENDIX 4: TCLP CONTAMINANT LIST

<table>
<thead>
<tr>
<th>EPA No.</th>
<th>Hw Contaminant</th>
<th>CAS No.</th>
<th>Regulatory Limit, mg/L</th>
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<tbody>
<tr>
<td>D004</td>
<td>Arsenic</td>
<td>7440-38-2</td>
<td>5.0</td>
</tr>
<tr>
<td>D005</td>
<td>Barium</td>
<td>7440-39-3</td>
<td>100.0</td>
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<tr>
<td>D018</td>
<td>Benzene</td>
<td>71-43-2</td>
<td>0.5</td>
</tr>
<tr>
<td>D006</td>
<td>Cadmium</td>
<td>7440-43-9</td>
<td>1.0</td>
</tr>
<tr>
<td>D019</td>
<td>Carbon tetrachloride</td>
<td>56-23-5</td>
<td>0.5</td>
</tr>
<tr>
<td>D020</td>
<td>Chlordane</td>
<td>57-74-9</td>
<td>0.03</td>
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<tr>
<td>D021</td>
<td>Chlorobenzene</td>
<td>108-90-7</td>
<td>100.0</td>
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<tr>
<td>D022</td>
<td>Chloroform</td>
<td>67-66-3</td>
<td>6.0</td>
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<td>D007</td>
<td>Chromium</td>
<td>7440-47-3</td>
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<tr>
<td>D023</td>
<td>o-Cresol</td>
<td>95-48-7</td>
<td>200.0</td>
</tr>
<tr>
<td>D024</td>
<td>m-Cresol</td>
<td>108-39-4</td>
<td>200.0</td>
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<td>D025</td>
<td>p-Cresol</td>
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<tr>
<td>D026</td>
<td>Cresol</td>
<td></td>
<td>200.0</td>
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<td>D016</td>
<td>2,4-D</td>
<td>94-75-7</td>
<td>10.0</td>
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<td>D027</td>
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<td>D028</td>
<td>1,2-Dichloroethane</td>
<td>107-06-2</td>
<td></td>
</tr>
<tr>
<td>D017</td>
<td>2,4,5-Tp (Silvex)</td>
<td>93-72-1</td>
<td>1.0</td>
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<tr>
<td>D029</td>
<td>1,1-Dichloroethylene</td>
<td>75-35-4</td>
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<td>D030</td>
<td>2,4-Dinitrotoluene</td>
<td>121-14-2</td>
<td>0.13</td>
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<tr>
<td>D012</td>
<td>Endrin</td>
<td>72-20-8</td>
<td>0.02</td>
</tr>
<tr>
<td>D031</td>
<td>Heptachlor (&amp; its epoxide)</td>
<td>76-44-8</td>
<td>0.008</td>
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<tr>
<td>D032</td>
<td>Hexachlorobenzene</td>
<td>118-74-1</td>
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<td>D033</td>
<td>Hexachlorobutadiene</td>
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<td>Hexachloroethane</td>
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<td>D008</td>
<td>Lead</td>
<td>7439-92-1</td>
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<td>D013</td>
<td>Lindane</td>
<td>58-89-9</td>
<td>0.4</td>
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<tr>
<td>D009</td>
<td>Mercury</td>
<td>7439-97-6</td>
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<td>D014</td>
<td>Methoxychlor</td>
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<td>D035</td>
<td>Methyl ethyl ketone</td>
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<tr>
<td>D036</td>
<td>Nitrobenzene</td>
<td>98-95-3</td>
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<tr>
<td>D037</td>
<td>Pentachlorophenol</td>
<td>87-86-5</td>
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<td>Pyridine</td>
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<tr>
<td>D010</td>
<td>Selenium</td>
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<td>D011</td>
<td>Silver</td>
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<tr>
<td>D039</td>
<td>Tetrachloroethylene</td>
<td>127-18-4</td>
<td>0.7</td>
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<tr>
<td>D015</td>
<td>Toxaphene</td>
<td>8001-35-2</td>
<td>0.5</td>
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<tr>
<td>D040</td>
<td>Trichloroethylene</td>
<td>79-01-6</td>
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<td>D041</td>
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<tr>
<td>D017</td>
<td>2,4,5-Tp (Silvex)</td>
<td>93-72-1</td>
<td>1.0</td>
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</table>
APPENDIX 5: PEROXIDE FORMING COMPOUNDS

(from Prudent Practices in the Laboratory)

Classes of Chemicals That Can Form Peroxides Upon Aging

Class I: Unsaturated materials, especially those of low molecular weight, may polymerize violently and hazardously due to peroxide initiation.

- Acrylic acid
- Acrylonitrile
- Butadiene
- Chlorobutadiene (chloroprene)
- Methyl methacrylate
- Styrene
- Tetrafluoroethylene
- Vinyl acetate
- Vinyl acetylene
- Vinyl chloride
- Vinyl pyridine
- Vinylidene chloride

Class II: The following chemicals are a peroxide hazard upon concentration (distillation/evaporation). A test for peroxide should be performed if concentration is intended or suspected.

- Acetal
- Cumene
- Cyclohexene
- Cyclooctene
- Cyclopentene
- Diacetylene
- Dicyclopentadiene
- Diethylene glycol dimethyl ether (diglyme)
- Diethyl ether
- Dioxane (p-dioxane)
- Ethylene glycol dimethyl ether (glyme)
- Furan
- Methyl acetylene
- Methyl cyclopentane
- Methyl-i-butyl ketone
- Tetrahydrofuran
- Tetrahydronaphthalene
- Vinyl ethers

Class III: Peroxides derived from the following compounds may explode without concentration.

- Organic
  - Divinyl ether
  - Divinyl acetylene
  - Isopropyl ether
  - Vinylidene chloride
- Inorganic
  - Potassium metal
  - Potassium amide
  - Sodium amide (sodamide)
NOTE: Lists are illustrative but not exhaustive.

APPENDIX 6: BINGHAMTON-JOHNSON CITY JOINT SEWAGE TREATMENT PLANT REGULATIONS

(Taken from The Binghamton-Johnson City Joint Sewage Board, Rules and Regulations)

Article 5

§5.01 Prohibited Discharges

No person shall discharge directly or indirectly into the POTW or into any private sewer drain emptying into the POTW any substances, materials, waters, or wastes in such quantities or concentrations which cause, or are capable of causing either alone or by interaction with other substances, interference with the operation or performance of the POTW treatment plant. No person shall discharge the following into the POTW:

a) Any stormwater, swimming pool water, surface water, roof runoff, subsurface drainage, uncontaminated cooling water, or unpolluted industrial process waters to any sanitary or combined sewer, except as is authorized by the Board.

b) Any liquids, solids, or gases which by reason of their nature or quantity are, or may be, sufficient either alone or by interaction with other substances to cause fire or explosion or be injurious in any other way to the treatment works or to the operation of the treatment works. This includes waste streams with a closed-cup flashpoint less than 140°F or 60°C using test methods specified in 40 CFR 261.21. Also, at no time shall two successive readings taken at ten minute intervals on an explosion hazard meter at the point of discharge into the system, or at any point in the system, be more than five percent nor any single reading over ten percent of the Lower Explosive Limit (LEL) of the meter. Prohibited materials include, but are not limited to, gasoline, kerosene, naphtha, fuel oil, benzene, and any other substances which the Joint Sewage Board, the DEC or EPA has notified the user constitute a fire or explosion hazard to the system. Lack of notification by these entities that a substance is a prohibited material does not constitute a defense to the User in and enforcement action for violation of this prohibition.
c) Solid or viscous substances which may cause obstruction to the flow in a sewer or other interference with the operation of the wastewater treatment facilities such as, but not limited to: petroleum oil, non-biodegradable cutting oil, products of mineral oil origin, grease, shredded garbage with particles greater than one-half inch in any dimension, animal guts or tissues, paunch manure, bones, hair, hides of fleshings, entrails, lime, stone or marble dust, metal, glass, straw, shavings, grass clippings, rags, spent grains, spent hops, waste paper, wood, plastics, tar, asphalt residues, residues from refining or processing of fuel or lubricating oil, mud or glass grinding or polishing wastes, snow, ice, any other solid objects, materials, refuse, and debris not normally contained in ordinary sewage.

d) Any wastewater having a pH less than 6.0 Standard Units (SU) or higher than 12.0 SU, or wastewater having any other corrosive property capable of causing damage or hazard to structures, equipment, and/or personnel or the treatment works.

e) Any wastewater containing toxic pollutants in sufficient quantity, either singly or by interaction with other pollutants, to injure or interfere with any wastewater treatment process, constitute a hazard to humans or animals, create a toxic effect in the receiving waters of the treatment works, or to exceed the limitation set forth in a categorical pretreatment standard, found in 40 CFR Chapter 1 Subchapter N, Part 405-471. A toxic pollutant shall include but not be limited to any pollutant identified pursuant to Section 307(a) of the Federal Act.

f) Any noxious or malodorous liquids, gases, or solids which either singly or by interaction with other wastes are sufficient to create a public nuisance or hazard to life or are sufficient to prevent entry into the sewer for their maintenance and repair.

g) Any substance which may cause the treatment works' effluent or any other product of the treatment works such as residues, sludge, or scums, to be unsuitable for reclamation and reuse or to interfere with the reclamation process where the treatment works is pursuing a reuse and reclamation program. In no case shall a substance discharged to the POTW cause the POTW treatment plant to be in non-compliance with sludge use or disposal criteria, guidelines, or regulations developed under Section 405 of the Federal Act; or any criteria, guidelines, or regulations affecting sludge use or disposal development pursuant to the Solid Waste Disposal Act, RCRA, or any state or federal requirements regarding solid or hazardous waste.
h) Any discharge resulting in pass through which will cause the treatment works to violate its State Pollutant Discharge Elimination System (SPDES) Permit or the receiving water quality standards.

i) Any pollutant, including oxygen-demanding pollutants (BOD, etc.,) released in a discharge at a flow rate and/or pollutant concentration, which will cause interference with the POTW.

j) Any wastewater with objectionable color not removed in the treatment process.

k) Any wastewater having a temperature which will inhibit biological activity in the POTW treatment plant resulting in interference, but in no case heated wastewater with a treatment at the introduction into the sewer system which exceeds 150°F (65.5°C) or in such quantities that the temperature of wastewater at the POTW treatment plant exceeds 104°F (40°C).

l) Any wastewater which causes a hazard to human life or creates a public nuisance.

m) Concentrated solutions, such as acid or caustic cleaning solutions or plating baths, without pretreatment.

§5.07 Restricted Discharges

No person shall discharge directly or indirectly into the POTW wastewater containing any of the following substances in concentrations exceeding those specified below. Concentration limits are applicable to wastewater effluent at a point just prior to discharge into the POTW.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Allowable Daily Average</th>
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</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>0.3</td>
</tr>
<tr>
<td>Chromium (Total)</td>
<td>12.0</td>
</tr>
</tbody>
</table>

1 All concentrations listed for metallic substances shall be as “total metal” which shall be defined as the value measured in a sample acidified to a pH value of less than 2 without prior filtration.

2 As determined by a composite sample taken of the User’s daily discharge over the operation and/or production period. Composite samples must consist of grab samples collected at intervals of at least one per hour.
APPENDIX 7: SPILL BUCKET CONTENTS

Contents of 5-gallon Spill Bucket:

5 lbs of Absorbent Clay - for most liquid spills

5 lbs of Calcium Carbonate - for acid spills

5 lbs of Citric Acid - for base spills

MSDS’s for Oil Dri, Calcium Carbonate, and Citric Acid

Mercury Spill Kit

Wisk Broom and Dust Pan

Sponge

pH Paper

5 - 5 Gallon Bags

5 - 9" x 12" Ziploc Bags

1 pair of Goggles

1 pair of Nitrile Gloves

3 - Dust Masks - for nuisance dust ONLY, not for chemical protection

Hazardous Waste Tags

Spill Cleanup Handout

<table>
<thead>
<tr>
<th>Element</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>8.0</td>
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<tr>
<td>Lead</td>
<td>2.5</td>
</tr>
<tr>
<td>Nickel</td>
<td>7.0</td>
</tr>
<tr>
<td>Zinc</td>
<td>20.0</td>
</tr>
</tbody>
</table>
Science Stores is located in the basement of Science II, room B15.

The Stores inventory consist of commonly used items at cost plus a 15% surcharge. The system provides centralized, large quantity purchasing and inventory of many chemicals, glassware, and laboratory supply items.

The Store has a supply of Hazardous Chemical Waste Tags.

A Science Stores requisition form is used when withdrawing supplies. The dollar value of withdrawals are charged against the department POETS string or research grants.

Contact Linda Schaffer at 7-2551 with any questions.

The on-line catalog can be found at:

http://bingweb.binghamton.edu/~lschaffe/ss_cat.htm

APPENDIX 9: REFERENCE MATERIALS


Alaimo, Robert J., Handbook of Chemical Health & Safety, The American Chemical Society, Oxford University Press, 2001


Luxon, S.G., *Hazards in the Chemical Laboratory*, Springer Verlag, 1992


*Safety in Academic Chemistry Laboratories*, The American Chemical Society, 1995

New York Codes, Rules and Regulations, 6 NYCRR parts 370-376

Code of Federal Regulations
   29 CFR 1910
   40 CFR 260-299
   49 CFR 100-199
WWW Sites

The National Microscale Chemistry Center:

http://www.microscale.org

New York State Department of Environmental Conservation Hazardous Waste Regulations:


U.S. Environmental Protection Agency Waste Programs:

http://www.epa.gov/region02/waste

U.S. Environmental Protection Agency College and University Compliance Assistance Information:

http://www.epa.gov/region02/p2/college/

Interactive Learning Paradigms, Inc – MSDS Site

http://www.ilpi.com/msds/index.html

University of Vermont – MSDS Site

http://www.siri.org