DEPARTMENT OF ENVIRONMENTAL HEALTH & SAFETY

CHEMICAL HYGIENE PLAN

Department of Environmental Health and Safety

General Services Bldg., Room 132

222 S. Chapel Street

Newark, DE 19716

302-831-8475

http://www.udel.edu/ehs

Effective Date: May 1, 1990

Revised: September, 2015

Emergency Phone Numbers

Newark Campus

Fire	911
University Police	911
Ambulance	911

Georgetown/Lewes Campus

Fire	9-911
Police	9-911
Ambulance	9-911

Dover Campus

Fire	99-911
Police	99-911
Ambulance	99-911

Wilmington Campus

Fire	9-911
University Police	9-911
Ambulance	9-911

Environmental Health & Safety	302-831-8475
University Police Non-Emergency	302-831-2222
Student Health Services	302-831-2226
Poison Information Center	1-800-722-7112 (Local)
	1-800-222-1222 (National)

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UNIVERSITY of DELAWARE
Office of the Executive Vice President & University Treasurer

Safety and Security Policies

Section: Safety and Security
Policy Number: 7-1
Policy Name: Safety Policy
Date: April 30, 1984
Revisions: June 5, 1989; December 18, 1991; March 1, 1996; January 4, 2006

I. POLICY

The policy of the University of Delaware is to provide the university community with a safe and healthful work environment. Serious attempts will be made to minimize recognizable hazards. It is the intent of the University to comply with all environmental health, safety, and fire regulations and recommended practices.

The implementation of this policy is the responsibility of the managerial and supervisory staff. Vice Presidents, Deans, Directors, Chairpersons, Heads of Offices, Laboratory Supervisors and other supervisory personnel will be held accountable for the health and safety of employees engaged in activities under their supervision. Supervisors must insist that employees and contracted personnel comply with health and safety rules and work in a safe and considerate manner. Fostering a positive attitude towards health and safety shall be the responsibility of supervisory staff.

Employees, faculty and students must understand their responsibility is to comply with health and safety rules issued by the University, their departments and their supervisors. Employees, faculty, and students are encouraged to report all unsafe conditions to their supervisors.

The Department of Environmental Health and Safety has the authority to assure overall compliance with the intent of this policy. The Department of Environmental Health and Safety also functions in an advisory and consultative capacity providing a wide variety of occupational health and safety services. Their assistance should be sought by any office, department, employee, faculty member, student, or supervisor who experiences an environmental health or safety problem. Health and Safety information is readily available through the EH & S web site or by calling 831-8475.

Submitted by: Environmentall Health & Safety

UNIVERSITY of DELAWARE
Office of the Executive Vice President & University Treasurer

Safety and Security Policies

Section: Safety and Security
Policy Number: 7-37
Policy Name: Occupational Exposures to Hazardous Chemicals in Laboratories
Date: November, 1990; November, 2003

I. PURPOSE

To ensure all activities related to the use of hazardous chemicals in laboratories are conducted in a safe manner as well as in compliance with OSHA regulations as specified in 29 CFR Part 1910.1450.

II. POLICY

No person shall purchase, possess, use, transfer, ship, transport, synthesize, or dispose of any hazardous chemicals in the laboratory in any manner that is inconsistent with the Chemical Hygiene Plan and the requirements established by the University Chemical Hygiene Committee.

For more information regarding the University Chemical Hygiene Committee and to access the University of Delaware Chemical Hygiene Plan visit www.udel.edu/OHS/chemindex.html or contact the Department of Environmental Health and Safety (ext. 8475).

Submitted by: Environmental Health and Safety

Chapter 1

Purpose

The University of Delaware's Chemical Hygiene Plan sets, in writing, specific administrative and engineering controls, best management practices, and rules of conduct to protect laboratory personnel from the hazards of exposure to chemicals in the laboratory.

This Plan also meets the requirements of the Federal Occupational Safety and Health Administration's Laboratory Standard 49 CFR 1910.1450, available at:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106

1.1 Scope

This Plan applies to all University of Delaware laboratory personnel, students working in laboratories either as a volunteer or paid employee, and students in instructional laboratories who use any quantity of commercial chemical products for research or instruction.

Its intention is to set procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in a laboratory setting at the University of Delaware.

1.2 Exclusions

The CHP does not apply to activities that do not fit the term "laboratory use"

The CHP does not apply to work exclusively with radioactive or biological materials. Procedures for work with these materials are addressed in the University of Delaware Radiation Safety Manual and/or Biosafety Manual.

If the Radioactive or Biological materials are mixed with a chemical or chemicals, procedures that are the most protective of worker health and safety while meeting regulatory requirements will apply.

1.4 Responsibilities

1.4.1 Duties at the University and Department Level

Development and implementation of the University of Delaware's Chemical Hygiene Plan (CHP) shall be the responsibility of the Department of Environmental Health and Safety (DEHS).

Approval of this CHP and regulatory required annual audits thereof shall be the responsibility of the Chemical Hygiene Committee (CHC) and the DEHS Chemical Hygiene Officer.

Each University of Delaware College, Department, Center or Program that uses chemicals in a laboratory setting shall tailor the generic CHP to their department and be responsible for its implementation. The Chairperson/Director for each designated College, Department, Center or Program shall appoint a qualified individual in their program as the Departmental Chemical Hygiene Officer (DCHO) who will facilitate the requirements of the CHP. Other individuals may be appointed to assist the DCHO with implementation of the CHP. The Director, Department of Environmental Health and Safety shall appoint a University CHO who will facilitate and manage the University Chemical Hygiene Program.

1.4.2 Duties of Principal Investigator/Laboratory Supervisor

The Principal Investigator (PI) or designated Laboratory Supervisor (LS) has responsibility for the health and safety of laboratory personnel doing work in his/her assigned laboratory(s). The PI/LS may delegate the safety duties for which he/she is responsible to a person working in the laboratory and familiar with the laboratory and laboratory processes, but the PI/LS must make sure that any delegated safety duties are completed in a timely manner.

Laboratory Supervisors and Principal Investigators are responsible for all aspects of chemical hygiene in the laboratory. They must ensure that workers know and follow the chemical hygiene plan. They must ensure that protective equipment is available, in working order and that appropriate training has been provided. They will conduct regular, formal chemical hygiene inspections of their facilities and equipment, know the current legal and University requirements concerning regulated substances, determine the required levels of protective apparel and equipment and mandate their use, and ensure that facilities and training for use of any material being ordered are adequate.

The Principal Investigator or Laboratory Supervisor responsibilities under this Chemical Hygiene Plan include:

- Acquiring the knowledge and information needed to recognize and control chemical hazards in the laboratory.
- Informing employees working in their laboratory of the potential hazards associated with the use of chemicals in the laboratory and instructing them in the safe laboratory practices, adequate controls, and procedures for dealing with accidents involving hazardous chemicals.
- Ensure that action is taken to correct work practices and conditions that may result in the release of toxic chemicals;
- Obtaining approval, when required, prior to using particularly hazardous substances or prior to performing extremely hazardous operations;
- Properly disposing of unwanted and/or hazardous chemicals and material;
- Identifying hazardous operations, processes, or conditions in the lab. Developing procedures and controls for identified hazardous operations, processes, or conditions in the lab that meet State and Federal regulatory requirements for worker protection. Implementing and enforcing developed procedures and control use in addition to standard safety procedures.
- Establishing standard safety operating procedures (general and protocol/process specific) using relevant, up-to-date safety and health literature.
- Establishing an approval process for highly toxic, carcinogenic or reproductive toxics use and preapproving users in the laboratory.
- Reviewing proposed new procedures in the laboratory.
- Maintaining the on-line chemical inventory for the laboratory.
- Providing personnel under his/her supervision with access to the CHP and laboratory specific standard operating procedures (SOP) and job hazard analysis (JHA).
- Training personnel who use the laboratory on hazardous chemicals and operations specific to the laboratory. This includes informing personnel on the location and availability of the Safety Data Sheets (SDS's) and lab specific SOPs/JHAs.
- Maintaining work place engineering controls (e.g. fume hoods) in functional working order with all manufacture provided safety controls (machine guarding, sash panels, etc.).
- Maintaining an adequate supply of personal protective equipment appropriate for the task (gloves, face shields, non-venting goggles, etc.), and in functional working order.
- Promptly reporting laboratory accidents and injuries to DEHS
- Providing their current and accurate personal emergency contact information other than submitting their office phone number on emergency contact cards placed behind lab signage to be used by emergency responders .

1.4.2.1 Safety Responsibilities during Leaves/Absences

Whenever a faculty member or lab supervisor will not be present in the laboratory for an extended period of time e.g. during a sabbatical, vacation**, or** protracted illness, etc., it is their responsibility to identify a colleague to oversee their laboratory operations with respect to safety procedures and requirements.

- The person selected must be familiar with the hazards of the operations occurring in the lab and be empowered to address concerns as they arise. Examples include a fellow faculty member, the
- Departmental Chemical Hygiene Officer, a full-time research associate or post-doctoral fellow; however, the individual must be a UD employee.

The faculty member must notify their Department Chair of who will be assuming responsibility for all safety aspects of their laboratory operations. The Department Chair and faculty member must be in agreement that the selected person has the experience, knowledge and background to assume the responsibilities. The faculty member must communicate the name of this responsible individual to the Departmental Safety Committee and the DEHS as well as list the name and contact information of the responsible individual on the emergency contact card posted at the laboratory.

1.4.3 Duties of Laboratory Workers

Laboratory workers are responsible for planning and conducting each operation in accordance with University chemical hygiene procedures and for developing good personal chemical hygiene habits (chemical safety practices and procedures).

Laboratory worker responsibilities, under the supervision of the Principal Investigator, include:

- Knowing and following the Chemical Hygiene Plan;
- Planning and conducting each operation in accordance with established safety protocols;
- Identifying hazards associated with the materials in the lab and handling chemicals in a safe manner;
- Proper collection, labeling, and storing of chemical waste;
- Informing visitors entering their laboratory of potential hazards and safety rules and precautions.

1.4.4 Employee Rights and Responsibilities

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

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

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

1.4.5 Departmental Chemical Hygiene Officers

Departmental Chemical Hygiene Officers have the responsibility as defined in the OSHA Laboratory Standard and the University Chemical Hygiene Plan, to implement the Chemical Hygiene Plan thus ensuring compliance with the regulatory requirements and maintaining a safe work environment. The Departmental Chemical Hygiene Officer has the following duties:

- To ensure all activities related to the use of hazardous chemicals in laboratories are conducted in a safe manner as well as in compliance with OSHA regulations as specified in 29 CFR Part 1910.1450, University Policy and Procedures and the University Chemical Hygiene Plan
- Provide reports at the department Safety Committee meetings on chemical hygiene activities performed.
- Work with principal investigator's (PI's) to develop, review and approve Job Hazard Analysis and Standard Operating Procedures detailing all aspects of proposed research activities that involve hazardous materials.

- Work with the PI's on the approval process for the purchase of highly toxic, reactive, or carcinogenic or other inherently hazardous materials.
- Investigate and complete a report for chemical related incidents and exposures in their department.
- Provide guidance with personal protective equipment selection based on the findings in the job hazard analysis.
- Work as a liaison with the University Chemical Hygiene Officer and the Department of Environmental Health and Safety to ensure compliance.
- Disseminate chemical safety information throughout their department through emails, posting, and other forms of communications.
- Provide general chemical safety guidance to department staff, students and faculty.
- Make copies of the approved Chemical Hygiene Plan available to the program and support staff.
- Facilitate Chemical Hygiene Plan training for all laboratory workers in the department.
- Facilitate the use of the Laboratory Management Program by the Principal Investigators and department staff.

1.5 Noncompliance with the Plan and applicable Federal and State regulations

It is the aim of the Chemical Hygiene Committee to work cooperatively with principal investigators and laboratory workers to achieve compliance with University safety policies, the Chemical Hygiene Plan and governmental regulations. When cooperation fails it may be necessary to impose sanctions to achieve compliance. Issues of non-compliance will be handled following the requirements of the Chemical Hygiene Committee Compliance Policy. This policy has been reviewed and approved by the University Provost. The Compliance Policy can be found in Appendix D of the Chemical Hygiene Plan.

Chapter 2: General Safety Guidelines

2.1 Overview

It is the obligation of the University to develop a culture of safety in our laboratories. A culture of safety consciousness, accountability, organization, and education is vital to provide a safe work and educational environment. Learning to participate in a culture of habitual risk assessment, experiment planning, and consideration of worst-case possibilities for oneself and ones fellow workers is as much a part of scientific education as learning the theories behind what happens on the lab bench or in the field.

In order to perform work in a prudent manner, you must consider the health, physical, and environmental hazards of the chemicals to be used. The ability to accurately identify and assess laboratory hazards must be taught and encouraged through training and ongoing organization support. This is the core of every good health and safety program. For management to lead, for personnel to be able to assess worksite hazards, and for hazards to be eliminated or controlled everyone involved must be trained and be a part of the culture of safety.[1]

2.2 General Principals

Minimize all chemical exposures and risks.

2.2.1 Facility Safety Equipment

Unless otherwise specified or exempted by the Director of the Department of Environmental Health and Safety, each laboratory, room, area or facility in which hazardous chemicals are used or stored shall be equipped with the following:

- A plumbed emergency eyewash
  - Must meet the current ANSI Z358.1 Standard.
  - Hand held single or double stream hoses are not a substitute for an ANSI approved hard-plumbed eyewash; however these units may be used to supplement the approved showers and eyewashes.
- An emergency shower meeting the current ANSI Z358.1 Standard.
  - A corridor emergency shower located within 10 seconds or 100 foot unobstructed travel distance from the hazard area will meet this requirement.

2.2.1.1 Based on the type of work occurring in the area, the following may be required:

- A Factory Mutual or Underwriters Laboratory approved flammable liquid storage cabinet.
- A Factory Mutual approved corrosive liquids cabinet.
- A laboratory chemical fume hood which meets the University's performance standards.

2.3 Safe Handling of Chemicals

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

2.3.1 Design phase: Identify the hazards, create a Job Hazard Analysis

Consider the following questions:

- Is the material flammable, explosive, corrosive, or reactive?
- Is the material toxic

[1] Adapted from OSHA 1910.1450 App A preamble

- How can one be exposed to the material (inhalation, skin or eye contact, accidental ingestion, accidental puncture)?
- Are the health effects acute, chronic or both?
- Is there evidence based on research with animals or humans that the substance is a carcinogen, mutagen, or teratogen or reproductive toxin?
- What kind of ventilation is necessary to protect users and occupants of the lab?
- What is the legal exposure limit (PEL) or recommended TLV?
- What kind of personal protective equipment (i.e. gloves, respirator, and goggles) does the handler and other occupants need for protection.
- Are you exposed to other chemicals at the same time? Can they have a combined (additive or synergistic) effect?
- Is any type of medical testing recommended?
- Will the process generate other toxic compounds as a result of the experiment or procedure?
- Could use of the chemical or the process/experiment itself result in a fire, explosion, etc.?
- Is the proposed storage facilities appropriate for the type of materials required?
  - What materials are incompatible and how can the incompatible materials be segregated?
- What possible accidents could occur and what steps should be taken to minimize the likelihood and impact of an accident?
- What are the proper procedures for disposal of the chemical(s) and contaminated materials?

Once the potential hazards associated with the chemical(s) have been evaluated and the process has been evaluated, the process can be designed and work procedures to minimize or eliminate the hazards included.

2.3.2 Implementation

Know the hazards associated with the materials used. Verify the information whether you designed the process or it is an established procedure in the lab. Carefully read the label before using a chemical. Review the Safety Data Sheet (SDS) for any special handling information. In some cases it may be necessary to do additional research. Consult the references listed in the Hazardous Material Safety Manual. Contact the Department of Environmental Health and Safety (831-8475) or your Departmental Chemical Hygiene Officer for assistance with the evaluation of hazards associated with a specific material.

2.3.2.1 Emergency preparation

Be prepared for hazardous material emergencies and know what action to take in the event of an emergency. Examples of emergencies are power failure, exhaust ventilation failures, spills, fires, explosions, etc. Assure necessary equipment and supplies are available for handling small spills of hazardous materials. Know the location of safety equipment: emergency shower, eyewash, fire extinguisher, fire alarm pull station.

2.3.2.2 Work practices

- **Do not** work alone in the laboratory when working with hazardous materials.
- Purchase the minimum amount of hazardous materials necessary to accomplish planned work and dispense only the minimum amount necessary for immediate use.
- Use hazardous chemicals only as directed and for their intended purpose.
- Never smell or taste hazardous chemicals.
- Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices.
- Inspect gloves and other PPE for degradation prior to use
- Verify the fume hoods have been certified within the last six months. Do not use the fume hood if there are any warning lights or you feel it is not working properly.

- Do not allow release of toxic substances in environmental chambers (cold rooms or warm rooms), since these have recirculated atmospheres.
- Inspect equipment or apparatus for damage before adding a hazardous chemical or beginning a hazardous procedure. Do not use damaged equipment.
- Assure ventilation is adequate for the materials used. Refer to the SDS for information on ventilation requirements, or contact the Department of Environmental Health and Safety. See the "Engineering Controls" section of this plan.
- Avoid practical jokes or other behavior which might confuse, startle or distract another worker.

2.3.3 Laboratory apparel

Required clothing in a laboratory setting or when using chemicals are a sleeved shirt, long pants or skirts/dresses that cover the entire leg, and closed toed shoes. Sandals, open-toed or perforated shoes, shorts, leave exposed skin vulnerable to chemical contamination.

Hair, ties or other dangling clothing, and jewelry can pose a snagging or ignition threat in the laboratory. Hair should be tied back, ties and loose clothing should be restrained or not worn in the laboratory.

2.3.4 Personal Protective Equipment

- Eye protection is required as soon as you enter the laboratory.
- Chemical protective gloves appropriate for the chemicals being used.
- Lab coats are recommended. They should be laundered at an industrial laundry on a regular basis. If contaminated with a chemical they must be disposed of as a chemical waste and not sent for laundering.

2.3.4 Work Station

Keep the work area clean and uncluttered with chemicals and equipment. Clean up any small spills immediately. At the end of each work day completely close and properly put away all chemicals that were used.

2.3.5 Labeling of containers

Original chemical container labels should be maintained in the original condition. If an original label becomes damaged a new label with all the same information should be placed on the container.

Supervisors shall ensure that labels on hazardous chemicals are not removed or defaced. All containers, regardless of size, must be labeled with a common chemical name and percentage (as applicable).

Containers other than original chemical containers at a minimum must have the following information clearly written on them or attached to them:

- Common chemical name. If it is a mixture all chemicals in the container must be included on the label.
- Percentage or concentration of the chemical(s).
- Date

2.3.6 Safety Data Sheets (SDS)

If an SDS was not provided with the shipment of a hazardous chemical, one must be requested from the manufacturer or distributor in a timely manner.

A SDS for each hazardous chemical must be available in the laboratory. The SDS must be readily accessible to all laboratory personnel. SDS's must be updated on a continual basis. Researchers and students should consult two SDS resources for every chemical they plan to use before they start the experiment or

procedure. This review will be used in the development of the SOP and process safety review. An annual review of all SDS should be included as part of the annual chemical safety training refresher.

Accidents involving chemicals require a SDS be provided to emergency response personnel and to the attending physician so proper treatment can be administered. The "rule of thumb" is that a person working in a laboratory should be able to produce a SDS for any hazardous chemical found in the laboratory within five minutes.

Environmental Health and Safety purchases subscriptions to two online SDS services, ChemWatch and the Canadian Center for Occupational Health and Safety (CCOHS) for use by the entire University. These online databases must be accessed from a computer connected to the University of Delaware Network or through the UD Proxy Server. SDS's provided by these two services are very comprehensive and have links to additional hazard fact sheets and toxicological information. The SDS provided by CCOHS are not manufacturer specific. A manufacturer specific SDS must be used if there is a need to contact or speak with an expert from the company that manufactured the specific chemical or hazardous material. The ChemWatch system provides SDS created by their scientists as well as SDS uploaded from specific manufacturers. Contact EHS to receive training on these two online systems. Links to the purchased subscriptions are:

SDS may be maintained in one of the following ways:

- SDS may be managed as printed hard copies in an organized fashion such as a binder. Laboratories are strongly urged to print the SDS sheets for their chemicals from the manufacturer that produced them and keep them in a clearly marked three ring binder in the laboratory on a bookshelf where they will be visible to all employees. These printed SDS must be updated and current.
- SDS may be maintained through a bookmarked Internet site. If the Internet is used, each person in the lab who uses chemicals must be registered, if required by the site, and trained to use the site to access and print a SDS. A functioning computer with internet access and a functioning printer must be available in the laboratory. If a laboratory chooses to use electronic access, the SDS website link must be posted on the computer or in another conspicuous location to facilitate easy access. Online SDS are generally updated frequently by the provider. SDS provided by the ChemWatch System, the Canadian Center for Occupational Health and Safety, Fisher Scientific, Sigma-Aldrich and Acros are kept up to date. Researchers will need to assure that the SDS provided by other sources are current. Provisions are needed for dealing with long-term interruptions to power, the network, or the server which would make electronic versions unavailable.
- SDS may be stored on a computer as an electronic file. If this method is used, each person in the laboratory must be trained to access and print a SDS. A functioning computer and a functioning printer must be available in the laboratory. If a laboratory chooses to use electronic access, desktop icons or shortcuts must be used on the computer or posted in a conspicuous location to facilitate easy access. These electronic copies must be updated and current. Provisions are needed for dealing with long-term interruptions to power, the network, or the server which would make electronic versions unavailable.

2.3.6.1 Emergency access to SDS during power, network or server outages

During power or ventilation outages, laboratories must be evacuated due to the loss of laboratory ventilation and possible loss of containment of hazardous materials. Although the laboratories must evacuate, there may still be a need for a researcher to access a SDS. Although the University Internet and Network Systems are very reliable, outages have occurred. Laboratories must develop a plan to access SDS in the event of an outage. Training on accessing SDS during an outage must be provided.

Options for accessing SDS during these outages include, but are not limited to:

1. Maintaining a backup electronic file of the SDS on a laptop computer with a fully charged battery.
2. Contacting the appropriate vendor and requesting a CD loaded with the SDS. Access is also needed to a laptop with a fully charge battery.
3. Accessing the online internet site through a laptop with a charged battery provided the network or server is functional.
4. Contacting the Department of Environmental Health and Safety and requesting the SDS. EHS maintains offline versions of the ChemWatch SDS program. EHS has access to emergency power and will be able to produce a hardcopy of a SDS during outages. These options should not be the sole provision to access SDS during outages since EHS may not be able to provide a SDS immediately based on the time of day and other circumstances.

2.3.7 Chemical substances developed in the laboratory

If the composition of a chemical substance produced for laboratory use is known and determined to be hazardous, the employer shall supply appropriate training.

If the chemical produced is a by-product whose composition is not known, the employer shall assume that it is hazardous and implement the Chemical Hygiene Plan.

If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for the preparation of a Safety Data Sheet and labeling.

Chapter 3: Exposure Control Measures

3.1 Administrative Controls

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

- Include safe practices in your experiment or process design.
  - Planning includes the development of written work procedures for safe performance of the work.
- Restricting access to areas in which hazardous materials are used;
- Using signs or placards to identify hazardous areas (designated areas);
- Label all hazardous materials removed from their original container;
- Substitution of less toxic materials for toxic materials;
- Good housekeeping
- Do not limit egress with clutter;
- Maintain a 36" aisle space throughout the laboratory; and
- Do not stockpile chemicals
- Good hygiene (e.g., Decontaminate before eating, drinking, smoking, applying cosmetics, lip balm, or going to the bathroom)
- Prohibiting eating, drinking, and smoking in laboratories or areas of chemical use, provide break areas for this purpose.
- No mouth pipetting.
- Adding acid to water, never water to acid.
- Assuring employees are provided adequate training for safe work with hazardous materials.
- Adhering to safe lab practices as taught by instructors.
- Disposing of waste in designated containers
- Do not block means of egress including lab windows.
- Do not block view panes in doors.
- Use secondary containers during storage of liquids
- Store chemical by hazard class in appropriate cabinets.
- Do not store liquids above eye level
- Restrict access to laboratory.
- Lock laboratory doors when no one is present in the laboratory.
- Challenge all visitors, including maintenance staff to assure that they are permitted in the laboratory.
- Do not work alone with hazardous materials. Do not perform hazardous operations alone. Assure that another trained researcher is available in the same laboratory or adjacent room to provide emergency assistance as needed.
- DO NOT wear contact lenses.
- Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants.
- Wear eye protection that is designed to go over prescription glasses.
- EHS recommends that researchers purchase prescription safety glasses or splash goggles or utilize eye protection with prescription inserts.

  See http://www.udel.edu/ehs/generalhs/construction/safety-glasses.html for more information.

3.2 Personal Protective Equipment

3.2.1 General Requirements

Personal protective equipment is required by University Policy 7-40, http://www.udel.edu/ExecVP/policies/safety_and_security/7-40.html. The policy applies to all University personnel, contract personnel, and visitors in applicable University facilities and/or University operations.

- The necessity for the use of personal protective equipment is usually determined after a job hazard analysis is completed for a specific task.
- Personal protective devices are to be used only where engineering and administrative controls cannot be used or made adequate.
- Departments are responsible for providing personal protective equipment. Students may be responsible for purchasing their own equipment. See Policy 7-40, Personal Protective Equipment (http://www.udel.edu/ExecVP/policies/safety_and_security/7-40.html).

3.2.2 Safety glasses

Safety glasses are required in a laboratory when eye hazards are present. See Policy 7-23, Eye Protection (http://www.udel.edu/ExecVP/polprod/7-23.html). In general, safety glasses are required at all times in all laboratories except computer laboratories. Personnel are required to evaluate their procedures to determine that safety glasses alone are sufficient. Researchers must upgrade to chemical safety splash goggles if a splash, spray or mist hazard exists. In general, safety glasses can be worn if the fume hood sash is properly positioned to provide the splash, spray and mist protection, otherwise indirect venting chemical safety splash goggles must be worn.

- All safety glasses must have side shields and be ANSI (American National Standards Institute) approved.
- Safety Glasses with side shields are used when there is the potential for dust particles and flying objects to be expelled into the air. They are impact resistant.
- Prescription safety glasses must have side shields as well. Contact your supervisor for more information.
- Chemical splash goggles shield the entire eye area. They are used for protection against chemical splashes, sprays, mists and/or impact.
- Indirect Venting: used mainly in goggles designed for sprays and mists.
- Direct Venting: used in goggles designed for high impact areas.
- Prescription inserts for goggles are available from the manufacturer. The prescription inserts must be filled by an optometrist. Contact your supervisor for more information.
- Face and neck shields for head and neck protection from various hazards (must be used in conjunction with safety glasses or goggles)

3.2.3 Clothing shall be appropriate to the laboratory; effort shall be made to minimize skin exposure

- Lab coats, long pants or skirts/dresses that completely cover the legs and regular closed toed shoes are required. Sandals, open-toed or perforated shoes and shorts leave exposed skin vulnerable to chemical contamination and are not permitted.
- Unconfined long hair, ties or other dangling clothing or jewelry can pose a snagging or ignition threat in the laboratory.

3.2.4 Chemical Protective Gloves

Before using a chemical, you must check to make sure of the proper type of glove needed. You can check for the proper chemical protective clothing by looking in the catalog used to purchase the gloves, talking to your supervisor or department Chemical Hygiene Officer, referring the EHS Gloves Selection Guide or calling the DEHS.

- Chemical protective gloves are usually task and chemical specific.
- No glove protects a worker from all chemicals.
- Promptly remove contaminated gloves and thoroughly wash hands with soap and water.
- Be aware should be aware of the **breakthrough time** of the glove. This is the time it takes for a substance to pass through the protective material of the glove.
- Gloves that are contaminated need to be properly disposed of according to the breakthrough time. Chemicals will always move through PPE, it is only a matter of the time it takes.

- Remove gloves and wash hands with soap and water prior to leaving the laboratory.

Latex Allergy Information

Latex allergy can result from repeated exposures to proteins in natural rubber latex. Exposure can be due to skin contact with a latex-containing item or inhalation of the proteins. Reactions can range from skin rash to anaphylaxis and shock. Some items that include latex are gloves, medical supplies, respirators, rubber bands, balloons, and baby bottle nipples.

The National Institute for Occupational Safety and Health (NIOSH) recommends reducing exposure to these proteins by selecting latex-free or low protein products.

If it is necessary to move chemical or materials from one laboratory to another area, use a cart or carry the chemical in one gloved hand and remove the other to avoid contaminating the door handles or other touch surfaces. See Transporting Chemicals fact sheet: http://www.udel.edu/ehs/research/chemical/transport-chemicals.html

Frequently inspection your PPE. Make sure that there are not any holes, tears, rips etc. that could compromise the protection. Material degradation occurs naturally to disposable gloves, non-disposable gloves, and even to unused gloves. Follow the manufacturer's recommended shelf life

All PPE, such as lab coats, gloves and any contaminated protective equipment, should be removed and left or properly disposed of in the lab area. Utilize carts to move chemicals between laboratories. Users must not touch door handles or other touch surfaces with chemical protective clothing.

Launder chemical protective garments as necessary. Departments should utilize a laundering service approved by Environmental Health and Safety or install laundering facilities in their buildings. PPE known or suspected to be contaminated with hazardous materials should not be laundered. Dispose of these materials through the appropriate hazardous waste program. Contact EHS for further information on PPE laundering or if the department is considering a laundering service or installing laundering facilities.

Refer to the Hazardous Materials Safety Manual for further guidance.

3.2.5 Respiratory Protection

Respirators must be used in accordance with University Policy (http://www.udel.edu/ExecVP/polprod/7-32.html) and the Respiratory Protection Program (http://www.udel.edu/ehs/generalhs/downloads/respiratory-protection-manual.pdf). Improper use of respirators can result in an exposure to hazardous materials, aggravation of a preexisting medical condition, serious injury or death.

- Examples of respirators include the following:
- Negative Pressure N-95 Particulate
- Negative Pressure P-100 Oil Mist
- Negative Pressure Half-Face Air Purifying
- Negative Pressure Full-Face Air Purifying
- Positive Pressure Self Contained Breathing Apparatus
- Positive Pressure Supplied Air Breathing Apparatus

Researchers interested in utilizing a respirator **must** contact DEHS. DEHS will evaluate the procedure or work process and determine if engineering controls such as fume hoods or local exhaust units can be utilized. If a respirator is determined to be necessary, training will provided to the individual as well as a proper fit test. A medical evaluation by a doctor and air sampling may be necessary prior to the training and fit testing. Departments are responsible for all costs associated with use of respirators.

Where the use of respirators is required to maintain exposure below the PEL, the employer (the researcher/staff member's respective department) shall provide the proper respirator equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134 and the University of Delaware Policy No. 7-29, Use of Respirators. In addition, see the University of Delaware's Respiratory Protection Program and contact your Department Chemical Hygiene Officer or the Department of Environmental Health and Safety (831-8475).

3.3 Special Precautions for specific chemical hazards

3.3.1 Physical Hazards

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

Certain chemicals cannot be safely mixed or stored with other chemicals because a severe reaction can take place or an extremely toxic reaction product can result. See the Hazardous Material Safety Manual for a table of incompatible chemicals (pages 9-11).

3.3.1.1 Special Precautions for Working with Flammables and Combustibles

- Flammable/Combustible Liquids: Materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source. The vapors of these materials are invisible, and a vapor trail to an ignition source away from the immediate area can result in a flashback. Flammables are more hazardous at elevated temperatures due to more rapid vaporization. In addition, flammable and combustible materials react with oxidizers which can result in a fire.
- Eliminate ignition sources such as open flames, smoking materials, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity. Post conspicuous "No Smoking" signs in areas where flammable materials are used or stored.
- Minimize the quantity kept in the work area.
- Store in approved flammable liquid containers (safety cans) and storage cabinets, or in a special storage room designed for that purpose. Store away from oxidizers.
- Flammable liquids stored in glass containers shall not exceed 1 quart. Exception: for conditions where chemical purity must be protected, flammable liquids stored in glass containers shall not exceed 1 gallon.
- Refrigerators and freezers used for the storage of flammables shall be explosion proof or lab safe.
- Assure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Assure bonding and grounding is checked periodically.
- Assure appropriate sprinkler system and/or fire extinguishers are in the area.

3.3.1.2 Special Precautions for Working with Corrosives

Corrosives: Materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface. Acids and bases are corrosives.

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

- An eyewash and safety shower must be readily accessible (within the room or area) to areas where corrosives are used and stored. In the event of skin or eye contact with corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Seek medical assistance.

3.3.1.3 Special Precautions for Working with Oxidizers

Oxidizers: Materials which react with other substances by accepting electrons and undergoing reduction. This reaction may result in fire or explosion. The intensity of the reaction depends on the oxidizing-reducing potential of the materials involved. Oxidation reactions are the most frequent cause of chemical accidents.

- Know the reactivity of the materials involved in the experiment or process. Assure there are not extraneous materials in the area which could become involved in a reaction.
- If the reaction can be violent or explosive, use shields or other methods for isolating the materials or the process.
- Use the minimum amounts necessary for the procedure. Do not keep excessive amounts of the material in the vicinity of the process.
- Store properly, away from organic materials, flammable materials and reducers.

3.3.1.4 Special Precautions for Working with Water Reactive Chemicals

Water Reactive Materials: Materials which react with water to produce a flammable or toxic gas, or other hazardous conditions, often a fire or explosion results

- Special precautions for safe handling of water reactive materials will depend on the specific materials, and the conditions of use and storage. Contact the Department Chemical Hygiene Officer or the Department of Environmental Health and Safety for information on the safe use of a specific material.
- Examples of water reactives include alkali metals such as lithium, sodium, and potassium; acid anhydrides, and acid chlorides.

3.3.1.5 Special Precautions for Working with Pyrophoric Materials

Pyrophoric Materials: Materials which ignite spontaneously upon contact with air.

- The flame may be invisible.
- Pyrophorics should be used and stored in inert environments
- Examples of pyrophoric materials are silane, silicon tetrachloride, white or yellow phosphorous.

3.3.1.6 Special Precautions for Working with Peroxidizables

Peroxidizables: Materials which react with oxygen to form peroxides which can explode with impact, heat, or friction such as removing a lid.

- Since these chemicals may be packaged in an air atmosphere, peroxides can form even though the container has not been opened.
- Date all peroxidizables upon receipt and upon opening.
- Unless an inhibitor has been added by the manufacturer, materials should be properly disposed of after 18 months from the date of receipt or 3 months from the date of opening.
- Do not open any container which has obvious crystal formation around the lid.
- Other special precautions are similar to those used for flammables.
- Examples of peroxidizables include ethyl ether, tetrahydrofuran, isopropyl ether, liquid paraffins (alkanes), and olefins (alkenes).

3.3.1.7 Special Precautions for Working with Light-Sensitive Materials

Light-Sensitive Materials: Materials which react in the presence of light, forming new compounds which can be hazardous, or resulting in conditions such as pressure build-up inside a container which may be hazardous.

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

3.3.1.8 Special Precautions for Working with Shock-Sensitive or Explosive Materials

Shock-Sensitive/Explosive Materials: Compounds which can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as peroxides, perchlorates (from perchloric acid), and azides. A list of materials which can be shock-sensitive is provided in the Hazardous Material Safety Manual.

- Contact the Department of Environmental Health and Safety at 831-8475 when work with shock-sensitive or explosive materials is planned or when it is suspected that the inadvertent formation of shock-sensitive materials in ductwork, piping, or chemicals being stored has occurred.
- Obtain prior approval for the purchase and use of the materials. Receive prior approval from DEHS and the Departmental Chemical Hygiene Officer for the possession and use of the material.
- Date all containers of explosive or shock-sensitive materials upon receipt and when opened. Unless an inhibitor has been added, unopened shock-sensitive materials should be discarded within 12 months after receipt. Open containers of shock-sensitive materials should be discarded within 6 months of the date opened.
- Use the minimum amount of materials necessary for a procedure. Keep a minimum amount of material on hand.
- If there is a chance of explosion, use barriers or other methods for isolating the materials or the process.

3.3.1.8 Special Precautions for Working with Cryogens

Cryogens: a liquid that boils at a temperature below 110 Kelvin (about -160 C) and is used to obtain very low temperatures. Liquid nitrogen is an example.

- Hazards associated with cryogens are fire, pressure, embrittlement of materials, and skin or eye burns upon contact with the liquid.
- Cryogens condense oxygen from the air, creating an oxygen rich atmosphere, increasing potential for fire if flammable or combustible materials and a source of ignition are present.
- Pressure is a hazard because of the large expansion ratio from liquid to gas, causing pressure to build up in containers.
- Many materials become brittle at extreme low temperatures.
- Brief contact with materials at extreme low temperatures can cause burns similar to thermal burns.
- Equipment should be kept clean, especially when working with liquid or gaseous oxygen.
- Mixtures of gases or fluids should be strictly controlled to prevent formation of flammable or explosive mixtures.
- For flammable cryogens the precautions provided in the "Flammable/Combustible Materials" section of this plan should be used.
- Always wear safety glasses with side shields or goggles when handling cryogens. If there is a splash or spray hazard, a full face protector, an impervious apron or coat, cuff less trousers, and high topped shoes must be worn. Watches, rings, and other jewelry should not be worn. Gloves must be liquid impervious and sufficiently large to be readily thrown off should a cryogen be spilled. Respirators may be required if the cryogen is toxic and sufficient local exhaust ventilation is not available.
- Containers and systems containing cryogens must have pressure relief mechanisms.
- Containers and systems must be capable of withstanding extreme cold without becoming brittle.

- Bulk filling areas may require oxygen detection and special ventilation.

3.4 Health Hazards

"Health Hazard" refers to chemicals for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. This term includes chemicals which are Substances Known to be Human Carcinogens, Reasonably Anticipated to be Human Carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, and neurotoxins, agents which act on the hematopoietic system and agents which damage the lungs, skin, eyes, or mucous membranes. For a discussion of industrial toxicology and information on health hazards associated with specific chemicals, refer to the Hazardous Material Safety Manual.

- For many toxic materials, hygienic standards have been established and action must be taken to assure personnel do not receive exposures in excess of these standards. These standards may be referred to as Threshold Limit Values (TLVs) or Permissible Exposure Limits (PELs). For specific information on the terms TLV or PEL, refer to the glossary in the Hazardous Material Safety Manual.
- The SDS will list the hygienic standard for the hazardous chemical or each component of a mixture. In addition, the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety have a complete listing of published TLVs and PELs and other works concerning the subject of industrial toxicology. If you would like to conduct a more thorough review of a particular compound, or if you would like an evaluation of the exposure to a specific material used in your work area, contact the Department of Environmental Health and Safety.
- Protection from health hazards is provided by assuring exposure to such hazards is minimized or eliminated. To minimize the exposure, it is necessary to determine the route by which the exposure may occur, i.e. inhalation, skin contact, puncture, ingestion, or a combination of exposure routes.

3.4.1 Special Precautions for Working with Allergens

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

Chapter 4: Engineering Controls and Laboratory Ventilation Program

4.1 Engineering Controls

Exposure to hazardous materials must be controlled to the greatest extent feasible by use of engineering controls. For assistance in determining engineering controls necessary for your work situation, contact the Department Chemical Hygiene Officer or the Department of Environmental Health and Safety. Engineering controls to reduce or eliminate exposures to hazardous chemicals include:

4.1.1 Substitution of less hazardous equipment, chemicals or processes (e.g. safety cans for glass bottles)

4.1.2 Isolation of the operator or the process (e.g. use of barriers when handling explosives, or completely enclosing the process in a glove box or other enclosure)

4.1.3 Local and general exhaust ventilation (e.g. use of chemical fume hoods)

4.2 Laboratory Exhaust Systems

4.2.1 Laboratory ventilation units are the primary safety equipment for protection from chemicals in the laboratory. The proper use of the fume hood and local exhaust units are as important as the design. Laboratory ventilation units are often used inefficiently or incorrectly. These units are designed to pull laboratory air through the face and exhaust the contaminants through the ductwork. Proper design and use of the units avoids contamination escaping out and into the user's breathing zone. Studies indicate that 50% of harmful exposures in the laboratory were due to improper use of laboratory ventilation units such as the laboratory fume hoods.

4.2.2 Types of Chemical Fume Hoods and Local Ventilation Systems (LEVs)

- Conventional Fume Hood - A constant volume of air enters the sash. Lowering the sash increases the air velocity. As the motor ages the sash can be lowered to provide sufficient air flow
- Variable Air Volume (VAV) Fume Hood – Hood provided with VAV systems maintain a constant face velocity regardless of the sash height.
- By-Pass Fume Hood - A constant volume of air enters above and through the sash. The by-pass hood approximates a constant velocity of air regardless of the sash opening. This is also accomplished through the use of sash positioning sensors that control valves in the exhaust ductwork.
- Auxiliary (Supplied Air) Fume Hood - Make-up air is supplied and is quickly exhausted through the fume hood. Energy savings is realized because the unheated air that is used for make-up air is also exhausted. Turbulence is created and contaminates can escape. EHS recommends against the installation of auxiliary fume hoods
- Perchloric Acid Hoods - There are a number of special design considerations due to the hazards of H_3ClO_4. Specifically designed to prevent the generation and buildup of explosive perchlorates in the hood system. Ductwork and interior areas of the hood are constructed with stainless steel. No organic caulking compounds are used. A wash down feature exists in the ductwork that allows the users to decontaminate the ductwork and remove any potential perchlorate contamination.
- Vertical Wet Benches - Used in Clean Room operations. Similar to a Biosafety Cabinet where a HEPA filtered clean environment is obtained inside the hood while still operating like a fume hood. Employee and product protection is obtained.
- Ductless Fume Hoods - All air enters through the hood and is exhausted through a charcoal and HEPA filter. This filtered air is dumped into the laboratory. Users must have permission of EHS to purchase.
- Local Ventilation Systems
- Canopy Hoods - Usually used for point source removal and operations involving heat generations (ovens, AA Units).

- Snorkels (Elephant Trunks) – Used for point source removal such as welding and soldering operations. Usually are movable.
- Trunks – Point source, capture is best the closer you get to the opening. Usually not movable.
- Slots – Points source for particulates and vapor over baths. Slot hoods are often used in photographic operations.

4.2.3 Laboratory Exhaust Certification and Testing Program. All laboratory exhaust units are certified by an outside contractor/manufacturer when installed. Most units are tested twice a year to assure that there is sufficient velocity for employee protection by Environmental Health and Safety Staff. A Certification Sticker is applied if the unit passes. A Do Not Use Posting is applied if the hood fails. A work order is then submitted to Facilities and the PI/Responsible Person is advised of the situation. EHS will retest the unit when Facilities has performed the repair.

4.2.4 Laboratory Ventilation Maintenance Shutdowns

During scheduled shutdowns of the laboratory ventilation system the following will occur:

- Facilities will send out a notice advising all occupants of the scheduled outage.
- EHS will communicate with the Department Chemical Hygiene Officer, Safety Committee Chair, Laboratory Manager or Building Representative.
- A notice will be attached to all fume hoods and posted in conspicuous locations in the building. This may be done by EHS staff or the effected department staff depending on the situation. This notice advises the users of the outage, lists the required actions to protect the maintenance staff who are working on the system and the building occupation and lists the activities that are prohibited for the duration of the outage. EHS will perform periodic walk-throughs to assure compliance.
- In general, the follow user shall take the following steps:
- All chemicals and hazardous materials must be sealed and closed.
- Researchers should make an effort to move all chemicals and other hazardous materials from the fume hoods and store them in their proper storage cabinets.
- All gas cylinders valves must be closed.
- All processes and reactions involving hazardous materials must be stopped and made safe. No reactions are permitted to occur during the outage.

4.2.5 Laboratory Ventilation Failures

If the laboratory ventilation fails (not associated with a schedule outage), users must:

- immediately make all operations safe,
- seal all chemical bottles and containers,
- close all gas cylinder valves and completely close all fume hood sashes,
- All users must evacuate the laboratories, and
- contact Facilities to advise them of the situation

4.3 Ventilation Controls

To determine if ventilation control is required check the SDS. Expressions on an SDS such as “Use with adequate ventilation”, “Avoid vapor inhalation”, “Use in a fume hood”, or “Provide local exhaust ventilation” indicate a need for ventilation:

4.3.1 Never work with hazardous materials if the required ventilation system is not working.

4.3.2 Ventilation recommendations must be adapted to the worksite and the specific process. Contact the University Chemical Hygiene Officer, the Department Chemical Hygiene Officer or the Department of

Environmental Health and Safety for assistance in determining specific ventilation requirements for your work situation.

4.3.3 Always use a hood or other local ventilation device when working with any appreciably volatile substance with a PEL or TLV of less than 50 ppm.

4.3.4 The Department of Environmental Health and Safety tests and certifies all fume hoods biannually. In addition all local ventilation systems have been equipped with magnahelic gauges or other audible/visual alarms to indicate operating status. If there are any questions concerning the adequacy of a fume hood or the procedures for safe use of a fume hood, contact the Department of Environmental Health and Safety.

4.4 Laboratory Fume Hood Operating Procedures

- Define the hazard level of the proposed work and locate a hood that meets the respective standard. Refer to the EHS sticker on the left side of the hood for certification velocity.

Hazard Level	Required Face Velocity (fpm)
Low Toxicity	60-80
Moderate Toxicity or Odorous Vapors	80-100
Highly Toxic, including Carcinogens	100-125
Radioactive Materials	100-125

- Visually check the magnehelic gauge or audible/visual alarm to verify that the system is operational.
- Clear the hood deck.
- When appropriate, line the deck with plastic backed absorbent paper taking care not to block air foils.
- Locate work at least 6 inches inside the sash and center relative to the hood sides.
- Set up equipment/apparatus to allow maximum flow of air across the deck surface. It may be necessary to elevate large pieces of equipment on blocks to allow air to flow under the equipment. This will minimize unwanted air currents that may allow contaminants to leave the front area of the fume hood and cause unwanted exposures. Use a length of tape to mark out six inches.
- Do not store chemicals or equipment inside your fume hood if they are not needed for the current experiment or process.
- Use your fume hood sash as a safety shield when working in a fume hood. Work with the sash at the proper level as indicated by the certification sticker placed on the fume hood. Some chemical fume hoods are equipped with horizontal sashes (sashes that move left to right). Position the horizontal sash unit directly in front of the researcher if possible. Contact Environmental Health and Safety to evaluate your work area.
- Prepare a plan of action in case of an emergency, such as a power failure. Your plan should include what actions are to be taken to make the operation and materials in the unit safe. Know where your fire extinguisher is located. Verify that it is approved for the materials being used. Contact EHS to receive

fire extinguisher training. Dial 911 on the Newark campus or 9-911 on the Lewes, Georgetown and Wilmington campuses should an emergency occur.

- To achieve maximum entrainment of room air and to increase the capture capacity of the chemical fume hood:
  - Close windows and doors.
  - Limit pedestrian traffic in the hood area, turn off portable fans. These currents draw contaminants out of the fume hood. Do not direct any other ventilation (portable vans, HVAC ductwork) towards a fume hood.
  - Limit operator body movement. Use well controlled movements when hands and arms are in the fume hood. Avoid movements that may draw contaminants out of the hood.
  - Lower the hood sash to the operating level.
  - Do not block exhaust ports or baffles.
  - Objects placed in close proximity to return ducts and baffles tend to interfere with air being pulled from the back portion of the fume hood. Place large equipment on stands to allow air flow underneath, remove unnecessary chemicals and equipment, and place them in a proper storage location.
- A chemical fume hood is to be used in conjunction with the appropriate personal protective equipment.
- Never work in a fume hood with a broken sash.
- Never attempt to lower a fume hood sash that has been broken.
- Never work in a chemical fume hood if the A/V alarm is sounding or you believe there is inadequate flow.
- Contact Facilities at 831-1141 (or fixit@udel.edu) or EHS to have a sash repaired or if there is another problem with the fume hood.

Chapter 5: Employee Training Program

5.1 Overview

Employees shall be provided with information and training to ensure that they are apprised of the hazards of chemicals 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. Employees shall receive an annual refresher.

Employees shall be informed of:

- The contents of this Chemical Hygiene Plan;
- The location and availability of the Chemical Hygiene Plan;
- The PELs for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where PELs do not exist; (See appendices.)
- Signs and symptoms associated with exposures to the hazardous chemicals used in the laboratory; and
- The location and availability of known reference materials such as SDSs. See your Department Chemical Hygiene Officer or the Department of Environmental Health and Safety Office for additional information.

Employee 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;
- Measures employees can use to protect themselves from these hazards, including specific procedures such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
- The employee shall be trained on the applicable details of the written Chemical Hygiene Plan.

Training requirements must be recorded on the Chemical Hygiene Plan Certificate Form (RTK form) available on EHS website under forms. The form must be returned to DEHS for record keeping.

5.2 Recordkeeping

The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and/or examinations including tests or written opinions required by this standard.

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

5.3 Chemical Inventories

The OSHA Laboratory Standard requires employees to be trained in the hazards of the chemicals present in the workplace. As a result, laboratories shall develop inventories to assure that proper training for all chemicals is provided. An annual inventory can reduce the number of unknowns and the tendency to stockpile chemicals. It also provides an opportunity to check the integrity of the chemicals and containers (i.e. picric acid that has become dry) and assures that a laboratory has not exceeded the quantity limitations for certain classes of chemicals. The International Building Code (IBC), International Fire Code (IFC), and National Fire Protection Agency (NFPA) have promulgated regulations that limit the amount of hazardous materials within a building. These are based on control areas – those areas surrounded by fire rated walls. A control area may be one room or a whole floor. Please contact EHS if you plan to add significant quantities of chemicals or compressed gases to your lab.

Chapter 6: Operations Requiring Prior Approval

6.1 Overview

The Department of Environmental Health and Safety together with the Chemical Hygiene Committee has determined specific laboratory operations, procedures or activities which require approval before implementation due to their inherent risk. Except for the most hazardous activities, approval will occur at the local level. The local level consists of the Principal Investigator, Department Safety Committee and/or the Department Chemical Hygiene Officer. The University Chemical Hygiene Officer is available for assistance.

6.2 Examples of activities requiring prior approval of the Principal Investigator/Supervisor or Department Chemical Hygiene Officer:

- Large scale operations (e.g. 22 liter volume or greater)
- Unattended operations, or longer than a normal eight-hour shift
- High pressure/low pressure operations (explosion/implosion hazards)
- After-hours work (before 8:00 am or after 5:00 pm)

6.3 Activities Requiring Approval of the University Chemical Hygiene Officer, the Director of Environmental Health and Safety or the University Chemical Hygiene Committee:

- Reactions using highly toxic, radioactive or carcinogenic chemicals
- Installation, removal, moving or changes to a laboratory exhaust ventilation unit (chemical fume hood, exhaust trunk, canopy hood, etc.)
- Purchase of refrigerators or freezers for chemical storage.
- When specified in project write-up of new capital projects
- Purchase of a Class 3B or IV Laser
- Potentially explosive laboratory reactions
- Experiment or process that impact building or laboratory design, i.e. a large piece of equipment or apparatus that blocks sprinkler heads.
- Purchase or use of a respirator. See the Respirator Protection Program for the definition and types of respirators

6.4 Minors Involved in Laboratory Research and Teaching Activities at the University of Delaware.

Persons under 18 years of age are not allowed in University laboratories where hazardous materials are present or hazardous activities take place except under the following circumstances:

- The minor is employed by the University or has been formally accepted as a volunteer worker; and
  - has been trained in safe laboratory procedures; and
  - has adult supervision at all times; and
  - has received and completed the appropriate State of Delaware, Department of Labor forms and approvals. Contact Human Resources for more information; and
  - has a parental hazard-acknowledgement form on file with the host department; or
- The minor is enrolled in a University class with a laboratory component; or
- The minor is participating in a University-sponsored program; and
  - has been trained in safe laboratory procedures; and
  - has adult supervision at all times; and
  - has a parental hazard-acknowledgement form on file with the host department
- The minor must attend all applicable safety training sessions, including but not limited to:
  - Right-To-Know
  - Chemical Safety/Hygiene Plan

- Any or all of the following, based on work performed:
  - Corrosive Chemical Safety
  - Laboratory Ventilation Safety
  - Chemical Waste Disposal
  - Laser Safety
  - Radioactive Materials Safety
  - Biosafety
  - Bloodborne Pathogens
  - X-Ray Device Safety

- The minor is under the responsibility of a faculty member in the laboratory or area where the work will occur.
- In situations where the minor is not participating in a laboratory science course, the responsible researcher must meet with the minor and review all Job Hazard Analysis (JHA) and Standard Operating Procedures (SOP). Written copies shall be provided. EHS shall review the JHA's or SOP's to assure all safety issues are addressed.
- The minor must use all required personal protective equipment. Each college, school, department, division or unit shall provide or otherwise make available to each minor required to wear personal protective equipment the devices appropriate for the activity and hazard involved. Minors enrolled in a University of Delaware laboratory science course may be required to purchase their own personal protective equipment.
- The minor must be monitored and supervised at all times by a knowledgeable and experienced adult employee. **They must not work alone**. Each task shall be evaluated. Work with reproductive toxins, chemical carcinogens and highly toxic materials shall not occur. Any procedures involving a hazardous operation shall be limited and controlled by the responsible researcher.
- The minor must follow all Departmental and University safety procedures and policies.
- The Departmental Safety Committee or Departmental Chemical Hygiene Office should perform spot inspections of the work and assure that all training is complete.
- The minor must follow all applicable state and federal requirements and guidelines
- The Release of Liability and Waiver Claim Form must be completed by the parent or guardian of the minor.
- The responsible Faculty member must complete the Principal Investigator/Supervisor Commitment Form.

6.5 Tours involving minors

Under **no** circumstances shall infants, toddlers, or children too young to understand safety training be permitted in University of Delaware laboratories except as research study participants with the signed consent of a parent or legal guardian.

Faculty Members or Principal Investigators must notify the Departmental Safety Committee and receive documented approval for the tour from the Chair of the Department or Director of the Program.

6.6 Demonstrations Involving Hazardous Materials or Hazardous Operations and Tours of Laboratory Facilities or Hazardous Areas

The safety of participants during demonstrations involving hazardous materials or hazardous operations and tours to laboratory facilities or hazardous areas at the University of Delaware is paramount. The sponsor of the demonstration or tour is responsible for the safety of the individuals involved and must assure that the following requirements are met.

- The sponsor of the demonstration or tour must notify the Departmental Safety Committee and receive approval from the Chair of the Department or the Director of the Program.
- The visitors and participants must be advised of the hazards present in the laboratory or area involved in the demonstration. This information shall include the types of physical and chemical hazards, procedures to follow should an emergency occur, signs and symptoms of a potential chemical exposure and any other pertinent safety information.
- All unnecessary experiments and procedures must be stopped and the laboratory or area be made safe for the duration of the tour or visit.
- All participants in the demonstration or tour must be provided and don all necessary personal protective equipment. The participants must wear the PPE at all times while in the laboratory or hazardous area.
- Participants in the tour or demonstration shall be monitored and supervised at all times. Sufficient departmental staff shall be on hand to effectively control the group involved in the tour of demonstration.
- All demonstrations involving hazardous materials or hazardous chemicals shall be reviewed and approved by the Departmental Chemical Hygiene Officer. The demonstration shall be presented in a safe manner, following the applicable aspects of the Chemical Hygiene Plan. Based on the audience, it may be necessary to add additional safety measures. The Departmental Chemical Hygiene Officer is encouraged to consult with the University Chemical Hygiene Officer to assure that the safety of the participants is maintained.
- Demonstrations for minors require the approval of the University Chemical Hygiene Officer.
- Demonstrations performed to any audience off campus or in an area, on or off campus, not designed for hazardous chemicals or a hazardous operation requires the approval of the University Chemical Hygiene Officer.

6.7 Volunteer Workers involved in Laboratory Research and Teaching Activities at the University of Delaware

University volunteers are individuals who are uncompensated by the University of Delaware and who perform services directly related to the business of the University to support the research, teaching or public service activities of the University or to gain experience in specific endeavors.

- Volunteer workers under the age of 18 are covered by the Minors Involved in Laboratory Research and Teaching Activities Policy, found in Chapter 10.5 of the University Chemical Hygiene Plan and at http://www.udel.edu/ehs/forms/downloads/minorsresearchpolicy.pdf
- Tours and visitors to laboratories are covered under Chapter 6.6 of the University Chemical Hygiene Plan and are not subject to section 6.7 of the Chemical Hygiene Plan.
- *Under **no** circumstances shall individuals unable to understand safety training be permitted in University of Delaware laboratories except as research study participants in an approved research protocol*
- Volunteer workers are permitted to perform research and teaching activities at the University of Delaware provided the following requirements are met:
  - Faculty Members or Principal Investigators must notify the Departmental Safety Committee and receive documented approval from the Chair of the Department or Director of the Program.
  - The volunteer worker must attend all applicable safety training sessions, including but not limited to:
    - Right-To-Know
    - Chemical Safety/Hygiene Plan
    - Any or all of the following, based on work performed:
      - Corrosive Chemical Safety
      - Laboratory Ventilation Safety
      - Chemical Waste Disposal
      - Laser Safety

- Radioactive Materials Safety
- Biosafety
- Bloodborne Pathogens
- X-Ray Device Safety

- The volunteer worker is under the supervision of a faculty member in the laboratory or area where the work will occur.
- The responsible researcher must meet with the volunteer worker and review all Job Hazard Analysis (JHA) and Standard Operating Procedures (SOP). Written copies shall be provided. EHS shall review the JHA's or SOP's to assure all safety issues are addressed.
- The volunteer worker must use all required personal protective equipment. Each college, school, department, division or unit should make available to each volunteer required to wear personal protective equipment the devices appropriate for the activity and hazards involved. The volunteer may be required to purchase certain individualized items of personal protective equipment.
- The volunteer worker must be monitored and supervised by a knowledgeable and experienced adult employee until the principal investigator is comfortable that the volunteer can work independently. **They must not work alone** while performing hazardous operations or while working with hazardous materials.
- The volunteer must follow all Departmental and University safety procedures and policies.
- The Departmental Safety Committee or Departmental Chemical Hygiene Officer should perform spot inspections of the work and assure that all training is complete.
  - The Release of Liability and Waiver Claim Form (http://www.udel.edu/ehs/forms/downloads/VolunteerResearchersPolicy.pdf) must be completed by the volunteer worker.
  - The responsible Faculty member must complete the Principal Investigator/Supervisor Commitment Form (http://www.udel.edu/ehs/forms/downloads/VolunteerResearchersPolicy.pdf).

6.8 Visiting Scholars involved in Laboratory Research and Teaching Activities at the University of Delaware

Visiting Scholars are individuals who are uncompensated by the University of Delaware and who perform services directly related to the business of the University to support the research, teaching or public service activities of the University or to gain experience in specific endeavors.

- Visiting Scholars under the age of 18 will be covered by the Minors Involved in Laboratory Research and Teaching Activities Policy, found in Chapter 6.5 of the University Chemical Hygiene Plan and at http://www.udel.edu/ehs/forms/downloads/minorsresearchpolicy.pdf.
- Tours and visitors to laboratories are covered under Chapter 10.6 of the University Chemical Hygiene Plan and are not subject to section 10.8 of the Chemical Hygiene Plan.
- *Under **no** circumstances shall individuals unable to understand safety training be permitted in University of Delaware laboratories except as research study participants in an approved research protocol.*
- *Visiting* Scholars are permitted to perform research and teaching activities at the University of Delaware provided the following requirements are met:
  - Faculty Members or Principal Investigators must notify the Departmental Safety Committee and receive documented approval from the Chair of the Department or Director of the Program.
  - The Visiting Scholar must attend all applicable safety training sessions, including but not limited to:
    - Right-To-Know
    - Chemical Safety/Hygiene Plan
    - Any or all of the following, based on work performed:
      - Corrosive Chemical Safety
      - Laboratory Ventilation Safety

- Chemical Waste Disposal
- Laser Safety
- Radioactive Materials Safety
- Biosafety
- Bloodborne Pathogens
- X-Ray Device Safety
- Department or Laboratory Specific Training
- Hydrofluoric Acid Safety

- The Visiting Scholar is under the supervision of a faculty member in the laboratory or area where the work will occur.
- The Principal Investigator or Faculty Member must assure that the Visiting Scholar reviews all Job Hazard Analysis (JHA) and Standard Operating Procedures (SOP). Written copies shall be provided. EHS shall review the JHA's or SOP's to assure all safety issues are addressed.
- The Visiting Scholar must use all required personal protective equipment. Each college, school, department, division or unit should make available to each Visiting Scholar required to wear personal protective equipment the devices appropriate for the activity and hazards involved. The Visiting Scholar may be required to purchase certain individualized items of personal protective equipment.
- The Visiting Scholar must be monitored and supervised by a knowledgeable and experienced employee until the principal investigator is comfortable that the individual can work independently. **They must not work alone** while performing hazardous operations or while working with hazardous materials.
- The Visiting Scholar must follow all Departmental and University safety procedures and policies
- The Departmental Safety Committee or Departmental Chemical Hygiene Officer should perform spot inspections of the work and assure that all training is complete.
- The Release of Liability and Waiver Claim Form (http://www.udel.edu/ehs/forms/downloads/VolunteerResearchersPolicy.pdf) must be completed by the Visiting Scholar.
- The responsible Faculty member must complete the Principal Investigator/Supervisor Commitment Form (http://www.udel.edu/ehs/forms/downloads/VolunteerResearchersPolicy.pdf).

Chapter 7: Highly Toxic, Carcinogen, Reproductive Toxin Permit Process

7.1 Safe Work Environment for Reproductive Health

Materials with undesirable reproductive effects can affect both men and women. As long as there is a potential for conception, the student/employee must consider the reproductive effects of the materials with which they are routinely in contact.

- A reproductive toxicant interferes with reproductive or sexual function of the male or the female from puberty through adulthood.
- A developmental toxicant produces an effect in the offspring from conception through puberty. There are four principal manifestations; death of the unborn child, structural abnormality, altered growth, functional deficiency. Developmental toxicants have been found to cause tertiary and quaternary effects. For example, mutagens and teratogens are substances that may affect the embryo, fetus or the exposed person in a manner, which produces cancer or disease.
- Certain chemicals can pass through the breast milk to a nursing child.
- Other chemicals can be brought home on clothing and impact the health of very young children and an unborn child.
- Physical hazards, such as noise, can also impact reproductive health.

A worker or student in the research environment should consider two principal issues.

- Identify potential hazards that they may be exposed to in their research setting.
- The adaptation of the work routine to minimize or eliminate these hazards.

7.1.1 Identifying the hazard

The most common hazard potential in many labs is exposure to chemicals. The individual must become familiar with the potential dangers of the chemicals found and used within the lab. This information can be found on the Safety Data Sheet (SDSs) available in each lab or through the Department of Environmental Health and Safety.

7.1.2 Minimize or eliminate the hazard

In the laboratory, begin minimizing exposure potential through implementation of prudent lab practices to prevent skin contamination or inhalation.

- Whenever possible, conduct processes in a chemical fume hood;
- Wear proper protective gloves to reduce exposure potential.
- For work that cannot be conducted in the chemical fume hood and a mutagen or teratogen is involved, contact your supervisor and the Department of Environmental Health and Safety for a job hazard analysis.

7.1.3 All personnel who use any reproductive toxins perform any operations that may impact a worker's reproductive health must complete the following procedures prior to initiating work:

- Obtain prior approval for the purchase and use of the materials. Receive prior approval from DEHS and the Departmental Chemical Hygiene Officer for the possession and use of the material. See Appendix H (http://www.udel.edu/ehs/reprotoxsop.doc) for the SOP/Approval Form for the Use of Reproductive Toxins.
- Review each use of reproductive hazards with research supervisor, the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety.
- Label the containers as follows: REPRODUCTIVE HAZARD: READ SPECIFIC PROCEDURES FOR USE.
- Store these substances in unbreakable containers or unbreakable secondary containers in well-ventilated areas.
- Use and store reproductive hazards only in designated (restricted access) areas placarded with appropriate warning signs. A designated area is defined as a fume hood, glove box, portion of a laboratory, or an entire laboratory room designated as the only area where work with quantities of carcinogenic or highly toxic

chemicals shall be conducted. Designated areas shall be posted and their boundaries clearly marked. Only those persons trained to work with the chemicals of concern will work with those chemicals in a designated area.

- Guard against spills and splashes. Ensure the engineering controls are operating properly before initiating work.
- Notify your supervisor or the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety of all incidents of exposure or spills. The Department of Environmental Health & Safety will arrange for a medical consultation if necessary.

Workers concerned about reproductive health must be made aware of the hazards before beginning work in the laboratory. The worker can voluntarily declare that there is a concern about the reproductive hazards they are working with. It is recommended that the worker consult their personal physician and provide a list of the chemical used in the laboratory. The final decision to continue to work in the laboratory rests with the employee. The employee can request permission to work on a different project, request a leave of absence, request medical leave or resign.

7.2 Highly Toxic chemicals

According to the Occupational Safety and Health Administration (OSHA),"highly toxic" is any chemical falling within any of the following categories:

- A chemical that has a median lethal dose 50 (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- A chemical that has a median lethal dose 50 (LD_{50}) 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 2 and 3 kilograms each.
- A chemical that has a median lethal concentration 50 (LC_{50}) 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.

Examples of Toxicity and Dose

Toxicity rating	Animal LD_{50}	Lethal Dose When Ingested a by 70-kg (150 lb) human
Extremely toxic	< 5 mg/kg	A taste (< 7 drops)
Highly toxic	5-50 mg/kg	7 drops - 1 tsp
Moderately toxic	50-500 mg/kg	1 tsp-1 ounce
Slightly toxic	500 mg/kg	1 ounce - 1 pint

Source: Prudent Lab Practices (1995)

* If this toxicity information cannot be found on the SDS, please contact DEHS for assistance/clarification.

7.3 Carcinogen
s

According to the Occupational Safety and Health Administration (OSHA), a carcinogen is any substance which meets one of the following criteria. See Appendix E of the CPR for a partial list of known and anticipated chemical carcinogens:

- It is regulated by OSHA as a carcinogen; or
- It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition) - http://ntp.niehs.nih.gov; or
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC) (latest editions) – http://monographs.iarc.fr/ENG/Classification/index.php; or
- It is listed in either Group 2A or 2B by IARC - http://monographs.iarc.fr/ or under the category, "reasonably anticipated to be carcinogens" by NTP - http://ehp.niehs.nih.gov/, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
  - After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;
  - After repeated skin application of less than 300 mg/kg of body weight) per week; or;
  - After oral dosages of less than 50 mg/kg of body weight per day.

7.4 Precautions/Safe work Practices for working with Highly Toxic Chemicals and Chemical Carcinogens:

All personnel who use any highly toxic chemicals and/or carcinogens must complete the following procedures prior to initiating work:

- Obtain prior approval for the purchase and use of the materials
  - **Highly Toxic Materials:** Receive prior approval from DEHS and the University Chemical Hygiene Committee (CHC) for the possession of highly toxic chemicals. Go to the EHS web site http://www.udel.edu/ehs/research/chemical/lab-operations.html for the SOP/Approval Form for Use of Highly Toxic Material.
  - **Carcinogenic Materials:** Receive prior approval from DEHS and the local Departmental Chemical Hygiene Officer for the possession and use of the carcinogenic chemicals. Go to the EHS web site http://www.udel.edu/ehs/research/chemical/lab-operations.html for the SOP/Approval Form for Use of Carcinogenic Material.
- A written job hazard analysis (JHA) outlining the hazards as well as the engineering and administrative controls must be generated to reduce or eliminate the hazard (i.e. PPE and local exhaust ventilation). This analysis must be conducted by knowledgeable personnel who have experience and expertise with the process. Each JHA is to be updated every 5 years or any time there is a change in the operation. Additionally, the JHA's shall be kept on record for the life of the project and made readily accessible to laboratory personnel. In general, JHAs can be integrated into a laboratory procedure, protocol or standard operating procedure (SOP). The SOP/Approval Form, generated by DEHS and the CHC, can serve as a JHA.
- Proper training and information must be shared with all laboratory personnel working with or around these chemicals. This training must include at least the hazards of the chemicals, the technology of the process and equipment involved. All of the following should be covered: all information in the SDS; process diagrams; process chemistry; inventory; safe upper and lower temperatures; pressures; flows or compositions to be used; instrument information; relief systems; ventilation needs; electrical issues; materials of construction; safety systems; consequences of failure to adhere to the safety controls and any other information that could affect the process safety. This training shall be documented and kept in the lab and a copy sent to EHS.
- A written standard operating procedure (SOP) must be readily accessible to the laboratory personnel at all times. This is to include initial startup, normal operations, emergency conditions and shutdown procedures. These will be re-evaluated anytime there is a change to the operation and a copy is to be kept in the laboratory.
- Conduct a cold/dry run prior to using any chemicals. Work through the process without actually using the chemicals in an effort to anticipate problems that may arise.

Safe/Prudent work practices:

1. Consult at least three resources (e.g. SDS's) that list toxic properties of known substances and learn what is known about the substance that will be used. Follow the specific precautions and procedures for the chemical.
2. Ensure that the chemical fume hood/glove box or other mechanical engineering control is properly functioning prior to initiating work each time.
3. Use and store highly toxic substances, reproductive toxin and or carcinogens only in designated (restricted access) areas placarded with appropriate warning signs. A designated area is defined as a fume hood, glove box, portion of a laboratory, or an entire laboratory room designated as the only area where work with quantities of carcinogenic or highly toxic chemicals shall be conducted. Designated areas shall be posted and their boundaries clearly marked. Only those persons trained to work with the chemicals of concern will work with those chemicals in a designated area.
4. On leaving the designated area, remove protective apparel and thoroughly decontaminate or dispose of contaminated items or shoes as solid chemical waste. Thoroughly wash hands and forearms.
5. Use a fume hood or other containment device for procedures. It may be necessary to consider incorporating a trap for released vapors to prevent their discharge with fume hood exhaust.
6. Maintain inventory records of the amounts of materials on hand, amounts used, and the names of the workers involved (tracking the substance cradle to grave).
7. Store contaminated waste in closed, suitably labeled, impervious containers.
8. Use a wet mop/wipe methods or a vacuum with a HEPA filter to decontaminate surfaces. DO NOT SWEEP DRY POWDERS.
9. Protect vacuum pumps against contamination with scrubbers or HEPA filters and vent effluent into the hood.
10. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed.
11. Work inside fume hood in secondary containers, use mechanical means to handle equipment/chemicals whenever possible. Assure that at least 2 trained people are present at all times.
12. Store breakable containers in chemically resistant secondary containers; also work and mount apparatus inside a secondary container or cover work and storage surfaces with removable, absorbent, plastic backed paper.

Accident/Emergency procedures:

- Be prepared for accidents and spills by having the appropriate spill/exposure kit in the laboratory or other immediately accessible area, i.e. the unlocked adjoining laboratory or unlocked common area. If the chemical requires a specific response (e.g. hydrofluoric acid), initiate the specific procedure immediately and seek medical attention.
- Ensure that the laboratory/hazardous material use area has a University Emergency Procedure Poster in preparation for general spills or exposures procedures.

Exemptions

The use and purchase of dilute solutions and mixtures of highly toxic or carcinogenic materials will not be required to comply with prior approval or conducting a dry run. It is important to note that the process of making the stock solution or mixture must comply with all aspects of the CHP. A dilute solution of the materials is described as follows:

1. Dilute Highly Toxic Material Mixture or Solution – a mixture or solution of highly toxic materials and non-hazardous solution (buffer, DI Water, etc.) in such a ratio that increases the LD_{50} above 50 mg/kg. Solutions in hazardous materials such as dimethyl sulfoxide, flammable liquids or corrosive liquids would still be regulated due to potential synergetic effects.
2. Dilute Carcinogenic Material Mixture or Solution – a solution or mixture containing less than 0.1% carcinogenic material by weight in a non-hazardous solution (buffer, DI Water, etc.). Solutions in hazardous materials such as dimethyl sulfoxide, flammable liquids or corrosive liquids would still be regulated due to potential synergetic effects.

7.5 Approval Process for the Use of Highly Toxic Materials

Step 1: Consult the following resources to determine if the chemical or substance meets the definition.

1. Chemical and Physical Characteristics of Highly Toxic and Carcinogenic Materials
2. Appendix E of the Chemical Hygiene Plan
3. The SDS for the chemical or substance
4. ChemWatch (EHS's online SDS Program)
5. Registry of Toxic Effects of Chemical Substances (RTECS)

Step 2: Go to EHS's online Standard Operating Procedures (SOP) and look for a generic SOP for the compound of concern. If a generic SOP is not available, complete a Standard Operating Procedure/Approval Form for Highly Toxic Materials (Word Format) using the SDS as a guide. It is important to complete all sections of the form. Complete the appropriate form and send via e-mail to the University Chemical Hygiene Officer (CHO). The CHO will review and make recommendations or changes to your procedure.

Step 3: Submit this approved form with original signatures through campus mail to the University CHO for conditional approval. Based on the material and laboratory practice, the Chemical Hygiene Committee (CHC) Member representing the department or the University CHO may need to meet with the Principal Investigator (PI) to discuss the material and its use. A list of the CHC members and the departments they represent can be found on the EHS website. The PI will receive conditional approval to begin use with the material. The University CHO will present the SOP at the next Chemical Hygiene Committee via email or at the next committee meeting for full approval.

Step 4: After completion of Step 3, provide and document training for every worker listed in the SOP. This training shall include hands-on instruction as well as a review of all JHA's, SOP's and the University Chemical Hygiene Plan.

Step 5: Contact the University CHO or Departmental CHO to be present during a trial run. At that time, the training records and other documentation will be inspected. Every PI and laboratory worker shall have Right-To-Know, Chemical Hygiene/Chemical Safety and Chemical Waste Training Certificates on file in the laboratory.

Step 6: Contact the University CHO or the Departmental CHO to be present the first time a process using the materials occurs. This can occur at the same time as Step 5. After successful completion of the process, PI's will receive approval to use and purchase the material for two years.

PI's must complete the *Standard Operating Procedure/Approval Renewal Form For Carcinogens and Highly Toxic Materials* to renew the approval.

7.6 Approval Process for the Use of Carcinogenic Materials

Step 1: Consult the following resources to determine if the chemical or substance meets the definition.

1. Chemical and Physical Characteristics of Highly Toxic and Carcinogenic Materials

2. Appendix E of the Chemical Hygiene Plan
3. The SDS for the chemical or substance
4. ChemWatch (EHS's online SDS Program)
5. Registry of Toxic Effects of Chemical Substances (RTECS)

Step 2: Go to EHS's online Standard Operating Procedures (SOP) and look for a generic SOP for the compound of concern. If a generic SOP is not available, complete a Standard Operating Procedure/Approval Form for Carcinogenic Materials (Word Format) using the SDS as a guide. It is important to complete all sections of the form. Complete the appropriate form and send via e-mail to the Departmental Chemical Hygiene Officer (DCHO) for review. The DCHO will review and make or recommend changes. A list of the current Departmental Chemical Hygiene Officers can be found on the EHS website.

Step 3: Submit the DCHO approved form with original signatures through campus mail to the University CHO for final approval. Based on the material and laboratory practice, the University CHO may need to meet with the Principal Investigator (PI) to discuss the material and its use or send the SOP/Approval Form to the Chemical Hygiene Committee for designated review.

Step 5: After completion of Step 3, provide and document training for every worker listed in the SOP. This training shall include hands-on instruction as well as a review of all JHA's, SOP's and the University Chemical Hygiene Plan.

After successful completion of the process, PI's will receive approval to use and purchase the material for two years. PI's must complete the *Standard Operating Procedure/Approval Renewal Form For Carcinogens and Highly Toxic Materials* to renew the approval.

7.7 Special Precautions for Work with Chemicals, Materials or Substances of Unknown Toxicity

Chemical whose toxic properties are unknown are defined as a chemical for which there is no known statistically significant study conducted in accordance with established scientific principles that establishes its toxicity. In the absences of peer review scientific toxicity data, a research must assume the material is toxic and follow prudent practices.

All personnel who use any materials with unknown toxicity must complete the following procedures prior to initiating work:

- Obtain prior approval for the purchase and use of the materials. Receive prior approval from DEHS and the Departmental Chemical Hygiene Officer for the possession and use of the material. An SOP/Approval Form for the Materials with Unknown Toxicity is available on the EHS website.
- Review each use of the material with the research supervisor, the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety.
- Label the containers as follows: UNKNOWN TOXICITY: READ SPECIFIC PROCEDURES FOR USE.
- Store these substances in unbreakable containers or unbreakable secondary containers in well-ventilated areas.
- Guard against spills and splashes. Ensure the engineering controls are operating properly before initiating work.
- Notify your supervisor or the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety of all incidents of exposure or spills. The Department of Environmental Health & Safety will arrange for a medical consultation if necessary.
- Use and store materials of unknown toxicity only in designated (restricted access) areas placarded with appropriate warning signs. A designated area is defined as a fume hood, glove box, portion of a laboratory, or an entire laboratory room designated as the only area where work with quantities the chemical of concern shall be conducted. Designated areas shall be posted and their boundaries clearly marked. Only

those persons trained to work with the chemicals of concern will work with those chemicals in a designated area.

7.8 Designating High Hazard Areas

Areas using or housing high hazard materials must be placarded with the following warning signs to identify restricted access, designated areas:

- DANGER – BIOHAZARDS
- CANCER HAZARD
- DANGER – RADIOACTIVE MATERIAL
- DANGER – RADIATION AREA
- DANGER – HIGH RADIATION AREA
- DANGER – ACUTELY TOXICITY
- CAUTION – REPRODUCTIVE TOXIN
- DANGER – X-RAY
- DANGER – LASER

When an area is designated as high hazard the following actions must be taken:

- A list with names and phone numbers of responsible personnel shall be posted on the door(s) to any restricted access, designated areas.
- Students, faculty, staff and administrators shall not enter a restricted area, except when accompanied by an authorized user of the facility.
- In general, all support personnel must have a minimal level of training (Delaware Right-to-Know) to enter any laboratory. Additional awareness training must be given by the Principle Investigator, Department Chemical Hygiene Officer or the Department of Environmental Health and Safety for support personnel to enter restricted areas.
- Custodians are permitted to enter restricted areas to perform routine tasks; however, custodians must not touch labeled waste containers, other research equipment or materials.
- Other support personnel, such as University Police, are permitted to enter restricted areas provided the work to be performed does not involve disturbing a use area within the facility, equipment, or materials. Examples include:
  - Fume hoods
  - Biological safety cabinets
  - Sinks
  - Placarded equipment
  - Chemicals or materials on lab benches

Laboratory Sign Program – Following prudent practices, DEHS has developed an ongoing program to label all laboratories and areas where hazardous operations occur or where hazardous materials are used with a uniform laboratory hazard warning sign. The purpose of the sign is to assure that adequate warnings and emergency phone numbers are clearly visible outside of a hazardous area. These signs identify restricted areas to visitors and will communicate to emergency responders the hazards present in the area. The signs also indicate that proper eye protection is required prior to entering the room. All areas, rooms or laboratories where hazardous materials are used or hazardous operations occur shall be labeled with and approved laboratory warning sign.

To request a sign or update an existing sign use the *Laboratory Sign Request Form* available on the EHS website under the Forms tab.

As an additional requirement to the laboratory signage, PI's, Lab Supervisors are required to complete a emergency contact card with current personal contact information (home and cell phone numbers) which will solely be used in the event of an emergency. A minimum of two individuals, preferably three, contacts are needed to ensure at least one person can be reached with knowledge of the chemicals/processes occurring within the lab. Emergency responders have been trained to look for these cards which are placed behind lab signs.

Chapter 8: Medical Consultations

8.1 Medical Consultation and Medical Examinations

All employees who work with hazardous chemicals shall be provided an opportunity to receive medical attention under the following circumstances:

- When the employee develops signs and/or symptoms that may be associated with a hazardous chemical to which the employee was exposed in the laboratory;
- When routine monitoring reveals an exposure above the PEL or action level;
- When an event takes place in the work area such as a spill or leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure.

All medical examinations and consultations shall be performed by a licensed physician or under his/her direct supervision.

- The employer shall provide the following information to the physician:
- The identity of the hazardous chemicals to which the employee may have been exposed;
- A description of the conditions under which the exposure occurred; and
- A description of the signs and symptoms of exposure the employee is experiencing, if any.
- The Physician shall provide a written opinion which shall include:
  - Any recommendation for further medical follow-up;
  - The results of the examination and any associated tests;
  - Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk; and
  - A statement that the employee has been informed by the physician of the results of the examination and any medical condition that may require further examination or treatment.
  - The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.
  - All medical consultations shall be coordinated by the Department of Environmental Health and Safety.

8.2 Exposure Evaluations

An exposure evaluation will be conducted for employees who, as a consequence of a laboratory operation, procedure, or activity, reasonably suspect or believe they have sustained an overexposure to a toxic substance.

- The exposure evaluation will be conducted by the University Chemical Hygiene Officer.
- Initial Monitoring - If there is reason to believe that exposure levels exceed the PEL or action level for a regulated substance, the employee's exposure will be measured.
- Periodic Monitoring - If initial monitoring indicates employee exposure above the PEL or action level, the monitoring provisions of the Chemical Hygiene Plan will be implemented.
- The employee must be notified of the result of the monitoring within 15 days of the employer's receipt of the results.
- Additional requirements may be required if a work place exposure assessment uncovers an issue or exposure. Departments may be required to install additional laboratory exhaust units, change processes or experiments, provide additional training or personal protective equipment or discontinue a procedure if suitable work place controls cannot be implemented or made available in another area or laboratory.
- Termination of Monitoring - The employer may terminate monitoring in accordance with the relevant standard.

Chapter 9: Emergency Response

Plan in advance for an emergency, consider:

- What possible emergencies could occur during your work, e.g., fire, spill, high level chemical exposure, ventilation failure?
- Are systems available to indicate an emergency situation, e.g., chemical exposure monitoring systems, chemical fume hood audible/visual alarms?
- What supplies and equipment should be maintained in the area to assist emergency response personnel in the event of an emergency, e.g., eyewash and safety shower, spill control materials, personal protective clothing?
- What training is required to handle an emergency in the area, e.g., emergency first aid or respirator use training?
- Is it safe for you to work alone?

Develop a written plan for each experiment or process, detailing the steps to take should an emergency occur. This plan should reference and answer the questions listed above. This plan can be integrated into an experiment procedure document. Provide and document training on the plan with all researchers involved in the experiment or process.

Develop a written plan for each experiment or process, detailing the steps to make the operation safe should a ventilation or power failure occur. The chance of a power or ventilation failure occurring is much higher especially during the summer months. It is a prudent measure to have a separate plan to handle these types of emergencies.

- Evaluate the work area for the following:
- Chemical monitoring systems;
- Supplies and equipment required to assist emergency response personnel in emergency activities;
- Eyewash;
- Safety shower;
- Spill control materials;
- Personal protective clothing;
- Meet the requirements in UD Policy 7-6 *Emergency Response/Fire – Other emergencies.*
- Consider whether planned work activities are safe to conduct alone. A lab partner is always required if you are working with hazardous materials.
- Check to see that all personnel have received emergency training.

Chapter 10: Chemical Waste Management Guidelines for Handling and Disposal of Chemical Waste

10.1 Overview

Proper chemical management is necessary to protect the health and safety of the University and surrounding communities and the environment. There are federal and state regulations that require all generators of chemical waste receive training and follow proper waste management and disposal procedures. These regulations have severe monetary and civil penalties associated with them. Between 1990 and 2004, over twelve million dollars in fines have been levied against University and Colleges for hazardous waste and other environmental violations, leading the EPA to question waste management at educational institutions.

10.2 Definition of Chemical Waste

Chemical waste is defined by the United States Environmental Protection Agency and by the Delaware Department of Natural Resources and Environmental Control. Definitions, management practices and compliance are outlined in 40 Code of Federal Regulations and the Delaware Rules Governing Hazardous Waste. All policies and practices developed by the University of Delaware are designed to meet or exceed these regulations and assure compliance.

University Policy 7-18 states that all University of Delaware personnel must manage all chemical and hazardous waste in compliance with these federal and state regulations and in accordance with procedures set up by the Department of Environmental Health and Safety.

Chemical waste is a broad term and encompasses many types of materials, Consult your Safety Data Sheet (SDS), Product Data Sheet or Label for a list of constituents. These sources will tell you if have a chemical waste that needs special disposal. To reduce its long-term liability, the University is proactive in managing all of its chemical waste in an environmentally sound manner.

10.3 Selecting A Container

Do not use containers that are old, dented, damaged, leaking or cracked. The container must be able to be capped, sealed or closed. The container must be compatible with the waste streams that will be placed in it. For example, do not use a metal container to store acids, do not use a glass container to store hydrofluoric acid, do not use glass or metal containers to store organic peroxides and do not use metal containers to store picric acid and solutions of picric acid. Do not use containers that can be confused with consumer commodities like soda bottles or milk jugs. Do not use metal containers for flammable liquid waste, unless proper bonding and grounding precautions are taken.

10.3.1 Liquid Chemical Waste

Once it is determined that chemical waste will be generated, a container must be selected prior to waste generation. Do Not Use glass, plastic-coated glass or other re-used reagent chemical bottles to store or accumulate bulk liquid chemical waste.

For bulk solvent and aqueous liquid waste streams use a Low Density Polyethylene Nalgene container. These containers will be returned within a week to the lab and are available from most laboratory supply companies and the campus storerooms. Nalgene containers are compatible with most chemical wastes, but there are a few waste streams that should not be accumulated in these containers.

Examples of chemical that should not be stored in Nalgene containers:

- Amyl Chloride
- Bromine
- Butyric Acid
- Carbon Disulfide

- Nitrobenzene
- Sulfur Dioxide
- Thionyl Chloride
- Vinylidene Chloride

Certain types of Nalgene containers work best for DEHS' operations. Please try to purchase containers that meet the following requirements:

- Low density polyethylene
- Either a 53B or 83B screw cap
- Containers with a large handle
- Capacity no larger than 5 gallons

For bulk corrosive liquid waste streams, use the "JustRite" Safety Containers for Waste Disposal. These containers are specially designed for corrosive chemical waste and vent under emergency conditions. Do not store or accumulate bulk liquid corrosive chemical waste in any other container. Go to Liquid Corrosive Chemical Waste Management (http://www.udel.edu/ehs/waste/acid-waste.html) for more information on managing corrosive waste streams.

10.4 Laboratory Clean Out of Regent Chemicals

All laboratories must on an annual basis inspect all of their reagent chemicals.

Identify chemicals that are no longer needed, old and out of date or unusable.

Redistribute unneeded chemicals to other researchers in the department or building.

If no one else needs the chemical or if they are out of date or unusable, then package them as follows for disposal through DEHS:

- Package by hazard class in sturdy cardboard boxes. Go to Chemical Storage Guidelines (http://www.udel.edu/ehs/research/chemical/chemical-storage.html) for guidance on packaging by hazard class.
- Use sufficient packing material to prevent container damage en route.
- Place a completed chemical waste label and packing slip on the outside of the box.

10.5 Sample Vials - Sealed 15 ml or less

Some laboratories generate a number of sealed sample vials. If the laboratory does not want to reuse the glassware or plasticware and does not want to empty the contents into a liquid chemical waste container, the following procedures must be used:

1. Obtain a clean 5-gallon polyethylene pail with lid.
2. Line the pail with a heavy-duty plastic bag.
3. Place a chemical waste label (http://www.udel.edu/ehs/waste/lab-waste-label.html) on the outside of the pail.
4. Place only compatible material in pail.
5. Place the lid on the pail. The lid must remain on the container unless you are actively adding waste to the container.
6. When full tightly seal bag with tape or bag closure tie and submit a chemical waste pickup request.

10.6 Solid Waste Streams

Solid waste includes any laboratory material that has come in contact with a chemical or is potentially contaminated with a chemical. Examples include gloves, bench-top paper, weighing boats and papers, paper towels, clean up material and permanently contaminated glassware and plastic ware. Use the following procedures to manage solid chemical waste:

1. Use solid waste containers provided by Environmental Health & Safety or purchase cardboard boxes from Fisher Scientific.
2. All containers must have lids. All containers must be lined with a heavy duty plastic liner.
3. Apply a completed chemical waste label on the outside of the container prior to adding waste.
4. Line the container with a 7-mil polyethylene bag or three standard trash bags.
5. All containers must be sealed unless laboratory personnel are actively adding waste. Seal the EHS provided solid waste containers with the lid provided. Seal other containers with the lid or the bag with a bag closure tie or a large binder clip.
6. When the container is full, seal the bag with tape. If the container is in a cardboard box, secure the box with tape as well.
7. It is important not to overload containers. Full boxes shall not weigh more than 40 pounds. Do not use overly large boxes. Only fill boxes two-thirds full if they contain broken glass.

10.7 Chemically Contaminated Sharps

Anything that is capable of cutting or puncturing must be managed in a sharps container. Examples of sharps include needles, syringes, razor blades, slides, scalpels, pipettes, broken plastic or glassware, micropipettes and pipette tips. Sharps containers are available free of charge from DEHS. Chemically contaminated sharps go in green sharps containers labeled with a properly filled out Orange Chemical Waste Label.

10.8 Empty Chemical Containers

Empty chemical containers are still hazardous to the University personnel and the environment until they are properly managed. Below is a summary of the steps required to make empty chemical containers that contained water miscible products safe for disposal:

1. Triple rinse with copious amounts of water. Collect the first rinse as chemical waste. Rinse two and three can go down the sanitary sewer.
2. Place a label over the original container label or deface the label.
3. Do not replace the cap on the container.
4. Place empty/triple rinsed containers in a glass only box, recycling container or directly into the dumpster.

10.9 Clean, Uncontaminated Broken Glassware

Clean, uncontaminated glassware and plastic ware should not be managed as waste. Unwanted clean non-broken glassware and plastic ware can be packaged up by the laboratory personnel and taken to the dumpster or recycling area. Broken glassware and plastic ware creates a potential hazard so special procedures are needed:

1. Purchase a glass only box from a campus storeroom or a laboratory supply company, or reuse a heavy corrugated cardboard box lined with a plastic liner.
2. Construct the box as per directions.

3. Tape the bottom.
4. When the container is 3/4's full, seal and take to the dumpster. Laboratory personnel must take the box to the dumpster, custodial staff is not allowed to. You must wear personal protective equipment (PPE) while handling these boxes. Minimum PPE includes leather work gloves and safety glasses. Custodial Services will not handle broken laboratory glassware and plastic ware.

10.10 Gas Cylinders

The disposal of gas cylinders is extremely expensive it can cost in excess of $1,000 to dispose of single lecture size cylinder. Always check to make sure that all labels on gas cylinders are in good condition and legible. Only purchase cylinders from vendors that will take them back.

10.11 Recycling and Laboratory Wastes

Certain laboratory materials can be recycled while others cannot.

Laboratory materials that can be recycled after triple rinsing:

a. Brown glass
b. Clear glass
c. Metal cans
d. Computer and electronic equipment

Laboratory materials that cannot be recycled even if cleaned or uncontaminated:

e. Any glass bottles that are plastic coated
f. Pyrex
g. Glass only boxes

10.12 Labeling Chemical Waste

After you have determined what waste you are going to generate and have obtained the appropriate containers, you must properly fill out a chemical waste label and attach it to the containers. Chemical waste labels are available from DEHS, free of charge. Labels must be applied on all chemical waste containers as soon as waste is added. These labels are designed to meet the regulatory requirements; therefore, every piece of information on the label is critical and must be completed.

Completing the Label:

1. The generator is the person who is filling out the waste label, not the lab group or Principal Investigator (PI) unless the PI is filling out the waste label.
2. Date the label with the date that the waste is first added.
3. Fill in building, room number and telephone number where the person who is filling out the waste label can be reached.
4. Circle the appropriate waste steam(s) or write it in.
5. List each waste constituent down to 1%; heavy metals must be listed down to the parts per million range. Label contents must add up to 100%. Volumes are acceptable.
6. Use only common chemical names or IUPAC nomenclature when listing the chemical constituents on the label.

Do not use:

Abbreviations;

Chemical symbols; or

Trade names

7. Check the appropriate boxes for the waste stream.
8. If this waste is being moved to a Central Accumulation Area such as the Brown Solvent Shed or ISE Lab Waste Area, fill in the date that it is moved into the central accumulation area on the line at the bottom of the waste label.

10.12 Adding Waste to a Container

Waste can be added only after you choose the proper container and it is labeled. All personnel working with chemical waste must wear the following:

1. Safety glasses
2. Splash goggles if working with liquid waste
3. Lab coat
4. Gloves specific for the compounds in use

Perform liquid chemical waste management in a fume hood. Mixing of liquid waste may generate toxic or corrosive aerosols.

1. Check the container label to assure that waste is being added to the correct container.
2. The container must be in secondary containment, i.e. large plastic bin or bucket.
3. Uncap the container.
4. Use a funnel sufficient for the size or the container and volume of waste being added.
5. Slowly add the waste, watching for any unintended reactions. If you observe a reaction, immediately stop adding the waste, close the fume hood sash and contact DEHS.
6. After the waste has been added, remove the funnel and seal the container with the cap. It is a regulatory requirement for the container to be closed when not actively adding waste.
7. Another option for liquid waste management is to use a specially designed waste funnel called ECO-Funnel. ECO-funnels securely attach to the container and have a lid attached to the funnel.

10.13 Storing Your Waste

Proper storage of chemical waste is extremely important. Explosions have occurred on campus that was caused by improper storage of chemical waste. If you improperly label a container, other laboratory personnel unknowingly may add incompatible material to the container.

Adhere to the following procedures on chemical waste storage to protect the health and safety of others, protect the University's facilities and to keep the University in compliance with all federal, state and local regulations:

1. Waste containers must remain closed or sealed at all times, except when waste is being added or removed from the container.
2. Liquid waste containers must be stored in secondary containment systems according to hazard class.

3. Store all bulk liquid waste containers in appropriate cabinets. DO NOT store bulk liquid chemical waste containers in fume hoods that have active experiments or reactions occurring.
    a. Flammable Cabinets
    b. Corrosive Cabinets
    c. Under Fume Hood Cabinets
4. Do not allow excess accumulation of chemical waste to build up in your lab.
5. Containers can only be filled to a maximum 90% full. Head space is needed for expansion and/or ease of dispensing.

10.14 Inspecting Your Waste Accumulation Areas

All satellite chemical waste accumulation areas must be inspected on a weekly basis. This inspection does not have to be a formal inspection with documentation but laboratory personnel must inspect all chemical waste stored in their laboratories to assure the following:

There are no leaking containers of chemical waste.

All containers holding chemical waste are labeled with a completed orange chemical waste label.

All containers are sealed and closed. This includes waste containers holding solid chemical waste.

All liquid chemical wastes are stored in secondary containment bins.

Incompatible wastes are stored away from each other and in separate containment bins.

There is not an excessive accumulation of waste stored in the laboratory. Immediately correct any of the above if they are encountered during the course of the weekly inspection.

10.15 How to Have Chemical Waste Removed

Certain departments and buildings have a Central Accumulation Area (CAA) set up in close proximity to their building. Laboratories in Brown, Lammot DuPont, Drake Hall, and ISE Lab should take their waste to the CAA.

Once a chemical waste container is 90% full, a Chemical Waste Pickup Webform should be filled out to remove the container or it should be moved to the CAA. In addition, if a chemical waste container has been in use in a laboratory for more than six months, it should be sent for waste removal. If your building does not have a CAA, follow the procedure below:

Request a chemical waste pick-up via the DEHS Web Page. From Webforms click on EHS Request for Service and complete the webform. If you do not have access to a computer or if the webform does not work, contact DEHS. This assists DEHS with complying with Federal and State Regulations.

DEHS will only remove waste that is properly labeled and in a satisfactory container. If the container is not labeled or is unsatisfactory (cracked, open, overfull), an attempt will be made to find laboratory personnel to correct the problem. If no one can be located, the container will be left and DEHS will send an email to the responsible parties notifying them that the container was not removed.

Chapter 11: Chemical Spills

11.1 General Information

The Laboratory Chemical Spill Clean-Up Procedures were created to give researchers and laboratory personnel a starting point for developing a chemical spill kit and providing guidance for cleaning up chemical spills. Chemical spills and accidents need to be minimized as much as possible. If a chemical spill should occur, a quick response with a stocked chemical spill kit will help minimize potential harm to personnel, equipment and laboratory space. Outlined below is the minimal equipment required for a spill kit. You may add equipment to the kit, provided all personnel are proficient in its use. Contact DEHS for information and guidance in construction of an advanced spill kit. DEHS approved chemical spill kits are available for purchase at UDMart.

Note that the majority of chemical spills can be prevented or minimized by:

- Maintaining a neat and organized work area;
- Performing a laboratory procedure review prior to conducting new experimental procedures;
- Storing liquid chemicals in secondary containment bins;
- Keeping reagent chemical containers sealed or closed at all times, except when removing contents;
- Ordering reagent chemicals in plastic or plastic coated glass containers whenever possible;
- Using secondary containment to store and move chemicals.

If the spill is too large for you to handle, involves materials listed in the table below; is a threat to personnel, students or the public; involves radioactive material; involves an infectious agent; or involves a corrosive, highly toxic, or reactive chemical, call EHS or 911 from a campus telephone for assistance.

Chemical Class	Example
Strong Acids Any acid that is concentrated enough to fume or emit acid gases	Fuming Sulfuric Acid, Red Nitric Acid, Hydrofluoric Acid, Perchloric Acid
Strong Bases - Any base that is concentrated enough to emit vapors	Ammonium Hydroxide
Poison by Inhalation - Any chemical that readily emits vapors or gases at normal temperature and pressure that are extremely toxic by inhalation	Phosphorous Oxychloride, Titanium Tetrachloride, Formates, Isocyanates
Reactive - Any chemical that is sensitive to air, water, shock, friction and/or temperature	Dry Picric Acid, Lithium Aluminum Hydride, Sodium Borohydride, Phosphorus Metal, Organic Peroxides
Mercury - Any mercury compound. Do not use a domestic or commercial vacuum cleaner. Uses of powder sulfur or mercury spill clean-up kits are not as effective as the specialized equipment EHS has on hand. These spill clean-up methods also increase the disposal cost.	Metallic Mercury, Mercury Salts, Aqueous Mercury Solutions
Extremely Toxic - Any chemical that is readily absorbed through the skin and is extremely toxic at small concentrations	Benzene, Sodium Cyanide

If the spill occurs in the laboratory, evacuate the room and call on the **Newark Campus – 911,** on the **Georgetown/Lewes/Wilmington Campus – 9-911** or the **Dover Campus – 99-911.** Follow the University Police's directions and stay by the laboratory until EHS responders arrive.

If the spill occurs in a public space (hallway, stairwell, elevator, etc.) or involves a large amount of flammable liquids (greater than four liters), flammable gas, or have the potential to threaten people outside of the laboratory, pull the building fire alarm and evacuate the building. The responsible researcher must report to the University Police Command Post and await the EHS responders.

The Department of Environmental Health and Safety is equipped to handle most spills that can occur at the University. If there is the slightest doubt as to how to proceed, do not hesitate to call for assistance.

For specific spill clean-up information, contact your supervisor, instructor, or the Department of Environmental Health and Safety.

11.2 Low Hazard Material Spills - Minor spills do not necessarily need the assistance of DEHS. Laboratory workers who have had the proper training and possess the appropriate equipment can safely and effectively handle the majority of chemical spills that occur in the laboratory. In addition, spills involving multiple chemicals may pose various hazards. Always contact DEHS if multiple chemicals are involved in a spill. Except for the chemical classes in Table I, labs can handle spills involving one liter or less of liquid and one pound or less of a solid. If the spill is large, contact DEHS to assist with the cleanup. The following procedures are specific guidelines for using the recommended spill cleanup materials. Contact DEHS with any questions or concerns about proper spill clean-up practices.

In the event of a chemical spill, first decide if you are trained, knowledgeable and equipped to handle the incident. Immediately evacuate the lab and notify UDPD if there is a possibility of an acute respiratory hazard present or if you need assistance to clean up the spill. Never proceed to clean up a spill if you do not know the hazards associated with the chemical or if you are unsure of how to clean up the spill. If anyone is injured or contaminated, immediately notify UDPD and begin decontamination measures or first aid, if trained.

Don the personal protective equipment from the spill kit; splash goggles and nitrile/Silver Shield combination gloves. Always ask a fellow researcher for assistance. They should also don splash goggles and nitrile/Silver Shield combination gloves. Make sure that all forms of local exhaust, i.e. fume hoods, are operating. It is normally not advisable to open the windows. If broken glass is involved, do not pick it up with your gloved hands. Use the scoop or tongs to place it in the bag, then place the bag in a strong cardboard box or plastic container. Follow the procedures provided below based on the class and type of chemical.

All tools used in the cleanup need to be decontaminated (plastic scoop, tongs, etc.). Remove all gross contamination with a wet paper towel. Dispose of the contaminated paper towels as waste. Rinse the tools off with copious amounts of water. Dispose of the gloves as waste. Dry the tools off and place back into the spill kit along with the splash goggles. Contact DEHS to obtain replacement gloves and spill clean-up material.

11.3 Liquid Spills other than flammable liquids - Spread the chemical spill powder over the spill starting with the edges first. This will help to confine the spill to a smaller area. Spread enough powder over the spill to completely cover the liquid. There should be no free liquid. Use plastic scoop to ensure that the liquid was completely absorbed by the powder. Pick up the powder with scoop and place in the polyethylene bag. Wipe the area down with a wet paper towel. Dispose of paper towel with the waste generated from the spill cleanup. Seal bag with tape and attach a completed orange hazardous waste sticker on the bag.

11.4 Flammable Liquid Spills - Control all sources of ignition. Lay the chemical spill pads over the spill. These pads are design to suppress the vapors emitted by a volatile liquid. Allow pads to completely soak up liquid. Pick up pads with tongs or other device that minimizes direct contact with a gloved hand. Place in the polyethylene bag. Wipe the area down with a wet paper towel. Dispose of paper towel with the waste

generated from the spill cleanup. Seal bag with tape and attach a completed orange hazardous waste sticker on the bag.

11.5 Solid Spills - Use the plastic scoop to place the spilled material into the polyethylene bag. Care should be taken so as not to create dust or cause the contaminated powder to become airborne. After the bulk of the material is cleaned up, wet a spill pad and wipe the area down. Place the pads into the polyethylene bag. Wipe the area down with a wet paper towel. Dispose of paper towel with the waste generated from the spill cleanup. Seal bag with tape and attach a completed orange hazardous waste sticker on the bag.

Note: Precautions must be taken to minimize exposure to the spilled chemical. Be careful not to step in the spilled material and track it around. Contact DEHS and UDPD if an exposure to a chemical occurs.

11.6 Recommended chemical spill kit contents:

- Universal Chemical Absorbent Pads - high capacity, chemically inert, absorbs aggressive chemicals as well as non-aggressive compounds such as water. Good for all chemicals; acids, bases, flammable liquids, formaldehyde
- Universal Chemical Absorbent Powder - high capacity, chemically inert. Absorbs aggressive chemicals as well as non-aggressive compounds such as water. Good for all chemicals; acids, bases, flammable liquids, formaldehyde
- Polyethylene Bags - strong construction, leak proof, at least 7-gallon capacity, 4 mm in thickness.
- Anti-Static Polypropylene Plastic Scoop
- Nitrile/Silver Shield Combination Gloves
- .011 thick Nitrile Gloves under Silver Shield Gloves, at least two pairs
- Two Pairs Indirect Venting Chemical Splash Goggles
- DEHS Orange Chemical Waste Labels

Chapter 12: Injury, Illness, Personal Contamination, Minor First Aid

12.1 Serious Injures, Serious Illnesses or Hazardous Materials Exposures

For serious injuries, serious illnesses or chemical exposures, call **911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses** for transportation to an appropriate hospital. Unless otherwise specified by Environmental Health & Safety, all injuries, regardless of severity, involving chemical or other hazardous materials will be reported by dialing 911. The University Police will contact EHS staff. EHS staff, depending on the hazardous material involved and the severity will make the decision to send the victim to a facility other than the nearest approved Emergency Room.

Tell emergency and medical personnel:

- Your name, location and nature of the emergency
- Name of the chemical involved
- The amount involved
- Area of the body effected
- Symptoms

If you have any questions regarding injury and illness procedures, contact your supervisor, instructor, or the Department of Environmental Health and Safety.

Do not move a seriously injured person unless they are in further danger.

Follow the appropriate steps outlined in section 12.3, Personal Contamination.

12.2 Non-life threatening injuries, illness or non-serious issues:

Undergraduate Students should report to the Student Health Service, Laurel Hall (ext. 2226), if medical attention is required. Students should be accompanied by a friend, teaching assistant, or instructor.

Employees and graduate students, after consultation with Environmental Health & Safety should be sent to Nurse Managed Health Center. Graduate Students may also utilize Student Health Services after consultation with Environmental Health and Safety

When in doubt as to what should be done, telephone the University Police for assistance.

12.3 Personal Contamination

12.3.1 Chemicals Spilled Over a Large Area of the Body

- The “buddy” or lab partner should assist the person to a safety shower and contact **911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses** immediately.
- Remove potentially contaminated clothing, jewelry, and other items while in the safety shower.
- Flush the affected area in the safety shower with water for at least **15 minutes** unless otherwise specified.
- Wash off chemical with water but do not use neutralizing chemicals, unguents, creams, lotions, or salves, unless indicated and approved by Environmental Health and Safety
- The “buddy” or lab partner should retrieve the SDS and provide to EMS
- Seek medical attention promptly.

12.3.2 Localized spills

- Flush under a faucet if convenient.
- Call Public Safety at 911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses or DEHS (normal working hours) at 831-8475.
- Notify your supervisor, teaching assistant or principal investigator.

12.3.3 Chemicals in the Eyes

- The "buddy" or lab partner should assist the person to eyewash and contact **911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses** immediately.
- Flush eyes with water for at least **15 minutes** using an eyewash station unless otherwise instructed. Hold your eyelids open when using the eyewash. Remove contact lenses if not already removed by the water.
- The "buddy" or lab partner should retrieve the SDS and provide to EMS.
- Seek medical attention promptly.
- Notify your supervisor, teaching assistant or principal investigator.

12.3.4 Inhalation of Vapors, Mists, Fumes or Smoke

- The "buddy" or lab partner should assist the person to fresh air and contact **911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses** immediately.
- In the event of an inhalation exposure, remove victim to fresh air only if it is safe to do so. Do not enter the area if a life threatening condition still exists such as:
  - Oxygen depletion
  - Explosive vapors
  - Cyanide gas, hydrogen sulfide, nitrogen oxides, carbon monoxide or other toxic gases, mists, vapors or fumes
- Utilize the safety shower or eyewash and flush effect areas as need for 15 minutes if applicable
- If trained and necessary, provide Rescue Breathing or CPR
- The "buddy" or lab partner should retrieve the SDS and provide to EMS.
- Seek medical attention promptly.
- Notify your supervisor, teaching assistant or principal investigator.

12.3.5 Burning Chemicals on Clothing

- Extinguish burning clothing by using the drop-and-roll technique or by dousing with cold water or use an emergency shower.
- Remove contaminated clothing; however, avoid further damage to the burned area. Do not remove any clothing or material that is stuck to the victim
- The "buddy" or lab partner should assist as necessary and when safe and contact **911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses** immediately.
- Cover injured person to prevent shock.
- Get medical attention promptly.

12.3.6 Ingestion of Hazardous Chemicals

- Identify the chemical ingested and obtain the SDS
- The "buddy" or lab partner should contact **911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses** immediately.
- Call the Poison Information Center (1-800-722-7112).
- Provide the ambulance crew and physician with the Safety Data Sheet, the chemical name and any other relevant information. If possible, send the container or the label with the victim.

12.4 Minor First Aid

Departments should obtain a first aid kit for treatment of minor first aid cases (cuts, scratches, minor burns). First aid kits may be purchased from the Department of Environmental Health and Safety.

- First aid kits must be readily accessible. If the kit is not visible, the area where it is stored must be clearly marked.

- First aid kits must be fully stocked at all times.
- Do not dispense or administer any medications, including aspirin.
- Do not put any ointments or creams on wounds or burns. Use ice, cold pack or cold water.
- The SDS contains special first aid information.
- After giving first aid, direct or transport the victim to a medical facility for evaluation.

Non-emergency undergraduate student first aid cases are treated at the Student Health Services (831-2226).

Non-emergency employee including graduate and postdoctoral student first aid cases, are treated at the Nurse Managed Health Center (831-3195) after consultation with EHS.

Visitors, regardless of the extent of the injury should be transport to the nearest hospital by ambulance.

Seriously injured individuals (employees or students) should be transported to the nearest appropriate hospital by ambulance

For specific first aid information, contact your supervisor, instructor, or the Department of Environmental Health and Safety.

Chapter 13: Transporting Hazardous Materials

13.1 This procedure states the requirements for the packaging and transport of chemicals in a manner that will minimize the threat of release via container breakage during transport. General requirements include:

- Hazardous materials cannot be transported in privately owned or personal vehicles.
- All transport must be conducted by a University employee in a University vehicle within the State of Delaware.
- Only small quantities of hazardous materials can only be transported for the purposes of conducting research, field investigations, educational purposes and other official university business.
- Please refer to University of Delaware Guidelines for Transporting Hazardous Materials for additional information.
- No extremely hazardous materials shall be transported in university vehicles (i.e. explosives, shock sensitive, temperature sensitive, highly toxic).

13.2 All chemicals must be transported and stored in approved secondary containers to prevent breakage.

Approved secondary container means a commercially available bottle carrier made of rubber, metal or plastic with carrying handle(s) and which is of large enough volume to hold the contents of the chemical container and not reactive with the chemical being transported.

If transporting chemicals of different hazard class, segregation must be accomplished by using multiple secondary containers. Lids or covers are desirable; but not necessary. Rubber or plastic should be used for acids/alkalis; while metal, rubber or plastic may be used for organic solvents.

13.3 Transporting hazardous chemicals in motor vehicles can be extremely dangerous because of conditions that could result from traffic accidents, equipment failure, shifting loads, or lack of proper ventilation.

13.4 Transportation of compressed gases and liquids under pressure must first be approved by the Department of Environmental Health and Safety. Contact the Chemical Hygiene Officer.

13.5 Field operations

Concentrated quantities of chemicals always pose a higher degree of risk than dilute solutions. Whenever possible, all working solutions should be diluted prior to taking them into the field. The smallest quantity of chemicals should be taken into the field. This procedure will allow a maximum of 5 gallons of chemicals transported at one time in a university vehicle, if you must transport more than the required amount you must obtain prior approval from the Department of Environmental Health and Safety. For the purpose of this transport procedure, the Department of Environmental Health and Safety will require the purchase of chemicals in these break resistant containers. Break resistant shall mean a container made of metal, plastic, plastic-coated glass, or metal overpacks of glass.

Small amounts of hazardous materials transported in the field should be in a cooler, which will act as the approved secondary container. Inside this cooler should be enough absorbent or cushioning to prevent shifting during transport. For larger quantities of chemicals, transport should be in an approved secondary container, which also requires sufficient amounts of absorbent or cushion to prevent shifting during transport.

Chapter 14: Laboratory and Laboratory Equipment Decontamination Close Out and Decommissioning Procedures

14.1 Overview

Research scientists and science instructors at the University of Delaware are responsible for the safe operation of their laboratories. If you are relocating, renovating or vacating your laboratory, you are also responsible for leaving your laboratory in a state suitable for re-occupancy or renovation. Department of Environmental Health and Safety must be notified of all moves in laboratory spaces. A Laboratory Decontamination/Decommissioning Procedures and Checklist should be completed and forwarded to DEHS at least 45 days prior to exiting a laboratory due to renovation, moving to another laboratory, or separation from the University. If there is more than one laboratory involved in this laboratory exit process, forms should be submitted at least 90 days in advance of the exit.

Increased public concern over environmental issues has led to a major expansion of federal and state environmental laws in recent years. Aggressive enforcement of these laws by regulatory agencies has also increased. This enforcement follows “cradle to grave” accountability for hazardous chemicals, biohazards, infectious waste and radioactive material. To this end, Researchers are required to properly “decommission” areas where these materials are used or stored. Chemical, biological and radioactive materials are used and stored within designated areas for teaching and research purposes throughout the University of Delaware. These designated areas can become contaminated with residues over a period of time and use. Contamination typically results from spills, splashes, failed containers, uncontrolled chemical reactions, storage of incompatible chemicals next to each other and simply using the areas for their intended purposes. To comply with this requirement, the Department of Environmental Health and Safety has prepared checklists for Principal Investigators (PI), Departmental Staff or F, P & C Project Managers who may be vacating or responsible for a lab where these materials are used, or who may be planning renovations to such areas.

14.2 Procedures

All decontamination and decommissioning work shall be completed in accordance with all University Policy and Procedures. Chemical, biological and radioactive waste will be disposed through the Department of Environmental Health and Safety. Contractors will possess appropriate experience and meet the forty hour training requirements outline in 40 CFR 1910.120, Hazardous Waste Operations and Emergency Response training, as well as the required eight hour annual refresher training. All personnel, including contractors and laboratory works will wear the necessary personal protection equipment, not limited to safety glasses, lab coats or chemical protective clothing and appropriate chemical protective gloves while completing laboratory decontamination.

Laboratories for the purpose of this procedure are defined as entire rooms or as designated areas within rooms such as fume hoods and associated ductwork, photographic darkrooms, glove-boxes, sinks, biosafety cabinets, storage cabinets and shelves, closets, refrigerators and freezers and lab equipment where chemical, biological and radiological materials are used and stored.

14.2.1 Laboratory Decommissioning

In General, the following steps must be followed if a laboratory needs to be decommissioned for renovation, transfer to another principle investigator or decontaminated for any reason.

- The Department requesting the cleaning must contact the Department of Environmental Health and Safety (DEHS) at 831-8475 to evaluate the laboratory. This can be completed by submitting a Laboratory Decontamination/Decommissioning Procedures and Checklist;
- DEHS will review the historical use of chemical, biological and radioactive materials within the laboratory;
- DEHS will inspect the laboratory;

- DEHS will determine whether the area needs to be decontaminated by a qualified contractor or simply cleaned by custodial services. Custodial Service personnel are not trained or equipped to clean areas that are contaminated with chemical, biological and radiological residues; therefore, they cannot clean contaminated areas;
- DEHS will coordinate with a qualified contractor to schedule and perform the cleaning, if needed;
- DEHS will confirm that the contractor adequately cleaned the laboratory and will provide written confirmation to the requesting Department contact;
- Laboratories may not be renovated or reoccupied until the DEHS has confirmed that the area is adequately cleaned; and
- All costs associated with the cleaning of a laboratory will be charged back to the requesting Department if it is necessary to hire a qualified contractor.

14.2.2 Equipment Decontamination

It is important that researchers properly decontaminate their laboratory equipment from hazardous materials (flammable, corrosive, reactive, toxic, radioactive, and biological) prior to allowing sending the equipment off for repair or service. It is important to check every piece of laboratory equipment that once held hazardous samples to insure that any remaining samples or standards have been removed. If any laboratory equipment has appreciable chemical, radiological or biological contamination on the outside surface, which would present a hazard to anyone handling it, the equipment, needs to be properly decontaminated by the researchers. Instruments, equipment or work areas must be certified as being free from potentially hazardous contamination prior to maintenance or repair by untrained, unprotected personnel or appropriate safeguards must be established and communicated to those involved with the operation. The means to protect personnel must be included on a decontamination certification form when decontamination is not reasonably possible. A decontamination form a must be included with all surplus containers and equipment whenever hazardous material contamination was a factor.

In general, the following must occur prior to service or repair:

- The item/area to be serviced must be cleaned of all visible residue and encrusted material whenever reasonably possible. The decontamination must be completed by a train laboratory worker. See section 14.3 for a list of recommended decontamination solutions.
- Where there is the potential for hazardous non-visible chemical contamination, it may be necessary to use pH test strips, peroxide test strips or other indicating mechanism to verify that no contamination is present.
- For items used with radioactive materials, no radioactivity must be detected with survey equipment or swipe tests. Contact the Radiation Safety Officer. See section 14.3 for a list of recommended decontamination solutions.
- Where infectious materials were used, disinfect all surfaces with an effective disinfectant. See section 14.3 for a list of recommended decontamination solutions.
- Remove or deface all hazard warning labels or signs once hazards have been successfully removed by decontamination. Remove gross contamination and maintain appropriate hazard warnings when decontamination is not reasonably possible. The word “residue” may be added to indicate that only residue remains.
- A Decontamination Statement (Form 205a - copy attached) must be completed and attached to the item/area. If service is requested and initiated on an item/area and it appears that decontamination or other measures are not adequate to protect involved persons, the requestor will be contacted to rectify the remaining hazard(s). Costs associated with decontamination or other protective action will be the responsibility of the requestor.
- Adequate protection may be provided by decontaminating only the part of an item needing service or by packaging items so that persons handling the equipment will not come into contact with contamination.

- Items that have been in contact with hazardous chemicals, radioactive substances or infectious materials and are intended for sale as surplus property must be decontaminated and a Decontamination Statement form must be attached to the item(s). Items that cannot be decontaminated must be disposed of through the Chemical Waste Program
- Exception: Items of high surplus value that cannot be decontaminated may be sold under certain conditions. An example of such an item would be the sale of laboratory equipment to another laboratory.

14.2.3 Certain equipment and systems require other special precautions prior to sending out for service and repair. The following must be accounted for. This is not an exclusive list.

- If you intend to discard your refrigerator or freezer, the Freon must be properly recycled from the coils by Facilities (x1141) personnel prior to the unit being disposed. Remove all contents, to include mercury thermometers, chemical reagents, and radioactive isotopes. Decontaminate the refrigerator if it held radioactive isotopes, infectious agents or toxic chemicals. Contact the Radiation Safety Officer for guidance for surveying refrigerators which stored radioactive isotopes. The refrigerator must be completely empty prior to being handled by Campus Movers or Facilities. Defrost the refrigerator/freezer if there is a buildup of ice around the freezer compartment.
- Ovens - Remove all mercury thermometers or containers holding samples or liquids. For outdated ovens, check the lining for the presence of asbestos (inhalation hazard). If the oven lining appears to be constructed of asbestos, contact Environmental Health & Safety Asbestos Specialist (x8070) for assistance.
- Incubators - Remove any remaining samples and drain the water from the jacket. Remove mercury thermometers.
- Centrifuges - Inspect for centrifuge tubes holding water or samples to insure they have been removed from the rotor system.
- Water baths - Drain the water from the unit and remove any remaining samples or mercury thermometers.
- Balances or scales - Wipe clean to remove any remaining chemical contamination inside the balance or on the scale.
- Chemical storage cabinets such as flammable or corrosive cabinets must have all the chemical containers removed prior to moving the cabinet. Decontaminate the chemical storage cabinet of any remaining spills or residues.
- Vacuum pumps contain vacuum pump oil. Vacuum oil, which is grossly contaminated with toxic chemicals or other hazardous materials, should be removed prior to repair. Discard all spent vacuum pump oil through Environmental Health & Safety as chemical waste.
- Heating blocks need to have samples and mercury thermometers removed. If necessary, decontaminate the heating block. Set all mercury thermometers aside for management as chemical waste. Do not use mercury thermometers with heating blocks, as it is an unnecessary inhalation hazard (use alcohol thermometer).
- Mercury containing sphygmomanometers & blood pressure cuffs may contain metallic mercury, which is an inhalation hazard when spilled. Seal the units inside clear plastic bags and set them aside for management through the chemical waste program.
- Mercury barometers contain metallic mercury which is an inhalation hazard when spilled. Completely drain the metallic mercury from the barometer into sealed plastic bottles. Set aside empty barometer and plastic bottles holding metallic mercury for management through the chemical waste program.
- Photo-processing equipment usually has three storage tanks holding caustic developer, acidic photographic fixer and rinse water. Drain the storage tanks (also supply and drain hoses). Discard the photo-processing chemicals through Environmental Health & Safety as chemical waste.
- Silver recovery cartridges, which are connected to photo-processing units, contain slightly acidic photographic fixer and silver salts. Have the silver recovery cartridge recycled through your supplier.
- Gas chromatographs (GC) which have electron capture detectors contain a radioactive source. Contact the Radiation Safety Officer.

- High Performance Liquid Chromatography (HPLC) may have columns that contain organic solvents. Drain the columns and waste lines prior to shipping the HPLC. Dispose the organic solvent wastes through Environmental Health & Safety.
- Tissue dehydrating units - Remove or drain all the ethanol and xylene from the storage tanks. Dispose the solvents through Environmental Health & Safety as chemical waste. Paraffin wax and tissue samples may also need to be removed from the tissue dehydrating unit.
- Colorimeters may contain cuvettes holding liquids (remove them).
- Spectrophotometers may have automatic sample feeders holding sample containers or standards (remove them).
- Desiccators may contain drying agents (Drierite, NaOH, phosphorus pentoxide). Discard the spent drying agents through Environmental Health & Safety as chemical waste.
- Transformers or high voltage regulators may contain oil. Outdated transformers may hold toxic PCB contaminated oil. Contact Environmental Health & Safety (x8475) whenever oil containing transformers or high voltage regulators are discovered. Do not ship oil containing transformers or high voltage regulators without approval from Environmental Health & Safety.
- Water purification systems - Remove all the free standing water from the water purification cartridges.
- pH electrodes & other chemical electrode systems may contain water and possibly other hazardous chemicals. Set aside electrodes containing liquids for management through the chemical waste program.

14.3 Recommended Decontamination Solutions

- For biological and infectious material contamination use a fresh 10% bleach solution in water. Other commercially available disinfectants may be used provided the manufacturer recommends it use for the biological material of concern.
- Use clean water to decontaminate equipment contaminated with low-chain compounds, salts, organic acids and other polar compounds. Follow up with a secondary decontamination using a dilute basic solution of a detergent or soap.
- Use a dilute basic solution of a detergent or soap to decontaminate equipment and areas contaminated with acidic compounds, phenol, thiols and nitro and sulfonic compounds.
- Use an organic solvent such as ethanol or acetone to decontaminate equipment and areas contaminated with non-polar compounds such as organic chemicals. Follow up with a secondary decontamination using a dilute basic solution of a detergent or soap.
- All applicable personal protective equipment must be worn during the decontamination and servicing of the equipment. A job hazard analysis should be completed to help determine the type of PPE required. See Chapter 16 for information on personal protection equipment.
- All waste materials, decontamination solutions and other discard products or materials must be handled through the appropriate waste disposal program.
- Engineering controls, such as fume hoods and elephant trunks should be used when decontaminating and servicing all laboratory equipment.

Chapter 15: Special Precautions for Working with Compressed Gasses

15.1 Policy for Safe Use and Storage of Compressed Gas Cylinders - Policy #7-24 (http://www.udel.edu/ExecVP/polprod/7-24.html).

15.2 Compressed Gases: Special systems are needed for handling materials under pressure. Toxic and corrosive gases present special problems in designing engineering controls. The pressure hazard compounds other hazards which may be associated with a material.

15.3 Improper use, handling, and storage of compressed air, gases, or related equipment can result in fatal consequences. University employees should be properly trained in the safe use and handling of such substances and equipment. Visual inspections of equipment, including portable cylinders are needed to ensure equipment is in safe operating condition prior to each use. Departments shall not possess cylinders without first obtaining the proper equipment to use, handle, or store them accordingly. No personal shall use compressed gases in any manner that is inconsistent with the Chemical Hygiene Plan and the requirements established by the University Chemical Hygiene Committee.

15.4 Ordering and Storage

15.4.1 When work with toxic, corrosive, or reactive gases is planned, the Department Chemical Hygiene Officer or the Department of Environmental Health and Safety should be contacted for information concerning specific handling requirements for the gas involved. Generally, these gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.

15.4.2 Know the contents of the cylinder and be familiar with the chemical and physical properties of that gas before you use it. Never use a cylinder which cannot be positively identified; cylinder color coding varies among gas vendors and is an unreliable identifier of cylinder contents. Immediately return unidentifiable cylinders to the vendor. Some sources of gas hazard information include the Safety Data Sheet, container label and tags, manufacturers' literature and Compressed Gas Association publications.

15.4.3 Laboratory personnel are responsible for prior approval procedures applying to toxic, corrosive and reactive gases used in your laboratory. Have written emergency procedures, equipment, and know how to contact emergency response personnel trained to stop leaks from the cylinder valve, pressure relief devices, pressurized equipment, and from cylinder valves stuck open.

15.4.4 Order the smallest volume cylinder needed to minimize the gas volume in the laboratory. However, lecture bottles and other small gas cylinders are also high pressure devices with high potential energy. If a catastrophic gas release occurs, the event will last not as long as a larger gas cylinder but it will happen nevertheless. You may order a cylinder half-filled or filled to the lowest pressure you actually need.

15.4.5 Store cylinders which are not necessary for current lab operations in a ventilated, dry area away from heat or ignition sources, out of direct sunlight and at temperatures less than 50°C. Laboratory gas storage is forbidden. Gas rooms should be protected by automatic sprinklers. Ventilation in the rooms should be negative with respect to the hallways and shall be separated from remainder of building in accordance with IBC based on occupancy classification.

15.4.6 Delaware state law requires that cylinders of oxidizing gas have a 20 ft. minimum separation from cylinders of flammable gas, and that they are secured at all times to prevent falling. Alternately, separate oxidizing and reducing gases by a one hour-rated fire wall at least 5 ft high. Do not store or leave cylinders unattended in hallways, corridors, stairways, or other areas of access or egress.

15.4.7 Hazard Identification signs shall be placed at all entrances to locations where compressed gases are produced, stored, used, or handled in accordance with NFPA 704

15.5 Quantity Limitations – All classes of gases must be below these quantity limitations per control area (IBC 2012 – 307.1(2))

Material	Storage	Use-closed systems
Flammable	1,000 [d, e]	1,000 [d, e]
Corrosive	Gaseous 810[f] Liquefied (150) [h]	Gaseous 810 [f] Liquefied (150) [h]
Highly Toxic	Gaseous 20[g] Liquefied (4) [g, h]	Gaseous 20 [g] Liquefied (4) [g, h]
Toxic	Gaseous 810 [f] Liquefied (150) [f, h]	Gaseous 810 [f] Liquefied (150) [f, h]
Pyrophoric	50 [e, g]	10 [g]

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied accumulatively.
e. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, day boxes, gas cabinets or exhausted enclosures or in listed safety cans in accordance with Section 5003.9.10 of the International Fire Code. Where Note d also applies, the increase for both notes shall be applied accumulatively.
f. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets or exhausted enclosures as specified in the International Fire Code. Where Note e also applies, the increase for both notes shall be applied accumulatively.
g. Allowed only when stored in approved exhausted gas cabinets or exhausted enclosures as specified in the International Fire Code.
h. Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

15.5.1 Research Laboratories

15.5.1.a Lecture bottle size cylinders of the following gases located in a laboratory shall be kept in a continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure

- All gases that have NFPA health hazard ratings of 3 or 4
- All gases that have a NFPA health hazard rating of 2 without physiological warning properties
- Pyrophoric gases

15.5.1.b Pyrophoric Gas – 50 ft^3 in storage, 10 ft^3 in use (total volume of gas) per control area, entire building must have an automatic sprinkler system

Silane must meet requirements of ANSI/CGA G-13

15.5.1.c Corrosive Gas – 810 ft^3 (total volume of gas) per control area

15.5.1.d Flammable Gas (based on internal cylinder volume at 70°F and 1atm) 1000 ft^3 per control area

1. Laboratories less than 500 ft^2 – 6.0 ft^3
2. Laboratories greater than 500 ft^2 – 0.012 ft^3 per ft^2 of laboratory work area

15.5.1.d Liquefied Flammable Gas (based on internal cylinder volume at 70°F and 1atm) 150 ft^3 per control area

1. Laboratories less than 500 ft^2 – 1.2 ft^3
2. Laboratories greater than 500 ft^2 – 0.0018 ft^3 per ft^2 of laboratory work area

15.5.1.e Highly Toxic Gas (Health Hazard Rating of 3 or 4 and cylinders of gases having a health hazard rating of 2 with no physiological warning properties) (based on internal cylinder volume at 70°F and 1atm) 20 ft^3 per control area

1. Laboratories less than 500 ft^2 – 0.3 ft^3
2. Laboratories greater than 500 ft^2 – 0.0006 ft^3 per ft^2 of laboratory work area or 20 ft^3 of total gas volume or whichever is less

15.5.1.f Oxidizing Gas (based on internal cylinder volume at 70°F and 1atm)1500 ft^3 per control area

1. Laboratories less than 500 ft^2 – 6.0 ft^3
2. Laboratories greater than 500 ft^2 – 0.0012 ft^3 per ft^2 laboratory work area

15.5.2 Teaching and Instructional Laboratories

1. Pyrophoric Gas – 5 ft3 gaseous, 0.4 ft3 liquefied (total volume of gas)
2. Highly Toxic Gas (Health Hazard Rating of 3 of 4) – 2 ft^3 gaseous, 0.4 ft^3 liquefied (total volume of gas
3. Corrosive Gas – 81 ft^3 (total volume of gas)
4. Flammable Gas – 100 ft3
5. Liquefied Flammable Gas (based on internal cylinder volume at 70°F and 1atm) – 15 lbs.
6. Oxidizing Gas (based on internal cylinder volume at 70°F and 1atm) – 150 ft^3

15.5.3 Separation of Gases by Hazard type

Incompatible gas cylinders, containers, and tanks must be separated in accordance with the following table.

15.5.3.a The distance may be reduced without limit where the compressed gas cylinders, containers, and tanks are separated by a barrier of non-combustible construction that has a fire resistance rating of at least 0.5 hour and interrupts the line of sight between the containers.

15.5.3.b The 20 ft (6.1 m) distance may be reduced to 5 ft. (1.5 m) when one of the gases is in a gas cabinet or without limit if both are in gas cabinets.

Separation of Gas Cylinders, Containers, and Tanks by Hazard Class (NFPA 55 2013 7.1.11.2)

Gas Category	Other Gas	Unstable Reactive Class 2, 3, or 4		Corrosive		Oxidizing		Flammable		Pyrophoric		Toxic or Highly Toxic	
		Ft	M	Ft	M	Ft	M	Ft	M	Ft	M	Ft	M
Toxic or highly toxic	NR	20	6.1	20	6.1	20	6.1	20	6.1	20	6.1	-	-
Pyrophoric	NR	20	6.1	20	6.1	20	6.1	20	6.1	-	-	20	6.1
Flammable	NR	20	6.1	20	6.1	20	6.1	-	-	20	6.1	20	6.1
Oxidizing	NR	20	6.1	20	6.1	-	-	20	6.1	20	6.1	20	6.1
Corrosive	NR	20	6.1	-	-	20	6.1	20	6.1	20	6.1	20	6.1
Unstable reactive class 2, 3, 4	NR	-	-	20	6.1	20	6.1	20	6.1	20	6.1	20	6.1

15.6 Transporting Gas Cylinders

15.6.1 Consider cylinders of compressed gases as high potential energy sources and therefore as potential explosives. Extensive damage and injury may occur if the cylinder valve is accidentally sheared off causing a "jet propelled" cylinder. When storing or moving a cylinder, screw on the safety cap securely to protect the valve, and transport only on a wheeled cart specifically designed for gas cylinders. Never roll, slide or lift a cylinder. Use a gas cylinder cart to move a cylinder from storage to the point of use. Do not substitute an ordinary dolly for a cylinder cart which is designed to cradle the cylinder and to restrain it with a chain. Be certain that your cylinder cart can accommodate a small size gas cylinder; old style cylinder carts may require the addition of an extra cradle and chain.

15.6.2 The average weight of a 200 ft^3 standard gas cylinder is 175 pounds. Crushing injuries occur when hands are trapped between cylinders or when a foot or leg is crushed by a toppled cylinder. Hand injuries are caused by excessive wrench force in regulator or gas fitting installation or when a second wrench is not used to stabilize the fitting when tightening.

15.6.3 The interior of an elevator is a confined space demanding special precautions when transporting compressed gases. People and compressed gas cylinders are not allowed on an elevator together. Sudden release of gas (e.g. - valve breakage, rupture disc blow-out, etc.) could cause death by asphyxiation. Therefore, when transporting a cylinder in an elevator, send it up unescorted and walk up the stairs to meet it at the destination. Those encountering a cylinder on the elevator must not enter until it is off-loaded at the destination. The engraved plastic sign on each cylinder transport dolly with "DO NOT ENTER ELEVATOR WHEN COMPRESSED GAS IS IN TRANSIT" reminds us to follow this safe transport procedure.

15.6.4 Cylinders shall not be transported in a motor vehicle by University personnel on a routine basis. This transport should be handled by a licensed outside vendor.

15.6.5 Welding and cutting carts shall only be transported in University Vehicles from a storage area to a job site or building. These systems shall not be stored in vehicles.

15.6.6 If transport by University personnel is absolutely necessary, contact the Department of Environmental Health and Safety at Extension 8475 for approval prior to transport.

15.7 Using Gases in the Laboratory

15.7.1 Firmly secure compressed gas cylinders at all times by a bench or wall-mounted cylinder clamp or chain. Have the cylinder clamp already mounted before moving the cylinder into the lab. Provide individual restraints for each cylinder to avoid the "domino effect" caused by piggy-backed or ganged cylinders.

15.7.2 Corrosive gases and regulators used in corrosive gas service must be returned to the vendor after 6 months use or replaced. Other gases are returned to the vendor on a schedule established by the department chemical hygiene officer.

15.7.3 Locate gas cylinders within the lab so that the cylinder valve is accessible at all times. When storing or moving a cylinder within the lab, screw the cap in place to protect the valve. Never expose cylinders to temperatures higher than 50°C, where temperature expansion of the gas will cause complete venting of the cylinder contents through the pressure relief valve.

15.7.4 Always wear industrial safety glasses with side shields when connecting a gas regulator and when performing any operation with compressed gases. Addition personal protective equipment may be required depending on the circumstances

15.7.5 Use cylinders only with matching Compressed Gas Association (CGA) connections on the cylinder valve and the regulator. Never install cylinder adapters on a regulator. Hand tighten the gas fitting, then snug with a

wrench; do not use excessive force. Never use a wrench extension lever - it will distort the machine threads. A proper connection will go together smoothly.

15.7.6 The valve on an unregulated cylinder should never be "cracked" open to blow out dust. It may freeze the valve in the open position and in the case of a flammable gas, can cause static discharge ignition. It is safe practice to open the main valve only 1/2 to 1 turn; opening the valve all the way could produce excessive flow. Never tamper with any part of a valve such as the safety relief or packing nuts.

15.7.7 No materials shall be released into the environment except when in compliance with state, local and federal agencies.

15.7.8 Pressure Reducing Regulator

15.7.8.aSlow gas leaks are avoided by inspecting the regulator and the cylinder valve CGA fitting for dent or scratch flaws across the CGA fitting surface before the regulator is attached; use a finger to feel for these flaws. Neither over tightening nor Teflon thread tape will stop a leak caused by a fitting flaw. Return leakers to the vendor for overhaul.

15.7.8.b Once the pressure reducing regulator is attached, the cylinder valve is opened slowly with the operator facing away in case the regulator diaphragm ruptures or the pressure gauge fails. Other sudden component failures may occur with fittings and low pressure components. This is usually due to improper installation of parts such as compression ferrules in tube fittings or neglecting to install uninterruptible pressure relief devices to protect components with limited pressure ratings.

15.7.8.c Close the main cylinder valve and depressurize the regulator when the equipment is unattended or not operating. Never leave partly assembled apparatus attached to gas cylinders. After bleeding off the regulator pressure, back off the pressure adjusting knob spring tension. This avoids rupturing the regulator diaphragm when the main cylinder valve is again opened. Return the regulator to the vendor for an overhaul if the gauges do not zero. Remove the regulator and cap the cylinder if unused or at low pressure. Also replace the valve cap before removing the cylinder from the laboratory.

15.7.8.d A cylinder should never be emptied to a pressure lower than 2 atmospheres (30 psi) leave a slight pressure to keep contaminants out and notify the vendor if draw-down occurs. Empty cylinders should not be refilled by anyone except the gas supplier. Empty and partially empty cylinders are chained at the loading dock empty cylinder area for pickup by the gas vendor. Be sure to deposit the yellow data tag to assure returned-cylinder credit on your research account.

15.7.8.e Regulator "creep" happens when the regulator poppet valve seat is worn, obstructed by contamination or eroded by corrosive gas service. This causes the pressure to increase past the set point. Diaphragm leaks occur from material fatigue of the diaphragm or the spring. Gas will escape from the regulator bonnet vent or a pressure drop will show on the outlet pressure gauge if the diaphragm leaks. Return the regulator to the vendor for an overhaul if either symptom occurs.

15.7.8.f Regarding gaskets and thread tape, always replace the gasket washer on flat-faced CGA fittings. Do not use Teflon thread tape on any CGA cylinder valve fitting (parallel machine threads). It interferes with the fitting, causes leaks and will clog small orifices and sintered filters. Use thread tape only on tapered pipe threads.

15.7.8.gA preventative maintenance program is required for all gas regulators. Corrosive gas service regulators are removed from service at semi-annual intervals (6 months) for overhaul. Toxic gas regulators are to be sent out for annual overhaul. Anytime a regulator shows gauge pressure discrepancies, bubbles upon leak testing or other abnormal characteristics, it will be removed from service and factory overhauled. Leak detection with gas detection equipment and with liquid soap solution are proven ways to detect imminent regulator failure. The user is expected to report detected leaks and to remove suspect regulators and fittings from service when leaks are found.

15.7.8.h Establish a record of when a new or rebuilt regulator is placed in service by removing the gauge bezel; stamp the date on the gauge face plate and replace the bezel. It is the user's responsibility to record the inspection dates and to return regulators for factory reconditioning.

15.7.8.i Leak test all connections to a cylinder with a polymer-soap solution. CAUTION! Any gas, regardless of its health hazard may cause asphyxiation by displacing oxygen.

15.7.8.j Pressurized systems are subject to OSHA lockout regulations for energy sources. This law requires that compressed gas or fluid-powered equipment have lockout valves to protect repair personnel. Some lockout valves are designed to bleed off the pressure in addition to locking the valve to protect personnel working on air or fluid-powered equipment. Injury caused by high pressure gas injected through the skin in to the body is prevented by not directing any open gas flow at yourself or other lab workers.

15.7.8.k Equip cylinder discharge lines with approved check valves to prevent inadvertent contamination of cylinders that are connected to a closed system where the possibility of flow reversal exists. Sucking back is particularly hazardous in the case of gases used as reactants in a closed system. If there is a possibility that a cylinder has been contaminated, it should be so labeled and returned to the supplier. Cooling coils used in pressurized reactors also require a sanitary check valve to prevent injection of the reactor contents into the potable water piping in event of the coil developing a leak.

15.7.8.l Safety committee or department chemical hygiene officer approval of high pressure reactor and gas handling system designs are required before apparatus construction begins.

15.7.8.m Regulator Inspection Procedures

These procedures apply to regulators used in both hazardous and non-hazardous applications.

1. If the regulator is greater than 10 years old, purchase a new one.
2. If it is 5-10 years old, weigh the cost of an equivalent new regulator versus the reconditioning cost.
3. If it is less than 5 years old, base reconditioning on the type of use. With corrosive and acid gases, they should be reconditioned yearly. In non-corrosive applications, base the decision on use and inspection observations as outlined below.
4. Gauges should read zero when gases are drained from the regulator. If not, they should be replaced.
5. Gas leaking out of the outlet when the regulator is in the closed position is an indication of a seat failure, and the regulator should be reconditioned or replaced.
6. At a given delivery pressure with the cylinder valve open and the outlet valve closed, you should not see a rise in pressure in a 5-10 minute time period. If you do, the regulator should be reconditioned or replaced.
7. Check the regulator for leaks with each cylinder change, or at least on a monthly basis. If leakage occurs around the adjusting knob or handle, the diaphragm could be damaged or contaminated and the regulator should be reconditioned or replaced. Leakage around fittings or seals should be repaired.
8. Excessive drop in flow from the outlet could indicate a blockage or occlusion, and service should be performed.

15.7.8.n Regulator Use Procedures

This document is intended to serve as a general guideline for the use of compressed gas regulators. It is assumed that the system or apparatus to which the gas cylinder is being connected has been properly designed and tested for the high pressures and other hazards associated with compressed gas. This is not a guide for the use of hazardous gases or systems using such gases. It is the responsibility of the operators to obtain the proper

training in such situations. Any reference to hazardous gases is purely incidental. Regulators for oxygen service require special considerations. Consult your gas supplier and SDS. This document should be read completely before proceeding.

1. Safety Precautions
    a. WEAR APPROVED EYE PROTECTION AND SAFETY APPAREL AS RECOMMENDED BY THE SDS.
    b. Know the specific hazards associated with gas to be used. Consult the SDS that was shipped with the gas or obtain a copy from Environmental Health & Safety.
    c. Leak test the system on which the gas is to be used.
    d. Make sure the regulator to be used is suitable for the application. Most gas company catalogs give this information for both gases and regulators or, if not, consult the vendors directly.
2. Categories of Regulators
    a. A single-stage regulator will usually require delivery pressure adjustment as the cylinder pressure decreases.
    b. Two-stage regulators will usually require no adjustment.
3. Installation and Operation
    a. Properly secure the cylinder to a stable surface.
    b. Remove the cap from the cylinder.
    c. Make sure the cylinder valve is tightly closed.
    d. Remove the cylinder valve cap or plug if present.
    e. Check the CGA regulator fitting and the fitting surface of the cylinder valve for damage, especially the threads and seat. If damaged, return the cylinder for replacement. Remove any loose debris from the threads and seat.
    f. Close the regulator by turning the adjusting knob or handle **counterclockwise.**
    g. Close the outlet valve fully in a **clockwise** direction. If a valve is not present, one should be purchased.
    h. Connect the regulator to the cylinder. DO NOT FORCE the connection. You should be able to make the initial connection by hand. If not, then you are using the wrong regulator, or the threads on the cylinder valve or CGA connection or both are damaged and should be replaced. Tighten until snug using a regulator wrench, an open end wrench or an adjustable wrench. DO NOT OVER-TIGHTEN.
    i. NEVER use lubricants or Teflon tape to aid in the connection or sealing of the CGA fitting.
    j. Check the cylinder valve for leaks around the thread connections into the cylinder and the valve handle, using an approved soap solution (available from gas suppliers). If any are discovered, return the cylinder for replacement.
    k. Hex nuts on the CGA connection with notches in the middle indicate left hand threads and are tightened in a counterclockwise direction.
    l. Some regulators require gaskets on the CGA connections. These should be inspected for wear or contamination and be replaced as necessary. USE THE PROPER REPLACEMENT GASKET. Do

not over-tighten, as this could cause the gasket to extrude in the gas stream. Replace the gasket at each cylinder change out.

m. Use the proper fittings on the outlet of the regulator to the system. Avoid too many connections. The correct fitting can be purchased from the regulator supplier. Do not make adapters to get to the proper fitting.

n. The operator should position himself/herself with the cylinder between themselves and the regulator. While looking away, SLOWLY open the cylinder valve in a counterclockwise direction, 1/8 turn. The high pressure gauge should rise to full cylinder pressure.

o. Leak check all connections using an approved soap solution or other leak checking device (hand-held detectors for specific gases, etc.). If leaks are discovered, depressurize, tighten, then recheck the connections. If you cannot easily make a leak-tight seal at the CGA fitting, and the problem is not with the cylinder valve, the CGA fitting should be replaced. These can be obtained from any gas supplier. DO NOT OVER-TIGHTEN THE CGA CONNECTION TO TRY AND ACHIEVE A LEAK TIGHT-SEAL.

p. If no leaks are discovered, open the valve fully to seat the valve, then close 1/8 turn.

q. Turn the regulator adjusting knob or handle clockwise to raise the delivery pressure to the desired working pressure while observing the delivery pressure gauge. DO NOT EXCEED THE MAXIMUM DELIVERY PRESSURE FOR THE REGULATOR OR THE SYSTEM.

r. Check the system for leaks.

s. Open the outlet valve on the regulator to supply gas to the system. Delivery pressure may need some adjustment.

4. Shutdown and Removal

a. For temporary shutdown (less than 30 minutes), simply close the outlet valve of the regulator.

b. For extended shutdown, shut off the gas cylinder valve completely, open the regulator adjusting valve (to delivery pressure) and outlet valve, and drain all gas from the regulator through the system. Both gauges should read zero. Close the regulator by turning adjust knob counterclockwise and outlet valves.

c. If replacing the cylinder, follow the procedure for extended shutdown, remove the regulator from the cylinder, and install the new cylinder as outlined in the installation procedures above.

d. In general, a cylinder is considered empty when the cylinder pressure is 2X the usable delivery pressure. Do not draw down below 2 bar.

15.7.9 Special Precautions and Provisions:

15.7.9.aToxic Gases

1. Handling a toxic gas requires written lab procedures under the OSHA Lab Standard including prior approval for use, engineering controls and designated use areas. Toxic gas engineering controls may include a mechanically ventilated gas cabinet or fume hood with air flow monitor, bonnet vent on regulator, flow restrictor devices, gas detector with automatic shutdown device and Self Contained Breathing Apparatus 2-person rule for toxics cylinder change out. Prior approval may include a Lab Hazard Review of toxic gas apparatus and handling.

2. All regulators used with toxic or corrosive gas service require a bonnet vent piped to an operating exhaust duct or to a fume hood ducted directly outside. Toxic gas regulators without a bonnet vent must be sent to the vendor for modification.
3. No toxic gases are permitted in any potential confined space. Use caution when connecting regulators to gas cylinders (check for flaws on CGA fitting or in cylinder valve), adjusting or observing regulator pressure (face away from regulator), opening or closing valves, replacing cylinders or moving cylinders into or out of storage (use the cylinder cart, cap on valve)
4. Cylinders of all gases having an NFPA health rating of 3 or 4 and cylinders of gases having a health hazard rating of 2 with no physiological warning properties shall be kept in a continuously mechanically ventilated enclosure.
5. Compressed gas cabinets should meet the following specifications:
    a. Cabinet and equipment must be designed specifically for the gases to be used and stored.
    b. Exhaust ventilation fans and gas cabinet equipment must be on emergency power.
    c. Fire extinguishing system inside
    d. Should be construct of compatible material not less than 0.097 inches (2.5 mm) steel.
    e. Self-enclosing limited access ports
    f. Outfitted with self-closing doors
    g. 200 fpm at access ports with minimum 150 fpm at any point of the access port
    h. 200 fpm – across unwelded fittings and connections in piping systems
    i. Non - combustible material
    j. Remote manual shutdown of process gas flow
    k. Purge panels – automated purge panel
6. Additional 2-person procedures are used when changing toxic or corrosive gas cylinders. These cylinders are located in either a continuously ventilated gas cylinder cabinet or restrained inside of an operating laboratory fume hood. The user must always wear the fully pressurized airline supplied breathing equipment or Self Contained Breathing Apparatus while manipulating cylinders, regulators and fittings. The Self Contained Breathing Apparatus-equipped backup watchman waits outside of the laboratory, ready to summon help if it is needed.
7. When ordering toxic or flammable gases, request a Critical Orifice Flow Valve not exceeding 0.006 inch in diameter on the gas cylinder. The orifice reduces a full-open leak rate [e.g.- regulator diaphragm failure] by 3 orders of magnitude giving the laboratory worker escape time and allowing normal lab ventilation to dilute the leak. This flow restrictor is vendor-installed in the cylinder valve so the user cannot forget to install it.
8. These gases may also be corrosive, but at the least present an acute health hazard. Metabolic asphyxiation occurs from CO, HCN or Arsine poisoning when it occupies O2 hemoglobin binding sites so that O2 cannot attach to red blood cells. Gases including H2S have a direct action on respiration. Ammonia, hydrogen fluoride and hydrogen chloride gases are absorbed in respiratory membranes and the skin.

9. Multiple interlocks are required in addition to using it in a continuously ventilated gas cabinet with vent failure/gas detection shutdown, and SCBA cylinder change out with 2-person rule with emergency equipment on hand.
10. Depending on performance specification of the system install an appropriate scrubber for the effluent from the toxic gases.
11. Addition requirements may be necessary depending on the toxicity of the compressed gas

15.7.9.b Inert Gases

1. Inert gases present substantial risk as asphyxiants, displacing breathing air. Be alert for confined spaces in labs including test chambers, tanks, elevators, dry ice storage chests and enclosed areas where nearby inert gas use could collect. SCBA air packs or breathing air lines are required when the air contains <19.5% oxygen. Consult your local chemical hygiene officer to determine if confined space entry procedures apply where inert gases are used in your laboratory.

15.7.9.c Oxidizing Gases

1. Use oxygen regulators only on oxygen cylinders. Contamination of oxygen regulators with the oil present in other gases can cause an explosion when the regulator is again used for oxygen. Do not lubricate regulator fittings or any component used with oxygen.
2. Oxidizing gases which include O2 and fluorine may cause compression ignition of metallic components. Avoid using ball valves or plug valves in oxygen service for this reason.
3. Oxygen enrichment (> 22% O2 in air) accelerates combustion and decreases required ignition energy. Oxygen-saturated clothing, hair and other organics can ignite from low-energy ignition sources or from contact with oils, grease and other hydrocarbons.
4. Oxygen condenses at boiling temperature of liquid nitrogen (-195.8 C) causing a buildup of liquid oxygen. Warm liquid nitrogen cold traps (containing condensed organics) above the boiling temperature of oxygen (-183.0 C) before opening the trap to atmosphere.

15.7.9.d Flammable Gas

1. Flammable gases such as hydrogen may have a very wide flammable range (4% LEL to 75% UEL), require low ignition energy and burn with invisible flame that requires an infra-red detector or straw broom to detect the flame front. Do not attempt to purify acetylene, an unstable explosive gas which is often replaced by MAAP (methylacetylene-propadiene) gas mixture. Do not use copper or red brass fittings, or silver-soldered connections in acetylene service. Keep the cylinder upright as commercial acetylene cylinders contain a fiber filler with acetone, in which the gas is actually dissolved.
2. The number of flammable gas cylinders permitted in a laboratory is determined by the floor area and by existence of a water sprinkler system. A flammable gas detection system is recommended where flammable gases are used. Connect all cylinders containing flammable gases to an earth ground and use metallic tubing when connecting these gases to other equipment to dissipate static electricity induced by fluid flow.
3. An explosive fuel-air mixture is avoided in reduction reactions (e.g. hydrogenation) using an inert purge to displace air from the system before reducing gas is charged into the system.
4. Adequate lab ventilation is required to dilute combustible gases with a minimum of 10 – 12 room volume air exchanges per hour. Do not flare or burn off residual gas from laboratory equipment; dilute it with exhaust air, verifying that the exhaust fan is electrically classified.
5. Connect flammable gas equipment to the gas cylinder only with metal tubing- not plastic tubing. The electrostatic potential generated by gas flowing in tubing creates a static discharge that can ignite the gas. Metal tubing equalizes the electrical potential, minimizing the ignition hazard.

15.7.9.e Corrosive Gases

1. Corrosives, for example hydrogen fluoride, nitric oxide, ammonia, and hydrogen sulfide, present an acute health hazard with direct attack of respiratory tract tissue and skin. Some corrosive gases paralyze the respiratory system or attack the nervous system directly. Labs using corrosive gases must have multiple interlocks installed with the cylinder in a ventilated cabinet or in the fume hood as per toxic gases. Corrosive gas regulators require a bonnet vent piped to an exhaust duct, and cylinder change out is done with SCBA with 2-person rule.
2. Equipment corrosion control requires a regulator purge after each use, routine cylinder exchange and a regulator maintenance schedule. An emergency plan for leaks and standby emergency equipment are required for corrosive gas use.

15.7.9.f Pyrophoric Gases

1. Pyrophoric gases ignite on exposure to air or moisture. These include gases used in electronics and solar cell manufacturing; diborane, arsine, phosphene. These gases are also acute poisons which require fail-safe interlocks, ventilation and fire suppression gas cabinet, ventilation failure alarm, gas detector alarm, rate-of-rise heat detector and a critical orifice cylinder valve. The point of use also requires gas detection.
2. When ordering pyrophoric gases, request a Critical Orifice Flow Valve not exceeding 0.010 inch (0.254mm) in diameter on the gas cylinder. The orifice reduces a full-open leak rate [e.g.- regulator diaphragm failure] by 3 orders of magnitude giving people in the laboratory escape time and allowing normal lab ventilation to dilute the leak. This flow restrictor is vendor-installed in the cylinder valve so the user cannot forget to install it.
3. Cylinders shall be kept in a, continuously mechanically ventilated enclosure that has a fire suppression system.
4. Compressed gas Cabinets should meet the following specifications:
    a. Cabinet and equipment must be designed specifically for the gases to be used and stored.
    b. Exhaust ventilation fans and gas cabinet equipment must be on emergency power.
    c. Fire extinguishing system inside
    d. Should be construct of compatible material not less than 0.097 inches (2.5 mm) steel.
    e. Self-enclosing limited access ports
    f. Outfitted with self-closing doors
    g. 200 fpm at access ports with minimum 150 fpm at any point of the access port
    h. 200 fpm – across unwelded fittings and connections in piping systems
    i. Non - combustible material
    j. Remote manual shutdown of process gas flow
    k. Purge panels – automated purge panel
    l. Purge gases – dedicated inert gases designed to prevent hazardous gases from entering the inert gas supply. Use of non-dedicated systems or portions of piping systems allowed in portions of venting systems that are continuously vented to atmosphere. Devices that could interrupt continuous flow of purge gas to atmosphere shall be prohibited.

m. Venting – Gas vent headers or individual purge panels vent line shall have a continuous flow of inert gas. Inert gas introduced upstream of first vent or exhaust connection to the header.

n. Purging operations – shall be performed by means of ensuring complete purging of piping and control system before the system is opened to atmosphere

5. Piping, tubing, valves, fittings, and related items - must be:
    a. Designed and installed in accordance with approved standards
    b. Compatible with material
    c. Adequate strength and durability to withstand pressure and stress
    d. Shall not be located within corridors, within any portion of a means of egress required to be enclosed in Fire resistance- rated construction or concealed spaces.
    e. Shall have welded, threaded or flanged connections throughout
    f. Piping and tubing shall be identified in accordance with ANSI-A13.1
    g. Pressure tested to approved standards
    h. Readily accessible manual valves or automated remotely activated valves.
    i. Fail safe approved Emergency shut off valve installed on supply piping and tubing at the following locations:
        i. Point of use
        ii. The source
    j. Shall be identified and the location clearly visible, accessible and indicated by means of a sign
    k. Backflow prevention or check valves
    l. If piping is pressurized greater than 15 psig an approved means of leak detection and emergency shut off or excess flow control must be provided at origination point.
6. Depending on performance specification of the system, install a Pyrolyzer or burn box for effluent for consideration of thermal destruction.

15.7.9.g Gas Detection Systems

1. Certain types of compressed gas will require gas detection. Typically gas detection will be required for highly toxic, pyrophoric gases and bulk filling locations.
2. In general, detection systems should be designed to the minimal specifications:
    a. Monitoring points in gas cabinet, equipment and rooms
    b. Alarms will shut off gas supply by solenoids
    c. Alarms to trigger building alarms
    d. Separate annunciation for gas detection
    e. Alarm to report to Public Safety
    f. Must be able to monitor gas levels from outside hazard area

Chapter 16: Shipping Research Samples, Products and Chemicals

16.1 Shipment of chemicals, samples or products is strictly regulated by the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA). Many research samples and chemicals, regardless of quantity, require special handling through DEHS. Fines for non-compliance start at $27,500 per violation. The complete shipping program procedures can found at:

16.1.1 Biological Shipments: http://www.udel.edu/ehs/research/biological/bio-shipping-and-transport.html

16.1.2 Chemical Shipments: http://www.udel.edu/ehs/research/chemical/hazmat-transport.html

16.2 Examples (not an inclusive list):

16.2.1 Dry Ice

16.2.2 Liquid Nitrogen

16.2.3 Synthesized Products and Samples

16.2.4 Materials of Biological Origin

16.2.5 Formaldehyde and Formalin

16.2.6 Flammable and Combustible Liquids

16.2.7 Anything Capable of Incapacitating a Pilot or Driver

16.2.9 Equipment Containing or Contaminated with Chemicals

16.2.10 Material Preserved with a Chemical

16.3 Shipping Process

16.3.1 Complete a DOT Shipping Request Form Available at: http://www.udel.edu/ehs/transhazmat.html

16.3.2 Email or Fax the Form to DEHS. NOTE: DEHS requires a signature certifying that the form was accurately completed

16.3.4 DEHS will review the form and either provide guidance to the requester on how to ship the material (if it is not regulated) or make arrangements to pick up the material and ship it for the requester.

16.4 DEHS has created an online training class to allow researchers to ship non-hazardous materials shipped on Dry Ice. Contact DEHS for information.

16.5 Unwanted or Improper Reagents Received from a Vendor

16.5.1 Do not accept the package from the transportation company if you did not order/expect the material.

16.5.2 If you open and determine that you received the improper material, contact the supplier and obtain return information.

16.5.3 Do not ship the material back to the supplier by yourself. Contact DEHS and arrange for shipment.

16.6 Transportation Security and Safety

16.6.1 Make an assessment of your laboratory area for hazardous materials and particular security issues.

16.6.2 Develop and implement lab security procedures for your lab group.

16.6.3 Train lab group members on security procedures and assign responsibilities.

16.6.4 Secure all hazardous material within your laboratory. Do not leave materials in a common area or loading dock while awaiting pick up or delivery.

16.6.5 Do not offer or receive any hazardous materials or chemicals from an unknown vendor or person. Ask for an identification card and look for a uniform.

16.6.6 Report any suspicious activity to the University Police by calling 911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses from a campus phone.

Resources

Hazardous Materials Safety Manual - http://www.udel.edu/ehs/research/downloads/hazmatman.pdf

Occupational Safety and Health Administration References

- Laboratory Standard - 29 CFR 1910.1450 – http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106
- National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory) – 29 CFR 1910.1450 App A – http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10107
- References (Non-Mandatory) – 29 CFR 1910.1450 App B – http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10108
- OSHA Permissible Exposure Limits (PEL) – 29 CFR 1910.1450 subpart Z – https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
- Limits for Air Contaminants – 29 CFR 1910.1000 – http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9991
- TABLE Z-2 – 29 CFR 1910.1000 TABLE Z-2 – http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9993
- TABLE Z-3 Mineral Dusts – 29 CFR 1910.1000 TABLE Z-3 – http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9994

List of Substances Known to be Human Carcinogens, Reasonably Anticipated to be Human Carcinogens and Highly Toxic Substances

- National Toxicology Program (NTP)(latest edition) – http://ntp.niehs.nih.gov/index.cfm?objectid=72016262-BDB7-CEBA-FA60E922B18C2540
- International Agency for research on Cancer Monographs (IARC) (latest editions) – http://monographs.iarc.fr/ENG/Classification/index.php

ACGIH Guide to Occupational Exposure Values – Request from the Department of Environmental Health & Safety or order online at http://acgih.org/store/

Safety Datasheets – http://www.udel.edu/ehs/

Prudent Practices in the Laboratory – http://www.nap.edu/openbook.php?record_id=12654&page=R1

Environmental Health and Safety Online Resources

- Chemical Hygiene Program – http://www.udel.edu/ehs/research/chemical/chemical-hygiene.html
- Chemical Storage Guidelines – http://www.udel.edu/ehs/research/chemical/chemical-storage.html
- Chemical Shipping Program – http://www.udel.edu/ehs/research/chemical/hazmat-transport.html
- Safety and Compliance Guide for Research Faculty and Laboratory Coordinators – http://www.udel.edu/ehs/safetycomm/downloads/facultycomplianceguide.pdf
- Standard Operating Procedures for Working with Chemicals – http://www.udel.edu/ehs/research/chemical/job-hazard-analysis.html

University of Delaware Respirator Protection Manual – Available at http://www.udel.edu/ehs/generalhs/downloads/respiratory-protection-manual.pdf

Nurse Managed Health Center
at the UNIVERSITY of DELAWARE

Nurse Managed Health Center
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July 12, 2014

Ms. Jane J. Frank
Chemical Hygiene Officer
Dept. Environmental Health & Safety
222 South Chapel Street
Room 132 GSB
Newark, DE 19716

Dear Ms. Frank,

This letter is to confirm that the University of Delaware - Nurse Managed Health Center will be able to perform evaluation, examination, and clinical management of individuals exposed to any hazardous materials and / or chemicals associated with your organization. This evaluation and management will be in compliance with OSHA Standard 29CFR1910.1450.

Regards,

Allen Prettyman, PhD, FNP-BC
Director – Nurse Managed Health Center

Patient Centered Healthcare

Chemicals Requiring Special Handling Procedures

List of chemicals that are carcinogenic, reproductive hazards or having listed exposure limits.

The following is an alphabetical compilation of chemical substances that meet the University of Delaware's definition of a Reproductive Hazard or Carcinogenic Chemical for the purpose of the University Chemical Hygiene Plan. This list requires special procedures and approval prior to purchase and use. This list is not considered all inclusive you should always check the SDS for the latest information.

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
ACEMETACIN	53164-05-9								
ACETALDEHYDE	75-07-0	ANTICIPATED	GROUP 1		YES	NIH			
ACETAMIDE	60-35-5				YES				
ACETATO-ORTHO-PHENYLMERCURY*									
ACETAZOLAMIDE	56-66-5					PROP 65			
ACETIC ACID-4,6-DINITRO-o-CRESYL ESTER	18461-55-7							0.2	
ACETOCHLOR	34256-82-1				YES				
ACETOHYDROXAMIC ACID	546-88-3					PROP 65			
ACETONE CYANOHYRDIN*	75-86-5						1	5 (C)	
ACETONYL CHLORIDE	78-95-5								X
3(alpha-ACETONYLFURFURYL)-4-HYDROXYCOUMARIN	117-52-2								
ACETOXYCYCLOHEXIMIDE	2885-39-4								
ACETOXYTRIETHYLSTANNANE	1907-13-7							0.1	
2-ACETYLAMINOFLUORENE	53-96-3	ANTICIPATED	GROUP 2B	1910.1003	YES				
ACETYLENE TETRABROMIDE	79-27-6						1	14	

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
1-ACETYL-2-THIOUREA*									
ACIFLUORFEN SODIUM	62476-59-9				YES				
ACROLEIN *	107-02-8						0.01	0.025	
ACRYLAMIDE	79-06-1	ANTICIPATED	GROUP 2A		YES	PROP 65/ATSDR			
ACRYLIC ACID	Reprotox								
ACRYLONITRILE*		ANTICIPATED	GROUP 2B		YES	ATSDR			
ACTYLYL CHLORIDE									
ACTIDIONE (CYCLOHEXYLAMINE SULFATE)	66-81-9								X
ACTINOMYCIN	1402-38-6								
ACTINOMYCIN 23-21	8506-83-5								
ACTINOMYCIN C	8052-16-2								
ACTINOMYCIN D	50-76-0				YES	PROP 65			
ACTINOMYCIN S	12623-78-8								
ACTINOMYCIN S3	11097-67-9								
1-ADRENALINE CHLORIDE	55-31-2					YES			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
ADRIAMYCIN (DOXORUBINCIN HYDROCHLORIDE)	23214-92-8	ANTICIPATED	GROUP 2A						
AF-2[2-(2-FURYL)-3-(5-NITRO-2-FURYL)ACRYLAMIDE]	3688-53-7		GROUP 2B						
AFLATOXINS	1402-68-2	KNOWN	GROUP 1		YES				
ALACHLOR	15972-60-8				YES				
ALDOXYCARB	1646-88-4								
ALDRIN	309-00-2				YES			0.025	X
ALLYL ALCOHOL	814-68-6								
5-ALLYL-5-BENZYL-2-THIOBARBITURIC ACID	64058-13-5								
ALLYL BROMIDE	106-95-6								
ALLYLIDENE DIACETATE	869-29-4								
ALLYL GLYCIDYL ETHER (AGE)	106-92-3						10 (C)	45 (C)	
ALLYL ISOTHIOCYANATE	57-06-7								
ALLYL PROPYL DISULFIDE	2179-59-1						2	12	
ALPHA-NAPHTHYLAMINE									
ALPRAZOLAM	28981-97-7					PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
ALTRETAMINE	645-05-6					PROP 65			
ALUMINUM SALTS						POSSIBLE			
ALUMINUM PHOSPHIDE	20859-73-8								
AMANTADINE HYDROCHLORIDE	665-66-7					PROP 65			
AMIKACIN SULFATE	39831-55-5					PROP 65			
2-AMINOANTHRAQUINONE	117-79-3	ANTICIPATED	GROUP 2B		YES				
P-AMINOAZOBENZENE	60-09-3				YES				
O-AMINOAZOTOLUENE	97-56-3		GROUP 2B		YES				
4-AMINOBIPHENYL	92-67-1	KNOWN	GROUP 1		YES				
1-AMINO-2,4-DIBROMOANTHRAQUINONE	81-49-2	ANTICIPATED	GROUP 2B		YES				
2-AMINO-3,4-DIMETHYLIMIDAZO[4,5-F]QUINOLINE (MEIQ)		ANTICIPATED	GROUP 2B						
2-AMINO-3,8-DIMETHYLIMIDAZO[4,5-F]QUINOXALINE (MEIQX)		ANTICIPATED	GROUP 2B						
4-AMINODIPHENYL	92-67-1			1910.1003					
3-AMINO-9-ETHYLCARBAZOLE HYDROCHLORIDE	6109-97-3				YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
2-AMINOFLUORENE	153-78-6				YES				
AMINOGLUTETHIMIDE	125-84-8					PROP 65			
AMINOGLYCOSIDES	---					PROP 65			
1-AMINO-2-METHYLANTHRAQUINONE	82-28-0	ANTICIPATED			YES				
2-AMINO-3-METHYLIMIDAZO[4,5-F]QUINOLINE (IQ)	76180-96-6	ANTICIPATED	GROUP 2A		YES				
2-AMINO-1-METHYL-6-PHENYLIMIDAZO[4,5-B]PYRIDINE (PHIP)		ANTICIPATED	GROUP 2B						
2-AMINO-5-(5-NITRO-2-FURYL)-1,2,4-THIADIAZOLE	712-68-5				YES				
4-AMINO-2-NITROPHENOL	119-34-6				YES				
AMINOPTERIN	54-62-6					PROP 65			
2-AMINOPYRIDINE	504-29-0						0.5	2	
4-AMINOPYRIDINE	504-24-5								
AMIODARONE HYDROCHLORIDE	19774-82-4					PROP 65			
AMITRAZ	33089-61-1					PROP 65			
AMITROLE	Reprotox	ANTICIPATED	GROUP 2B			PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
AMOXAPINE	14028-44-5					PROP 65			
AMSACRINE	51264-14-3				YES				
ANABOLIC STEROIDS			GROUP 2A			PROP 65			
ANDROSTENEDIONE	27208-37-3				YES				
ANGIOTENSIN CONVERTING ENZYME (ACE)	---					PROP 65			
ANILINE	62-53-3				YES				
ANISIDINE (O-,P-ISOMERS)	29191-52-4	ANTICIPATED	GROUP 2B		YES			0.05	X
ANISINDIONE	117-37-3					PROP 65			
ANTHRAQUINONE	84-65-1				YES				
ANTIMONY TRICHLORIDE									
ANTIMONY TRIOXIDE	1309-64-4				YES				
ARAMITE	140-57-8				YES				
ARISTOLOCHIC ACID		KNOWN	GROUP 1		YES				
ARSENIC AND ARSENIC COMPOUNDS	7440-38-2	KNOWN	GROUP 1		YES	NIH			
ARSENIC ACID, SODIUM SALT	7631-89-2				YES				
ARSENIC ACID, SOLUTION	7778-39-4				YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
ARSENIC IODIDE	7784-45-4				YES				
ARSENIC PENTAFLUORIDE	7784-36-3				YES				
ARSENIC PENTASULFIDE	103-34-0				YES				
ARSENIC PENTOXIDE	1303-28-2				YES				
ARESNIC TRICHLORIDE	7784-34-1				YES				
ARSENIC TRIOXIDE	1327-53-3				YES				
ARSENIC TRISULFIDE	1303-33-9				YES				
ARSENIOUS ACID	1327-53-3				YES				
ARSENIOUS OXIDE	1327-53-3				YES				
ARSINE	7784-42-1						0.005	0.02	
ASBESTOS		KNOWN	GROUP 1		YES				
ASPIRIN (ACETOSALIC ACID)	50-78-2					PROP 65			
ATENOLOL	29122-68-7					PROP 65			
ATRAZINE						ATSDR			
AURAMINE	492-80-8				YES				
AURANOFIN	34031-32-8					PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
AVERMECTIN B1	71751-41-2					PROP 65			
AZACITIDINE	320-67-2	ANTICIPATED	GROUP 2A		YES				
AZASERINE	115-02-6				YES				
AZATHIOPRINE	446-86-6	KNOWN	GROUP 1		YES	PROP 65			
AZINPHOS-METHYL	86-50-0					YES		0.02	X
AZIRIDINE	151-56-4								
AZOBENZENE	103-33-3				YES				
BARBITURATES	----					PROP 65			
BARIUM						ATSDR			
BECLOMETHASONE DIPROPIONATE	5535-09-8					PROP 65			
BENOMYL	17804-35-2					PROP 65			
BENTHIAVALICARB-ISOPROPYL	177406-68-7				YES				
BENZ[J]ACEANTHRYLENE	202-33-5								
BENZAL CHLORIDE	98-87-3		GROUP 2A						
BENZ[A]ANTHRACENE	56-55-3				YES				
BENZENE	71-43-2	KNOWN	GROUP 1			NIH/PROP 65	1		

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
BENZEDRINE	300-62-9								
BENZENETHIOL (PHENYL MERCAPTAN, THIOPHENOL)	108-98-5						0.5		X
BENZIDINE	92-87-5	KNOWN	GROUP 1	1910.1003	YES				
BENZIDINE-BASED DYES	----	KNOWN	GROUP 1		YES				
BENZIMIDAZOLES						NIH			
BENZO[A]ANTHRACENE		ANTICIPATED	GROUP 2B						
BENZODIAZEPINES	----					PROP 65			
BENZO[A]FLUORANTHRACENE		ANTICIPATED							
BENZO[B]FLUORANTHRACENE	205-99-2	ANTICIPATED	GROUP 2B		YES				
BENZO[J]FLUORANTHRACENE	205-82-3	ANTICIPATED	GROUP 2B		YES				
BENZO[K]FLUORANTHRACENE	207-08-9	ANTICIPATED	GROUP 2B		YES				
BENZOFURAN	271-89-6				YES				
BENZO[C]PHENANTHRENE	195-19-7								
BENZOPHENONE	119-61-9				YES				
BENZO[A]PYRENE	50-32-8	ANTICIPATED	GROUP 1		YES	KNOWN			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
BENZOTRICHLORIDE	98-07-7	ANTICIPATED	GROUP 2A		YES				
BENZPHETAMINE HYDROCHLORIDE	5411-22-3					PROP 65			
BENZYL CHLORIDE	100-44-7		GROUP 2A		YES				
BENZYL VIOLET 4B	1694-09-3				YES				
BERYLLIUM AND COMPOUNDS	7440-41-7	KNOWN	GROUP 1		YES	KNOWN		2	
BENZOYL CHLORIDE	98-88-4		GROUP 2A						
BETA-NAPHTHYLAMINE (2-NAPTHYLAMINE)	91-59-8	KNOWN	GROUP 1						
BIDRIN	141-66-2							0.25	X
2,2-BIS-(BROMOETHYL)-1,3-PROPANEDIOL	3296-90-0	ANTICIPATED	GROUP 2B		YES				
BIS(2-CHLOROETHYL)ETHER	111-44-4				YES				
N,N-BIS(2-CHLOROETHYL)-2-NAPHTHYLAMINE (CHLORNAPHAZINE)	494-03-1		GROUP 1		YES				
BIS-CHLOROETHYL NITROSOUREA (BCNU) (CARMUSTINE)	154-93-8	ANTICIPATED	GROUP 2A		YES	NIH/PROP 65			
BIS-CHLOROMETHYL ETHER	542-88-1	KNOWN	GROUP 1		YES				
BIS(2-CHLORO-1-METHYLETHYL)ETHER, TECHNICAL GRADE	----				YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
BLEOMYCINS	11056-06-7								
BORON HYDRIDE	19287-45-7								
BORON TRICHLORIDE	10294-34-5								
BORON TRIFLUORIDE	7637-07-2						1 (C)	3 (C)	
BROMINE	7726-95-6						0.01	7	
BROMACIL LITHIUM SALT	53404-19-6					PROP 65			
BROMATE	15541-45-4				YES				
BROMOCHLOROACETIC ACID	5589-96-8				YES				
BROMODICHLOROMETHANE	75-27-4	ANTICIPATED	GROUP 2B		YES				
BROMOETHANE	74-96-4				YES				
BROMOFORM	75-25-2				YES		0.05	5	X
1-BROMOPROPANE (1-BP)	106-94-5					PROP 65			
2-BROMOPROPANE (2-BP)	75-26-3					PROP 65			
BROMOXYNIL	1689-84-5					PROP 65			
BROMOXYNIL OCTANOATE	1689-99-2					PROP 65			
BUSULFAN (1,4-BUTANEDIOL	55-98-1	ANTICIPATED	GROUP 1		YES	PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
DIMETHANESULFONATE)									
BUTABARBITAL SODIUM	143-81-7					PROP 65			
1,3-BUTADIENE	106-99-0	KNOWN	GROUP 1		YES	OSHA/NIH/ PROP 65	1		
N-BUYTL ACRYLATE									
BUTYLATED HYDROXYANISOLE (BHA)	25013-16-5	ANTICIPATED	GROUP 2B		YES				
BUTYL BENZYL PHTHALATE (BBP)	85-68-7					PROP 65			
BETA-BUTYROLACTONE	3068-88-0		GROUP 2B		YES				
2-sec-BUTYL-4,6-DINITROPHENOL (DNBP)	88-85-7								
N-BUTYL MERCAPTAN									
CACODYLIC ACID	75-60-5				YES				
CADMIUM AND COMPOUNDS	7440-43-9	KNOWN	GROUP 1		YES	ATSDR/NIH/ PROP 65			
CAFFEIC ACID	331-39-5				YES				
CALCIUM CYANIDE	592-01-8								
CAPTAFOL	2425-06-1	ANTICIPATED	GROUP 2A		YES				
CAPTAN	133-06-2				YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
CARBAMAZEPINE	298-46-4					PROP 65			
CARBARYL (SEVIN)	63-25-2					CDC/NIH/ PROP 65		5	
CARBAZOLE	86-74-8				YES				
CARBON BLACK (AIRBORNE, UNBOUND PARTICLES OF RESPIRABLE SIZE)	1333-86-4				YES				
CARBON DISULFIDE	75-15-0					CDC/PROP 65			
CARBON MONOXIDE	630-08-0					PROP 65			
CARBON TETRACHLORIDE		ANTICIPATED	GROUP 2B		YES				
CARBONYL CHLORIDE	75-44-5								
CARBONYL FLUORIDE	353-50-4								
CARBONYL OXYFLUORIDE	353-50-4								
CARBOPLATIN	41575-94-4					PROP 65			
N-CARBOXYMETHYL-N-NITROSOUREA	60391-92-6				YES				
CATECHOL	120-80-9				YES				
CERAMIC FIBERS (RESPIRABLE SIZE)	----	ANTICIPATED	GROUP 2B		YES				
CHENODIOL (CHENODEOXYCHOLIC ACID)	474-25-9					PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
CHLORAL	75-87-6				YES				
CHLORAL HYDRATE	302-17-0				YES				
CHLORAMBUCIL	305-03-3	KNOWN	GROUP 1		YES	PROP 65			
CHLORAMPHENICOL	56-75-7	ANTICIPATED	GROUP 2A						
CHLORAMPHENICOL SODIUM SUCCINATE	982-57-0				YES				
CHLORCYCLIZINE HYDROCHLORIDE	1620-21-9					PROP 65			
CHLORDANE	57-74-9				YES			0.05	X
CHLORDECONE (KEPONE)	143-50-0				YES	ATSDR/CDC/ PROP 65			
CHLORENDIC ACID		ANTICIPATED	GROUP 2B						
CHLORINATED CAMPHENE	8001-35-2							0.05	X
CHLORDIAZEPOXIDE	58-25-3					PROP 65			
CHLORDIAZEPOXIDE HYDROCHLORIDE	438-41-5					PROP 65			
CHLORINATED DIBENZON-P-DIOXINS (CDD)						ATSDR			
CHLORINATED DIPHENYL OXIDE	55720-99-5							0.05	
CHLORINATED PARAFFINS	108171-26-2	ANTICIPATED	GROUP 2B			PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
CHLORINE	7782-50-5								
CHLORINE DIOXIDE									
CHLORINE PENTAFLUORIDE	13637-63-3							2.5	
CHLORINE TRIFLUORIDE	7790-91-2						.01(C)	.04 (C)	
CHLOROACETALDEHYDE	107-20-0						1 (C)	3 (C)	
a-CHLOROACETOPHENONE (PHENACYL CHLORIDE)	532-27-4						0.005	0.03	
CHLOROANILINE	106-47-8				YES				
CHLOROBIPHENYLS									
1-CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)FURANONE	77439-76-0								
CHLORODIPHENYL (42% CHLORINE)(PCB)	53469-21-9					YES		1	X
CHLORODIPHENYL (54% CHLORINE)(PCB)	11097-69-1					YES		0.05	X
1-(2-CHLOROETHYL)-3-CYCLOHEXYL-1-NITROSOUREA (CCNU)	13010-47-4		GROUP 2A		YES	PROP 65			
1-(2-CHLOROETHYL)-3-(4-METHYLCYCLOHEXYL)-1-NITROSOUREA (MeCCNU)	13909-09-6	KNOWN	GROUP 1		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
CHLOROFORM	67-66-3	ANTICIPATED	GROUP 2B		YES	ATSDR PROP 65			
CHLORODIMETHYL ETHER, TECH-GRADE	107-30-2	KNOWN	GROUP 1	1910.1003	YES				
3-CHLORO-2-METHYLPROPENE	563-47-3	ANTICIPATED	GROUP 2B		YES				
CHLOROMETHYL SILANE									
4-CHLORO-O-PHENYLENEDIAMINE	95-83-0	ANTICIPATED	GROUP 2B		YES				
4-CHLORO-ORTHO-TOLUIDINE		ANTICIPATED	GROUP 2A						
CHLOROPHENOXY HERBICIDES									
CHLOROPICRIN	76-06-2						0.01	7	
ß-CHLOROPRENE	126-99-8	ANTICIPATED	GROUP 2B		YES				
1-CHLORO-2-PROPANOL	Reprotox								
2-CHLORO-1-PROPANOL	Reprotox								
CHLOROPROPIONIC ACID	598-78-7					PROP 65 (MALE)			
CHLOROTHALONIL	1897-45-6				YES				
CHLOROZOTOCIN	54749-90-5	ANTICIPATED	GROUP 2A		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
CHROMIUM, HEXAVALENT COMPOUNDS	---	KNOWN	GROUP 1			KNOWN(NTP) PROP 65			
CHRYSENE	21801-9				YES				
CICLOSPORIN	79217-60-0		GROUP 1		YES				
CIDOFOVIR	113852-37-2				YES	PROP 65			
CISPLATIN	15663-27-1	ANTICIPATED	GROUP 2A		YES			0.002	
13-CIS-RETINOIC ACID (ISOTRETINOIN AND ACCUTANE)	4759-48-2					PROP 65			
CLADRIBINE (2-CHLORO-2'-DEOXYADENOSINE)	4291-63-8					PROP 65			
CLARITHROMYCIN	81103-11-9					PROP 65			
CLOBETASOL PROPIONATE	25122-46-7					PROP 65			
CLOMIPHENE CITRATE	50-41-9				YES	PROP 65			
CLOPIDOL	2971-90-6							5	
CLORAZEPATE DIPOTASSIUM	57109-90-7					PROP 65			
COAL TARS AND COAL-TAR PITCHES		KNOWN	GROUP 1						
COBALT AND COMPOUNDS	7440-48-4	ANTICIPATED	GROUP 2A		YES			0.01	
CODEINE	52-28-8					PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
COKE OVEN EMISSIONS	---	KNOWN	GROUP 1		YES				
COLCHICINE	64-86-8					PROP 65			
CONJUGATED ESTROGENS	---				YES	PROP 65			
COUMADIN (WARFARIN)	81-81-2					PROP 65		0.1	
P-CRESIDINE	120-71-8	ANTICIPATED	GROUP 2B		YES				
CRESOL, ALL ISOMERS	1319-77-3		GROUP 2A					5	
CROTONALDEHYDE	123-73-9						5	22	X
CUPFERRON	135-20-6	ANTICIPATED	GROUP 2B		YES				
CYANAZINE	21725-46-2					PROP 65			
CYANIDES (AS CN)						ATSDR			
CYANOGEN	460-19-5								
CYCASIN	14901-08-7				YES				
CYCLOATE	1134-23-2					PROP 65			
CYCLOHEXIMIDE	66-81-9					PROP 65			
CYCLOPENTAL[CD]PYRENE	27208-37-3		GROUP 2A		YES				
CYCLOPHOSPHAMIDE	50-18-0	KNOWN	GROUP 1		YES	PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
CYCLOSPORIN A	79217-60-0	KNOWN	GROUP 1						
CYHEXATIN	13121-70-5					PROP 65			
CYTARABINE (CYTOSINE ARABINOSIDE)	147-94-4					PROP 65			
DACARBAZINE	4342-03-4	ANTICIPATED	GROUP 2B		YES	PROP 65			
DANAZOL	17230-88-5					PROP 65			
DANTHRON (1,8-DIHYDROXYANTHRAQUINONE)		ANTICIPATED	GROUP 2B						
DAUNOMYCIN	20830-81-3				YES				
DAUORUBICIN HYDROCHLORICE	23541-50-6					PROP 65			
DEMETON (SYSTOX)	8065-48-3						0.005	0.03	X
N,N'-DIACETYLBENZIDINE	613-35-4				YES				
2,4-DIAMINOANISOLE SULFATE	39156-41-7	ANTICIPATED	GROUP 2B		YES				
4,4'-DIAMINODIPHENYL ETHER	101-80-4				YES				
2,4-DIAMINOTOLUENE		ANTICIPATED	GROUP 2B		YES				
DIAZOAMINOBENZENE		ANTICIPATED	GROUP 2B		YES				
DIBENZ[A,H]ACRIDINE	226-36-8	ANTICIPATED	GROUP 2B		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
DIBENZ[A,J]ACRIDINE	224-42-0	ANTICIPATED	GROUP 2B		YES				
DIBENZ[A,H]ANTHRACENE	53-70-3	ANTICIPATED	GROUP 2A		YES				
DIBENZO[C,G]CARBAZOLE	194-59-2	ANTICIPATED	GROUP 2B		YES				
DIBENZO[A,E]PYRENE	192-65-4	ANTICIPATED	GROUP 2B		YES				
DIBENZO[A,H]PYRENE	189-64-0	ANTICIPATED	GROUP 2B		YES				
DIBENZO[A,I]PYRENE	189-55-9	ANTICIPATED	GROUP 2B		YES				
DIBENZO[A,L]PYRENE	191-30-0	ANTICIPATED	GROUP 2A		YES				
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	ANTICIPATED	GROUP 2B		YES	ATSDR/OSHA /CDC/PROP 65			
1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	106-93-4	ANTICIPATED	GROUP 2B		YES	ATSDR PROP 65			
2,3-DIBROMO-1-PROPANOL	96-13-9	ANTICIPATED	GROUP 2B		YES				
TRIS(2,3-DIBROMOPROPYL) PHOSPHATE	126-72-7	ANTICIPATED	GROUP 2A		YES				
DIBUTYL PHTHALATE	84-74-2						1	5	
DICHLOROACETIC ACID	79-43-6				YES	PROP 65			
1,4-DICHLOROBENZENE	106-46-7	ANTICIPATED	GROUP 2B		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
3,3'-DICHLOROBENZIDINE	91-94-1	ANTICIPATED	GROUP 2B	1910.1003	YES				
3,3'-DICHLOROBENZIDINE DIHYDROCHLORIDE	612-83-9	ANTICIPATED	GROUP 2B		YES				
3,3'-DICHLORO-4,4'-DIAMINODIPHENYL ETHER	28434-86-8		GROUP 2B		YES				
1,3-DICHLORO-5, 5-DIMETHYL HYDANTOIN	118-52-5							0.02	
DICHLORODIPHENYLTRICHLOROETHANE (DDT)	789-02-6 50-29-3	ANTICIPATED	GROUP 2B		YES	ATSDR PROP 65			
1,1-DICHLOROETHANE	75-24-3				YES	ATSDR			
1,2-DICHLOROETHANE(ETHYLENE DICHLORIDE)	107-06-2	ANTICIPATED	GROUP 2B		YES				
DICHLOROMETHANE (METHYLENE CHLORIDE)	75-09-2	ANTICIPATED	GROUP 2B		YES				
2,2'-DICHLORO-N-METHYLDIETHYLAMINE	51-75-2					YES			X
2,4-DICHLOROPHENOXY ACETIC ACID (2,4-D)						CDC			
2,4-DICHLOROPHENYL-P-NITROPHENYL ETHER									
1,2-DICHLOROPROPANE	78-87-5	ANTICIPATED	GROUP 2B		YES				
DICHLORVOS (DDVP)	62-73-7				YES				
DICYCLOPENTADIENYL IRON (RESPIRABLE FRACTION)	102-54-5							5	

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
DIELDRIN	60-57-1				YES			0.025	X
DIEPOXYBUTANE	1464-53-5	ANTICIPATED	GROUP 2B		YES				
DI(2-ETHYLHEXYL)PHTHALATE (DEHP)	117-81-7	ANTICIPATED			YES	ATSDR PROP 65			
1,2-DIETHYLHYDRAZINE	1615-80-1				YES				
o,o-DIETHYL-o-(p-(METHYLSULFINYL)PHENYL)PHOSPHOROTHIOATE (BAY 25141, FENSULFOTHION)	115-90-2							0.1	
o-DIETHYLS-[2-(ETHYLTHIO)ETHYL]PHOSPHORODITHIOATE (DISULFOTON)	298-04-04							0.05	X
DIETHYL PHTHALATE						ATSDR			
DIETHYLSTILBOESTROL	56-53-1	KNOWN	GROUP 1		YES	PROP 65			
DIETHYL SULFATE	64-67-5	ANTICIPATED	GROUP 2A		YES				
DIGLYCIDYL ETHER (DGE)	123639						.5 (C)	2.8 (C)	
DIGLYCIDYL RESORCINOL ETHER	101-90-6	ANTICIPATED	GROUP 2B		YES				
DIHYDROSAFROLE	94-58-6				YES				
DIISOPROPYL SULFATE	2973-10-6				YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**OSHA**	**PROP 65**		**PPM**	**Mg/M3**	**SKIN**
3,3'-DIMETHOXYBENZIDINE	119-90-4	ANTICIPATED	GROUP 2B		YES				
N,N'-DIMETHYLACETAMIDE	127-19-5					PROP 65			
4-DIMETHYLAMINO-AZOBENZENE	60-11-7	ANTICIPATED	GROUP 2B	1910.1003	YES				
(N,N-DIMETHYLANILINE)	121-69-7						5	25	X
3,3'-DIMETHYLBENZIDINE	119-93-7	ANTICIPATED	GROUP 2B		YES				
DIMETHYLCARBAMOYL CHLORIDE	79-44-7	ANTICIPATED	GROUP 2A		YES				
DIMETHYL-1,2-DIBROMO-2, 2-DICHLOROETHYL PHOSPHATE	300-76-5							3	
DIMETHYLHYDRAZINE	57-14-7 540-73-8	ANTICIPATED	GROUP 2A		YES				
DIMETHYLSULFATE	77-78-1	ANTICIPATED	GROUP 2A		YES				
DIMETHYLVINYL CHLORIDE	513-37-1	ANTICIPATED	GROUP 2B		YES				
DINITROBENZENE	528-29-0 99-65-0 100-25-4					ATSDR PROP 65		1	X
3,7-DINITROFLUORANTHENE	105735-71-5				YES				
3,9-DINITROFLUORANTHENE	22506-53-2				YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
DINITRO-O-CRESOL	534-52-1							0.02	X
1,3-DINITROPYRENE	75321-20-9				YES				
1,6-DINITROPYRENE	42397-64-8	ANTICIPATED	GROUP 2B		YES				
1,8-DINITROPYRENE	42397-65-9	ANTICIPATED	GROUP 2B		YES				
2,4-DINITROTOLUENE 2,6-DINITROTOLUENE	121-14-2 606-20-2				YES	ATSDR/CD C PROP			
DINOCAP	39300-45-3					CDC PROP 65			
DINOSEB	88-85-7					CDC PROP 65			
1,4-DIOXANE	123-91-1	ANTICIPATED	GROUP 2B		YES				
DIOXATHION	78-34-2							0.1	X
DIPHENYL (BIPHENYL)	92-52-4						0.02	1	
DIPHENYLHYDANTOIN	57-41-0				YES	CDC PROP 65			
DIPHENYLHYDANTOIN SODIUM SALT	630-93-3				YES				
DYOHINATE (FONOFOS)	944-22-9							0.1	X
ENDOSULFAN (BENZOEPIN, THIODAN)	115-29-7							0.1	X

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
ENDRIN	72-20-8					PROP 65		0.01	X
EPICHLOROHYDRIN	106-89-8	ANTICIPATED	GROUP 2A		YES	CDC PROP 65			
ERIONITE	66733-21-9	KNOWN	GROUP 1		YES				
ESTROGENS, STEROIDAL		KNOWN							
ETHIONAMIDE	563-33-4					PROP 65			
2-ETHOXYETHANOL (ETHYLENE GLYCOL MONOETHYL ETHER)	110-80-5					OSHA PROP 65			
2-ETHOXYETHYL ACETATE (ETHYLENE GLYCOL MONOETHYL ETHER ACETATE)	111-15-9					PROP 65			
ETHOXY-4-NITROPHENOXYPHENYLPHOSPHINE (EPN)	2104-64-5							0.5	X
ETHYL ACRYLATE	140-88-5		GROUP 2B		YES				
ETHYL ALCOHOL	---					ATSDR PROP 65			
ETHYL BENZENE	100-41-4				YES				
ETHYL CARBAMATE (URETHANE)	51-79-6		GROUP 2A		YES				
ETHYLENE DIBROMIDE	106-93-4		GROUP 2A		YES	CDC PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
ETHYLENE CHLOROHYDRIN	107-07-3						5	16	X
ETHYLENE GLYCOL						CDC			
ETHYLENE GLYCOL DINITRATE	628-96-6						.02 (C)	1 (C)	X
ETHYLENEIMINE (AZIRIDINE)	151-56-4			1910.1003	YES		0.5	0.88	X
ETHYLENE OXIDE	75-21-8	KNOWN	GROUP 1		YES	OSHA PROP 65			
ETHYLENE THIOUREA	96-45-7	ANTICIPATED	GROUP 2B		YES	PROP 65			
ETHYL METHANESULFONATE	62-50-0	ANTICIPATED	GROUP 2B		YES				
ETHYLMETHYLENE PHOSPHORODITHIOATE (ETHION)	563-12-2							0.4	X
N-ETHYL-N-NITROSOUREA	759-73-9		GROUP 2A						
ETHYL THIOPYROPHOSPHATE (SULFOTEP, TETRAETHYL DITHIOPYROPHOSPHATE)	3689-24-5							0.2	
ETOPOSIDE	33419-42-0		GROUP 1		YES	PROP 65			
ETRETINATE	54350-48-0					PROP 65			
FENSULFOTHION	2224-92-6							0.1	X
FERROVANADIUM DUST	12604-58-9							1	

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
FLUORINE	7782-41-4						0.01	0.02	
FONOFOS	944-22-9							0.1	
FORMALDEHYDE	50-00-0	KNOWN	GROUP 1		YES				
FURAN	110-00-9	ANTICIPATED	GROUP 2B		YES				
FURFURAL	98-01-1						5	20	X
GALLIUM ARSENIDE	1303-00-0		GROUP 1		YES				
GLASS WOOL (RESPIRABLE SIZE)	---	ANTICIPATED	GROUP 2B		YES				
GLYCIDOL	556-52-5	ANTICIPATED	GROUP 2A		YES				
GUTHION (AZINPHOS METHYL)	86-50-0							0.2	X
HALOTHANE	151-67-7					KNOWN PROP 65			
HEPATITIS B VIRUS	---	KNOWN	GROUP 1						
HEPATITIS C VIRUS	----	KNOWN	GROUP 1						
HEPTACHLOR	76-44-8				YES	PROP 65		0.05	X
HEPTACHLOR EPOXIDE	1024-57-3				YES				
HEXACHLOROBENZENE	118-74-1	ANTICIPATED	GROUP 2B		YES	ATSDR PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
HEXACHLOROCYCLOHEXANE	---		GROUP 2B		YES				
HEXACHLOROETHANE	67-72-1	ANTICIPATED	GROUP 2B		YES				
HEXACHLORONAPHTHALENE	1335-87-1							0.02	X
HEXAFLUOROACETONE	684-16-2					PROP 65			
HEXAMETHYLENE DIISOCYANATE	822-06-0						0.0050		
HEXAMETHYLPHOSPHORAMIDE	680-31-9	ANTICIPATED	GROUP 2B		YES	PROP 65			
HEXANE	110-54-3					ATSDR	50		
HUMAN PAPILLOMAVIRUSES: SOME GENITAL-MUCOSAL TYPES		KNOWN	GROUP 1						
HYDRAZINE	302-01-2	ANTICIPATED	GROUP 2B		YES				
HYDRAZINE SULFATE	10034-93-2	ANTICIPATED	GROUP 2B		YES				
HYDRAZOBENZENE	122-66-7	ANTICIPATED	GROUP 2B		YES				
HYDROGNE CYANIDE	74-90-8					PROP 65			
HYDROQUINONE	123-31-9							2	
HYDROXYACETONITRILE (GLYCOLONITRILE)	107-16-4							5	
INDIUM PHOSPHIDE	22398-80-7		GROUP 2A		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
INDENO[123-CD]PYRENE	193-39-5	ANTICIPATED	GROUP 2B		YES				
IONIZING RADIATION	---	KNOWN	GROUP 1						
IRON DEXTRAN COMPLEX	9004-66-4	ANTICIPATED	GROUP 2B		YES				
IRON PENTACARBONYL	13463-40-6						0.1		
ISOPRENE	78-79-5	ANTICIPATED	GROUP 2B		YES				
KEPONE (CHLORDECONE)	143-50-0	ANTICIPATED	GROUP 2B		YES	PROP 65			
LANNATE (METHOMYL)	16752-77-5							2.5	
LEAD AND INORGANIC LEAD COMPOUNDS	---	ANTICIPATED	GROUP 2A	CDC	YES	ATSDR/OSHA			
LEAD ARSENATE		ANTICIPATED	GROUP 2A						
LEAD CHROMATE		ANTICIPATED	GROUP 2A						
LINDANE	---	ANTICIPATED	GROUP 2B		YES				
MALONONITRILE	2698-41-1						0.005	0.04	
MELPHALAN (1-PHENYLALANINE MUSTARD)	148-82-3	KNOWN	GROUP 1		YES	PROP 65			
MERCURY AND COMPOUNDS	7439-97-6					PROP 65		2	
METHIMAZOLE	60-56-0					PROP 65			
METHOXSALEN WITH ULTRAVIOLET A THERAPY		KNOWN	GROUP 1						

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
METHOXYCHLOR	---					ATSDR			
2-METHOXY ETHANOL	109-86-4					OSHA			
2-METHOXYETHYL ACETATE	110-49-6					OSHA ATSDR	25 0.1	120 0.5	X
8-METHOXYPSORALEN (METHOXSALEN)	298-81-7		GROUP 2A		YES				
2-METHYLAZIRIDINE (PROPYLENEIMINE)	75-55-8	ANTICIPATED	GROUP 2B		YES				
METHYL BROMIDE	74-83-9					PROP 65			
METHYL T-BUTYL ETHER (MTBE)	1634-04-4						50		
METHYL CARBAMATE	598-55-0				YES				
METHYL CHLORIDE	74-87-3					PROP 65			
5-METHYLCHRYSENE	3697-24-3	ANTICIPATED	GROUP 2B		YES				
2-METHYL CYCLOPENTADIENYL MANGANESE TRICARBONYL	12108-13-3							0.1	X
4,4-METHYLENEBIS(CHLOROANILINE) (MOCA)	101-14-4	ANTICIPATED	GROUP 1		YES				
METHYL HYDRAZINE (MONOMETHYL HYDRAZINE)	60-34-4						0.02 (C)	0.035 (C)	X
METHYL IODIDE	74-88-4				YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
METHYL ISOCYANATE	624-83-9					PROP 65	2	0.005	X
4-4'METHYLENEBIS(N,N'-DIMETHYL)BENZENAMINE	101-61-1	ANTICIPATED	GROUP 2B		YES				
METHYLENE BISPHENYL ISOCYANATE (MDI)	101-68-8						0.002 (C)	0.02 (C)	
METHYLENEDIANILINE	101-77-9	ANTICIPATED	GROUP 2B		YES				
METHYLEUGENOL	93-15-2	ANTICIPATED	GROUP 2B		YES				
METHYLHYDRAZINE	60-34-4				YES				
METHYL METHANESULFONATE	66-27-3	ANTICIPATED	GROUP 2A		YES				
METHYL MERCURY	593-74-8				YES	PROP 65			
N-METHYL-N'-NITRO-N-NITROSOGUANIDINE (MNNG)	70-25-7	ANTICIPATED	GROUP 2A		YES				
METHYLPARATHION	298-00-0							0.2	
METHYL VINYL KETON (2-BUTEN-2-ONE)	78-94-4							0.2 (STEL)	X
METRONIDAZOLE	443-48-1	ANTICIPATED			YES				
MEVINPHOS (PHOSDRIN)	7786-34-7							0.1	X
MICHLER'S KETONE	90-94-8	ANTICIPATED	GROUP 2B		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
MINERAL OILS: UNTREATED AND MILDLY TREATED	---	KNOWN	GROUP 1						
MIREX	2385-85-5	ANTICIPATED	GROUP 2B		YES				
MITOMYCIN C	50-07-7				YES				
MOLYBDENUM AND COMPOUNDS	7439-98-7							5	
MONOCROTOPHOS	6923-22-4							0.25	
MONOMETHYL ANILINE	100-61-8						2	9	X
MUSTARD GAS (SULFUR MUSTARD)	505-60-2	KNOWN	GROUP 1		YES				
NAPHTHALENE	91-20-3	ANTICIPATED	GROUP 2B		YES				
2-NAPHTHYLAMINE	91-59-8	KNOWN	GROUP 1	1910.1003	YES				
N-(1-NAPHTHYL)-2-THIOUREA	86-88-4							0.3	
NICKEL COMPOUNDS AND METALLIC NICKEL	---	KNOWN	GROUP 1		YES				
NICKLE, METALLIC	7440-02-0	ANTICIPATED	GROUP 2B		YES				
NITRILOTRIACETIC ACID	139-13-9	ANTICIPATED	GROUP 2B		YES				
O-NITROANISOLE	91-23-6	ANTICIPATED	GROUP 2B		YES				
NITROBENZENE	98-95-3	ANTICIPATED	GROUP 2B		YES	PROP 65			

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
4-NITROBIPHENYL	92-93-3			1910.1003	YES				
P-NITROANILINE	100-01-6						1	6	X
P-NITROCHLOROBENZENE	100-00-5							1	X
6-NITROCHRYSENE	7496-02-8	ANTICIPATED	GROUP 2B		YES				
NITROFEN	1836-75-5	ANTICIPATED	GROUP 2B		YES				
NITROGEN MUSTARD HYDROCHLORIDE	51-75-2	ANTICIPATED	GROUP 2A		YES	PROP 65			
NITROMETHANE	75-52-5	ANTICIPATED	GROUP 2B		YES				
2-NITROPROPANE	79-46-9	ANTICIPATED	GROUP 2B		YES				
1-NITROPYRENE	5522-43-0	ANTICIPATED	GROUP 2B		YES				
4-NITROPYRENE	57835-92-4	ANTICIPATED	GROUP 2B		YES				
N-NITROSODI-N-BUTYLAMINE	924-16-3	ANTICIPATED	GROUP 2B		YES				
N-NITROSODIETHANOLAMINE	1116-54-7	ANTICIPATED	GROUP 2B		YES				
N-NITROSODIETHYLAMINE	55-18-5	ANTICIPATED	GROUP 2A		YES				
N-NITROSODIMETHYLAMINE	62-75-9	ANTICIPATED	GROUP 2A	1910.1003	YES				
N-NITROSODI-N-PROPYLAMINE	621-64-7	ANTICIPATED	GROUP 2B		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
N-NITROSO-N-ETHYLUREA	759-73-9	ANTICIPATED			YES				
4-(N-NITROSOMETHYLAMINO)-1-(3-PYRIDYL)-1-BUTANONE	64091-91-4	ANTICIPATED			YES				
N-NITROSO-N-METYLUREA	684-93-5	ANTICIPATED	GROUP 2B		YES				
N-NITROSOMETHYLVINYLAMINE	4549-40-0	ANTICIPATED	GROUP 2B		YES				
N-NITROSOMORPHOLINE	59-89-2	ANTICIPATED	GROUP 2B		YES				
N-NITROSONORNICOTINE	16543-55-8	ANTICIPATED	GROUP 1		YES				
N-NITROSOPIPERIDINE	100-75-4	ANTICIPATED	GROUP 2B		YES				
N-NITROSOPYRROLIDINE	930-55-2	ANTICIPATED	GROUP 2B		YES				
N-NITROSOSARCOSINE	13256-22-9	ANTICIPATED	GROUP 2B		YES				
NITROSOUREA CHEMOTHEAPEUTIC AGENTS		KNOWN							
NITROTOLUENE (ALL ISOMERS)	---	ANTICIPATED	GROUP 2A		YES		5	30	X
NITROUS OXIDE	10024-97-2					PROP 65			
NORETHISTERONE	68-22-4	ANTICIPATED	GROUP 2B		YES	PROP 65			
OCHRATOXIN A	303-47-9	ANTICIPATED	GROUP 2B		YES				
OSMIUM TETROXIDE	20816-12-2						0.0002		

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
OXYGEN DIFLUORIDE	7783-41-7						0.005	0.01	
4,4'-OXYDIANILINE	101-80-4	ANTICIPATED	GROUP 2B		YES				
OXYMETHOLONE	434-07-1	ANTICIPATED	GROUP 2B		YES	PROP 65			
OZONE	10028-15-6						0.01	0.02	
PARAMETHADIONE	115-67-3					PROP 65			
PARAQUAT (RESPIRABLE DUST)	4685-14-7 1910-42-5 2074-50-2							0.05	X
PARATHION	56-38-2								X
PENTABORANE	19624-22-7						0.005	0.001	
3,4,5,3',4'-PENTACHLOROBIPHENYL (PCB 126)			GROUP 1						
2,3,4,7,8-PENTACHLORODIBENZOFURAN			GROUP 1						
PENTACHLORONAPHTHALENE	1321-64-8							0.05	X
PENTACHLOROPHENOL	87-86-5				YES	ATSDR		0.05	X
PERCHLOROMETHYL MERCAPTAN	594-42-3							5	
PERCHLORYL FLUORIDE	7616-94-6					YES		2	
PERFLUOROISOBUTYLENE	382-21-8								

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
PHENACETIN	62-44-2	KNOWN	GROUP 1		YES		0.01	0.06	
PHENAZOPYRIDINE HYDROCHLORIDE	136-40-3	ANTICIPATED	GROUP 2B		YES				
PHENOLPHTHALEIN	77-09-8	ANTICIPATED	GROUP 2B		YES				
PHENOXYBENZAMINE HYDROCHLORIDE	63-92-3	ANTICIPATED	GROUP 2B		YES				
PHENYL PHOSPHINE	638-21-1						0.05		
PHENYTOIN		ANTICIPATED	GROUP 2B						
PHORATE	298-02-2							0.05	X
PHOSGENE (CARBONYL CHLORIDE)	75-44-5					YES	0.01	0.04	
PHOSPHINE	7803-51-2						0.03	0.04	
PHOSPHORUS (YELLOW)	7723-14-0							0.01	
PHOSPHORUS PENTACHLORIDE	10026-13-8							1	
PHOSPHORUS PENTASULFIDE	1314-80-3							2	
PHOSPHORUS TRICHLORIDE	2125683						0.05	3	
PHTHALIC ANHYDRIDE	85-44-9						2	2	
PICLORAM	1918-02-1							5	
PINDONE (2-PIVALYL-1,3-INDANDIONE)	83-26-1							0.01	

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
POLYBROMINATED BIPHENYLS	---	ANTICIPATED	GROUP 2B		YES	PROP 65			
POLYCHLORINATED BIPHENYLS	---	ANTICIPATED	GROUP 2A		YES	PROP 65			
POLYCYCLIC AROMATIC HYDROCARBONS	---	ANTICIPATED	GROUP 2B						
PROCARBAZINE	671-16-9	ANTICIPATED	GROUP 2A		YES				
PROGESTERONE	57-83-0	ANTICIPATED	GROUP 2B		YES				
1,3-PROPANE SULTONE	1120-71-4	ANTICIPATED	GROUP 2B		YES				
PROPIOLACTONE	57-57-8	ANTICIPATED	GROUP 2B	1910.1003	YES				
PROPYLENEIMINE	75-55-8						2	5	X
PROPYLENE OXIDE	75-56-9	ANTICIPATED	GROUP 2B		YES				
PROPYLTHIOURACIL	51-52-5	ANTICIPATED	GROUP 2B		YES	PROP 65			
RDX (CYCLONITE)						ATSDR			
RESERPINE	50-55-5	ANTICIPATED	GROUP 2B		YES				
RETINOIC ACID, 1,3-CIS-	302-79-4					PROP 65			
RIDDELLIINE	23246-96-0	ANTICIPATED	GROUP 2B		YES				
SAFROLE	94-59-7	ANTICIPATED	GROUP 2B		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
SELENIUM COMPOUNDS	---					ATSDR			
SELENIUM SULFIDE	7446-34-6	ANTICIPATED	GROUP 2B		YES				
SILICA, CRYSTALLINE (Respirable Size - 2-10 MICRONS)	14808-60-7	KNOWN	GROUP 1		YES				
SILVER						ATSDR			
SODIUM AZIDE	26628-22-8							0.3	
SODIUM DICHROMATE	7789-12-0		GROUP 1						
SODIUM FLUOROACETATE	62-74-8					PROP 65		0.05	X
SOOTS	---	KNOWN	GROUP 1			PROP 65			
STREPROZOTOCIN	18883-66-4	ANTICIPATED	GROUP 2B		YES	PROP 65			
STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID	---	KNOWN	GROUP 1		YES				
STRYCHNINE	57-24-9							0.015	
STYRENE	100-42-5	ANTICIPATED	GROUP 2B					2	
STYRENE-7,8-OXIDE	96-09-3	ANTICIPATED	GROUP 2A		YES				
SULFALLATE	95-06-7	ANTICIPATED	GROUP 2B		YES				
SULFUR DIOXIDE	7446-09-5					PROP 65	5	13	

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
TAMOXIFEN	10540-29-1	KNOWN	GROUP 1		YES				
TELLURIUM HEXAFLUORIDE	7783-80-4						0.002	0.02	
TENIPOSIDE	29767-20-2		GROUP 2A			PROP 65			
TEPP (TETRAETHYL PYROPHOSPHAATE, VAPATONE)	107-49-3							0.005	X
TERT-BUTYL CHROMATE	1189-85-1							.01 (C)	X
TETRACHLOROETHYLENE (PERCHLOROETHYLENE)	127-18-4	ANTICIPATED	GROUP 2A		YES	CDC			
2,3,7,8-TETRACHLORODIBENZO-PARA-DIOXIN (TCDD)	1746-01-6	KNOWN	GROUP 1		YES	PROP 65			
TETRACHLORONAPHTHALENE	1335-88-2							2	X
TETRAETHYL LEAD	78-00-2					YES		0.75	X
TETRAFLUOROETHYLENE	116-14-3	ANTICIPATED	GROUP 2B		YES				
TETRAMETHYLSUCCINONITRILE	3333-52-6						0.05	3	X
TETRANITROMETHANE	509-14-8	ANTICIPATED	GROUP 2B		YES				
THALIDOMIDE	50-35-1					PROP 65			
THIOACETAMIDE	62-55-5	ANTICIPATED	GROUP 2B		YES				

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
4,4'-THIODIANALINE	139-65-1	ANTICIPATED	GROUP 2B		YES				
THIOTEPA	52-24-4	KNOWN	GROUP 1						
THIOUREA	62-56-6	ANTICIPATED	GROUP 2B		YES				
THIRAM	137-26-8							5	
THORIUM DIOXIDE	1314-20-1	KNOWN	GROUP 1		YES			0.01	X
TOLUENE	108-88-3					PROP 65	20		
TOLUENE DIISOCYANATE (TDI)	584-84-9	ANTICIPATED	GROUP 2B		YES				
o-TOLUIDINE	95-53-4	ANTICIPATED	GROUP 1		YES				
TOXAPHENE	8001-35-2	ANTICIPATED	GROUP 2B		YES				
AFLATOXINS	1402-68-2	KNOWN	GROUP 1						
TREOSULFAN	299-75-2		GROUP 1		YES				
TRICHLOROETHYLENE	79-01-6	ANTICIPATED	GROUP 2A		YES	PROP 65			
2,4,6-TRICHLOROPHENOL	88-06-2	ANTICIPATED	GROUP 2B		YES				
1,2,3-TRICHLOROPROPANE	96-18-4	ANTICIPATED	GROUP 2B		YES				
1,3,5 TRINITROBENZENE						ATSDR			
TRIORTHOCRESYL PHOSPHATE	78-30-8							0.01	

		Carcinogen Information				Reproductive Hazard	Exposure Limits (PEL)		
Chemical Agent	CAS #	NTP	IARC	OSHA	PROP 65		PPM	Mg/M3	SKIN
TRIPHENYL PHOSPHATE	115-86-6							3	
TRIS(2,3-DIBROMOPROPYL) PHOSPHATE	126-72-7	ANTICIPATED	GROUP 2A		YES				
URACIL MUSTARD	66-75-1				YES	PROP 65			
URETHANE	51-79-6	ANTICIPATED	GROUP 2B		YES	PROP 65			
VANADIUM AND ITS SALTS	1314-02-1					ATSDR			
VANADIUM PENTOXIDE	1314-62-1		GROUP 2B		YES				
VINYL BROMIDE	593-60-2	ANTICIPATED	GROUP 2A		YES				
VINYL CHLORIDE	75-01-4	KNOWN	GROUP 1		YES				
4-VINYL CYCLOHEXENE	100-40-3				YES	PROP 65			
4-VINYL-1-CYCLOHENENE DIEPOXIDE	106-87-6	ANTICIPATED	GROUP 2B		YES	PROP 65			
VINYL FLUORIDE	75-02-5	ANTICIPATED	GROUP 2A		YES				
WARFARIN	81-81-2					PROP 65			
WHITE PHOSPHORUS						ATSDR			
XYLIDINE	1300-73-8						5	25	
YTTRIUM	7440-65-5							2	

Chemical Hygiene Committee Compliance Policy

Approved: October 26, 2005

Amended: December 15, 2008

It is the aim of the Chemical Hygiene Committee to work cooperatively with principal investigators and laboratory workers to achieve compliance with University safety policies, the Chemical Hygiene Plan and governmental regulations. From time to time, however, it may be necessary when cooperation fails to impose sanctions to achieve compliance. This policy is designed to ensure compliance through a system of phases that applies increasing pressure on a principal investigator to make the appropriate corrective actions. The Chemical Hygiene Committee in conjunction with the Provost has the authority to modify this policy at any time.

Category 1 Deficiency – Immediate or Imminent Hazards

Category 1 includes issues that represent an immediate or imminent hazard to University Personnel, risk to the environment or potential to cause damage to University facilities. The Department Safety Committee should contact DEHS for guidance should they discover an immediate or imminent hazard.

The following actions are to be taken if the deficiency represents an immediate or imminent hazard:

1. Educate the user and/or Principal Investigator (PI) on what safety policy, rule or best management practice has been violated. Provide information on why the issue is a violation and recommend a course of action to correct the deficiency.
2. An attempt will be made to correct the deficiency immediately.
3. If the issue is not immediately corrected or arrangements to rectify the issue are not immediately made, the Department Chair and PI are notified of the deficiency and the required corrective actions. The PI must immediately correct or make arrangements to correct the deficiency.
4. If immediate actions are not taken, the Director of Environmental Health and Safety will meet with the Chair of the Department, Dean and/or Provost and consider the next course of action. Steps taken can include temporary loss of laboratory privileges or loss of the ability to order or use chemicals.
5. The PI is informed of any restrictions in person, by phone and/or by email. A letter, signed by the Chemical Hygiene Officer and/or Chemical Hygiene Committee Chair, is sent to the PI explaining any restrictions. A copy of the letter is also sent to the Chairperson of the PI's department.
6. Authorization to reinstate privileges will occur only after the PI has appeared in person before the Chemical Hygiene Committee, at a meeting called specifically for that purpose, and satisfactorily explained the measures taken to avoid future deficiencies.
7. Once the PI is re-authorized, DEHS audits the laboratory of the PI once a month until otherwise instructed by the Chemical Hygiene Committee

Category 2 Deficiency

Category 2 deficiencies include items on the DEHS Laboratory Inspection Form not identified as a Category 1.

The following process shall be followed should a deficiency be identified in a laboratory. These deficiencies can be uncovered or identified by the Department Safety Committee, the Department Chemical Hygiene Officer, or DEHS, or during a quarterly laboratory inspection or any other inspection or audit.

Phase 1

When a deficiency is identified in a laboratory by the Department Safety Committee or DEHS, the following steps are taken:

1. Educate the user and/or Principal Investigator (PI) on what safety policy, rule or best management practice has been violated. Provide information on why the issue is a violation and recommend a course of action to correct the deficiency.
2. An attempt will be made to correct the deficiency immediately.
3. If the deficiency is not or cannot be immediately corrected, the Principal Investigator (PI) is informed of the deficiency in person, by phone and/or by email.
4. If the deficiency is noted by DEHS, DEHS will refer the follow up to the Department Safety Committee.
5. The deficiency is noted on the Lab Inspection Form, which is sent to the PI and the Department Safety Committee, if necessary.
6. The PI is informed on the Lab Inspection Form that a follow-up audit will be conducted and that a repeat of the deficiency will result in a Notice of Violation.
7. Within 90 days, a follow-up audit by the Department Safety Committee is conducted to determine if the PI's corrective actions were successful at eliminating the deficiency.

Phase 2

When a follow up audit identifies the same, or a similar, deficiency the following steps are taken:

1. The PI is informed of the repeat deficiency in person, by phone and/or by email.
2. The Department Safety Committee sends a report to DEHS by email.
3. A Notice of Violation, signed by the Chemical Hygiene Officer and/or Chemical Hygiene Committee Chair, is sent to the PI, copying the Department Chair, requiring that the PI send a written response to the Chemical Hygiene Committee explaining the corrective measures that will be employed to prevent future deficiencies. The PI must respond within 30 days.
4. The Chemical Hygiene Committee reviews the PI's response. If unsatisfactory, the Committee will exercise its judgment to either require more information from the PI or move directly to Phase 3. If satisfactory, the Committee responds to the PI in writing. The PI is informed that another violation of the same requirement anytime in the next 12 months will initiate Phase 3 actions.
5. The laboratory of the PI is audited once a month by DEHS for the next 12 month period.

Phase 3

The following actions are taken if any of the following occur-- 1) the PI does not respond to a Notice of Violation (NOV) within 90 days, 2) the PI's response to the NOV is deemed unsatisfactory by the Chemical Hygiene Committee or 3) the same (or similar) deficiency is noted within 12 months of the Chemical Hygiene Committee's acceptance of the PI's NOV response

1. The Department Chair and PI are notified of the deficiency and the required corrective actions. The PI must immediately correct or make arrangements to correct the deficiency.
2. If immediate actions are not taken, the Director of Environmental Health and Safety will meet with the Chair of the Department and the Dean and consider the next course of action. Steps taken can include temporary loss of laboratory privileges or loss of the ability to order and use chemicals.

3. The PI is informed of these restrictions in person, by phone and/or by email. A letter, signed by the Chemical Hygiene Officer and/or Chemical Hygiene Committee Chair, is also sent to the PI explaining any restrictions. A copy of the letter is also sent to the Chairperson of the PI's department.
4. Authorization to reinstate privileges will occur only after the PI has appeared in person before the Chemical Hygiene Committee, at a meeting called specifically for that purpose, and satisfactorily explained the measures taken to avoid future deficiencies.
5. Once the PI is re-authorized, DEHS audits the laboratory of the PI at an increased frequency until otherwise instructed by the Chemical Hygiene Committee.

Phase 4

If deficiencies continue past the Phase 3 stage, the Chemical Hygiene Committee in consultation with the Dean and Provost will determine the next course of action on a case-by-case basis. This may include temporary or permanent loss of laboratory privileges.

Examples of Category 1 deficiencies include, but not limited to:

1. Working with highly toxic chemicals, reactive material, Hydrofluoric Acid or other extremely dangerous materials without proper training and/or specialized personal protective equipment
2. Improper storage and use of reactive or highly toxic chemicals
3. Improper storage in refrigerators
4. Evidence of improper waste disposal
5. Chemicals, chemical waste and/or gas cylinders stored and used in a manner that represents a hazard to personnel or the environment
6. Excessive quantities of chemicals or flammable liquids or reactive material
7. Unlabeled chemical containers, gas cylinders, chemical waste containers
8. Unsafe, unguarded equipment or electric wires.
9. Unsafe housekeeping or blocked egresses
10. Improper use or lack of fume hoods or other laboratory ventilation equipment
11. No immediate access to safety showers or eyewashes
12. Evidence of eating, drinking or smoking occurring in a laboratory space
13. Laboratory personnel not wearing proper laboratory attire (lab coat, closed toe shoes, long pants or skirts below the knees), safety glasses and other required personal protective equipment based on work being performed
14. An incident that results in an injury or damage to University property

Examples of Category 2 deficiencies, include, but are not limited to:

1. Lack of Standard Operating Procedures for highly hazardous materials and carcinogens
2. Lack of a Job Hazard Analysis for all processes
3. Lack of or undocumented Right-To-Know, Chemical Hygiene Plan, Emergency Planning, Chemical Waste and/or other necessary training
4. Use of extension cords

5. Poor housekeeping and hygiene (laboratory and fume hoods)
6. Slipping or tripping hazards
7. Unnecessary storage of gas cylinders
8. Improper shipment of chemical materials off campus
9. Chemical waste not in secondary containment
10. Chemical waste containers not stored sealed and closed (except when actively adding)
11. No spill or first aid kits
12. Improper storage of chemicals that does not represent an immediate hazards

Please refer to the Laboratory Inspection guide http://www.udel.edu/ehs/labinspectguide.html for more description of the above deficiencies.