Chemical Hygiene Plan

University of Delaware

ENVIRONMENTAL HEALTH & SAFETY

University Of Delaware

Chemical Hygiene Plan

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

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

Table Of Contents

Appendices

A. Hazardous Materials Safety Manual (See Binder Pocket)

- http://www.udel.edu/ehs/hazmatman.pdf

B. Resources – Available at the Websites Listed

B1 – 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 Permissable Exposure Limits (PEL) – 29 CFR 1910.1450 subpart Z – http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10147
- 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

B2 – 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

B3 – ACGIH Guide to Occupational Exposure Values – Request from the Department of Environmental Health & Safety or order online at http://acgih.org/store/

B4 – Material Safety Datasheets – http://udel.chemwatchna.com/

B5 – Prudent Practices in the Laboratory – http://www.nap.edu/readingroom/books/prudent/

B6 –Environmental Health and Safety Online Resources

- Chemical Hygiene Program – http://www.udel.edu/ehs/chemindex.html
- Chemical Storage Guidelines – http://www.udel.edu/ehs/chemcompatstorage.html
- Chemical Shipping Program – http://www.udel.edu/ehs/transhazmat.html
- Safety and Compliance Guide for Research Faculty and Laboratory Coordinators – http://www.udel.edu/ehs /facultycomplianceguide.pdf
- Standard Operating Procedures for Working with Chemicals – http://www.udel.edu/ehs/labsop.html

C. EHS Respiratory Protection Program –

- http://www.udel.edu/ehs/respiratory.html

D. Statement of Agreement of Medical Consultant –

- http://www.udel.edu/ehs/agreement.pdf

E. Chemicals Requiring Special Handling Procedures

F. Chemical Hygiene Compliance Policy

- http://www.udel.edu/ehs/CHCCompliancePolicy.pdf

G. Procedures for Regulatory Inspections at the University

- http://www.udel.edu/ehs/inspectorsoncampus.pdf

H. Chemical Hygiene Forms

- Chemical Hygiene Plan and Right-To-Know Training Guidance and Certification Form – http://www.udel.edu/ehs/chptraining.html
- DOT Shipping Request Form – http://www.udel.edu/ehs/dotshippingrequest.doc
- Laboratory Close Out/Decontamination/Decommissioning Checklist – http://www.udel.edu/ehs/LabDecommission0605.pdf
- General Process and Experiment Standard Operating Procedure – http://www.udel.edu/ehs/chpsop/generalprocesssop.doc
- Laboratory Inspection Form – http://www.udel.edu/ehs/chemical/labinfor.doc
- Laboratory Warning Sign Request Form – http://www.udel.edu/ehs/labhazardcheck.doc
- Pressure and Vacuum Processes and Experiments Standard Operation Procedure – http://www.udel.edu/ehs/chpsop/pressureandvacuumsop.doc
- Standard Operation Procedures for Use of Highly Toxic and Carcinogenic Materials – http://www.udel.edu/ehs/chpsop/toxicsop.doc
- Minors Involved in Laboratory Operations Form – http://www.udel.edu/ehs/minorsresearchpolicy.pdf
- Volunteer Workers Involved in Laboratory Research and Teaching Activities Form –

http://www.udel.edu/ehs/VolunteerResearchersPolicy.pdf

- Visiting Scholars Involved in Laboratory Research and Teaching Activities Form – http://www.udel.edu/ehs/VisitingResearchersPolicy.pdf
- Use of High Explosives and Reactive Material Standard Operating Procedure – http://www.udel.edu/ehs/reactivesop.doc

Chapter 1: University or Delaware Safety Policy 7-1

(http://www.udel.edu/ExecVP/polprod/7-01.html)

1.1 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 occupational health, safety, and fire regulations and recommended practices.

1.2 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.

1.3 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.

1.4 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 occupational health or safety problem.

Chapter 2: The OSHA Laboratory Standard

University of Delaware Policy 7-37 (http://www.udel.edu/ExecVP/polprod/7-37.html)

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

2.2 Among other requirements, the final standard provides for employee training and information, medical consultation and examination, hazard identification, respirator use and recordkeeping. In addition, employers need to identify circumstances under which a particular laboratory operation, procedure, or activity require prior approval before implementation. To the extent possible, the standard allows a large measure of flexibility in compliance methods.

2.2.1 Effective Date: May 1, 1990

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

Chapter 3: The Delaware Hazardous Chemical Information Act (Right-to-Know)

http://www.delcode.state.de.us/title16/c024/index.htm

3.1 In July 1984, the State of Delaware enacted the Hazardous Chemical Information Act. The General Assembly found the health and safety of persons living and working in Delaware may be improved by providing access to information regarding hazardous chemicals to which they may be exposed either during their normal employment activities or during emergency situations.

3.2 Many employers in the State of Delaware have already established suitable information programs for their employees as was required of all manufacturing employers by November 1985 under the Federal Occupational Safety and Health Administration's Hazard Communication Standard. However, the Federal standard does not apply to non-manufacturing employers like the University of Delaware. It is, therefore, the intent and purpose of the Act to provide accessibility to information regarding chemicals to employees who may be exposed to such chemicals in non-manufacturing employer workplaces.

3.2.1 The Act also applies to students and the laboratory use of hazardous chemicals.

Chapter 4: Responsibility

4.1 University and Department Level

4.1.1 The development and implementation of a generic Chemical Hygiene Plan (CHP) shall be the responsibility of the Department of Environmental Health and Safety. Approval of the generic CHP and annual audits thereof shall be the responsibility of the Chemical Hygiene Committee (CHC). Each department designated by the CHC shall tailor the generic CHP to their department and be responsible for its implementation. The Chairperson/Director for each designated department shall appoint a Department 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's CHO who will facilitate and manage the University Chemical Hygiene Program.

4.2 Laboratory Level

4.2.1 Laboratory Supervisors and principal investigators are responsible for chemical hygiene in the laboratory. They must ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order and that appropriate training has been provided. 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 ensure that facilities and training for use of any material being ordered are adequate. It is also anticipated and expected that laboratory supervisors and principal investigators are responsible for:

4.2.1.a Acquiring the knowledge and information needed to recognize and control chemical hazards in the laboratory.

4.2.1.b 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.

4.2.1.c Ensure that action is taken to correct work practices and conditions that may result in the release of toxic chemicals.

4.2.1.d Obtaining approval, when required, prior to using particularly hazardous substances or prior to performing extremely hazardous operations.

4.2.1.e Properly disposing of unwanted and/or hazardous chemicals and material.

4.2.1.f Developing an understanding of the current legal requirements regulating hazardous substances used in his/her laboratory.

4.2.2 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). It is also anticipated and expected that laboratory works are responsible for:

4.2.2.a Being aware of the hazards of the materials she/he is around or working with, and handling those chemicals in a safe manner;

4.2.2.b Planning and conducting each operation in accordance with established chemical hygiene procedures;

4.2.2.c Reporting unsafe conditions to his/her supervisor, or the department chemical hygiene officer.

4.2.3 The principal investigator and laboratory workers share responsibility for collecting, labeling and storing chemical hazardous waste properly, as well as informing visitors entering their laboratory of the potential hazards and safety rules/precautions.

4.2.4 Safety Responsibilities during Faculty Leaves/Absences

4.2.4.a University Policy 7-1 assigns responsibilities to each individual for conducting their activities in a safe and compliant manner. In addition, faculty hold increased responsibility for safety in laboratory and other research operations (e.g. field work**)** in that they must monitor and enforce safety requirements and practices to assure that students, staff, and visiting scientists adhere to these protections. Furthermore, Department Chairs must audit the performance of the faculty with respect to safety issues and address deficiencies as appropriate.

4.2.4.b Whenever a faculty member will not be present in the laboratory for an extended period of time, e.g., sabbatical, vacation**,** 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 could

be 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.

4.3 Employee Rights and Responsibilities

4.3.1 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.

4.3.2 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.

4.3.3 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.

4.4 Departmental Chemical Hygiene Officers

4.4.1 The Department Chemical Hygiene Officer has 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 Department Chemical Hygiene Officer has the following duties:

4.4.1.a 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

4.4.1.b Provide reports at the department Safety Committee meetings on chemical hygiene activities performed.

4.4.1.c 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.

4.4.1.d Work with the PI's on the approval process for the purchase of highly toxic, reactive, or carcinogenic or other inherently hazardous materials.

4.4.1.e Investigate and complete a report for chemical related incidents and exposures in their department.

4.4.1.f Provide guidance with personal protective equipment selection based on the findings in the job hazard analysis.

4.4.1.g Work as a liaison with the University Chemical Hygiene Officer and the Department of Environmental Health and Safety to ensure compliance.

4.4.1.h To disseminate chemical safety information through out their department through emails, posting, and other forms of communications.

4.4.1.i Provide general chemical safety guidance to department staff, students and faculty.

4.4.1.j Make copies of the approved Chemical Hygiene Plan available to the program and support staff.

4.4.1.k To facilitate Chemical Hygiene Plan training for all laboratory workers in the department.

4.4.1.l Facilitate the use of the Laboratory Management Program by the Principal Investigators and department staff.

Chapter 5: Definitions

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

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

5.3 Laboratory Use of Hazardous Chemicals - handling or use of such chemicals in which all of the following conditions are met:

5.3.1 Chemical manipulations are carried out on a laboratory scale,

5.3.2 Multiple chemical procedures or chemicals are used,

5.3.3 The procedures involved are not part of a production process, nor in any way simulate a production process, and

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

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

5.5 Chemical Hygiene Plan - a reasonable written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by toxic substances used in the particular workplace.

5.6 Regulated Area - a laboratory, an area of a laboratory or device such as a laboratory hood for which access is limited to persons who are aware of the hazards of the substances in use and the precautions required.

5.7 Hazardous Chemical - any element, chemical compound or mixture of elements and/or compounds which is a physical hazard or a health hazard. See the Hazardous Material Safety Manual for more information.

5.8 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} or LC_{50} above the definitions listed in section 12.7.1. Solutions in hazardous materials such as Dimethyl Sulfoxide, flammable liquids or corrosive liquids would still be regulated due to potential synergetic effects.

5.9 Dilute Carcinogenic Material Mixture or Solution – the 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.

5.10 Reproductive Toxicant – Interferes with reproductive or sexual function of the male or female from puberty through adulthood.

5.12 Developmental Toxicant – Produces an effect in the offspring form conception through puberty, with four principal manifestations:

5.12.1 Death of the unborn child
5.12.2 Structural Abnormality
5.12.3 Altered Growth
5.12.4 Functional Deficiency
5.12.5 Tertiary and even Quaternary Effects

Chapter 6: Scope and Application

6.1 This plan applies to all employees working in laboratories using hazardous chemicals.

6.2 This amends (for laboratories) all other provisions of 29 CFR 1910, Subpart Z except for the written Permissible Exposure Limits (PEL).

6.3 This plan does not apply to activities that do not fit the term "laboratory use."

6.4 At the University of Delaware, all faculty, staff, and graduate students working in laboratories must comply with this standard as well as the State of Delaware's Hazardous Chemical Information Act (Delaware Right-to-Know). Undergraduate students assigned to a research laboratory are also covered by both regulations. Students in undergraduate teaching laboratories are only covered by the Delaware Right-to-Know Law, but should be informed of and make an attempt to adhere to the CHP as best as possible.

6.5 This Chemical Hygiene Plan describes the University of Delaware's safety programs, including but not limited to personal protective equipment used, control equipment inventory and operations (such as vented hoods), employee training programs, medical programs, and safety inspections. The Chemical Hygiene Plan is supplemented by appendices of existing applicable programs all of which are integral parts of the CHP. The Chemical Hygiene Plan is designed as a tool to coordinate safety procedures. Every employee in the laboratory must be trained in the applicable details of this Plan.

6.6 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. Issues of non-compliance will be handled following the requirements of the Chemical Hygiene Compliance Policy (http://www.udel.edu/ehs/CHCCompliancePolicy.pdf). This policy was reviewed and approved by the University Provost. The Compliance Policy can be found in Appendix F of the Chemical Hygiene Plan.

Chapter 7: Labels and Material Safety Data Sheets (MSDS)

7.1 With respect to labels and Material Safety Data Sheets:

7.1.1 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).

7.1.2 A MSDS for each hazardous chemical must be available in the laboratory. The MSDS must be readily accessible to all laboratory personnel. MSDS must be updated on a continual basis. Researchers and students should consult two MSDS 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 MSDS should be included as part of the annual chemical safety training refresher. Accidents involving chemicals will require a MSDS 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 MSDS for any hazardous chemical found in the laboratory within five minutes.

7.1.3 Environmental Health and Safety purchases subscriptions to two online MSDS 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. MSDS provided by these two services are very comprehensive and have links to additional hazard fact sheets and toxicological information. The MSDS provided by CCOHS are not manufacturer specific. A manufacturer specific MSDS 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 MSDS created by their scientists as well as MSDS uploaded from specific manufacturers. Contact EHS to receive training on these two online systems. Links to the purchased subscriptions are:

7.1.3.a ChemWatch Program - http://jr.chemwatch.net/chemgoldusa/

7.1.3.b Canadian Center for Occupational Health and Safety - http://ccinfoweb.ccohs.ca/msds/search.html

7.1.4 MSDS may be maintained in one of the following ways:

7.1.4.a MSDS may be managed as printed hard copies in an organized fashion such as a binder. Laboratories are strongly urged to print the MSDS 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 MSDS must be updated and current.

7.1.4.b MSDS 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 MSDS. 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 MSDS website link must be posted on the computer or in another conspicuous location to facilitate easy access. Online MSDS are generally updated frequently by the provider. MSDS 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 MSDS 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.

7.1.4.c MSDS 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 MSDS. 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.

7.1.5 Emergency access to MSDS during power, network or server outages

7.1.4.a 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 MSDS. Although the University Internet and Network Systems are very reliable, outages have occurred. Laboratories must develop a plan to access MSDS in the event of an outage. Training on accessing MSDS during an outage must be provided.

7.1.4.b Options for accessing MSDS during these outages include, but are not limited to:

1. Maintaining a backup electronic file of the MSDS on a laptop computer with a fully charged battery.
2. Contacting the appropriate vendor and requesting a CD loaded with the MSDS. 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 MSDS. EHS maintains offline versions of the ChemWatch MSDS program. EHS has access to emergency power and will be able to produce a hardcopy of a MSDS during outages. These options should not be the sole provision to access MSDS during outages since EHS may not be able to provide a MSDS immediately based on the time of day and other circumstances.

7.2 Chemical substances developed in the laboratory:

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

7.2.2 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.

7.2.3 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 Material Safety Data Sheet and labeling.

7.3 The Department of Environmental Health and Safety is the Central Repository for MSDS's for the University. A Material Safety Data Sheet (MSDS) is a document containing chemical hazard and safe handling information and is prepared in accordance with the OSHA Hazard Communication Standard. A MSDS shall be obtained for each chemical used in the laboratory.

7.4 Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals with an appropriate MSDS for each hazardous chemical/product purchased.

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

7.6 If you wish to review an MSDS, contact your supervisor, instructor, Department Chemical Hygiene Officer, or the Department of Environmental Health and Safety. If you need an MSDS for your work area file, contact your Department Chemical Hygiene Officer or the Department of Environmental Health and Safety. See the Hazardous Material Safety Manual for MSDS section by section description. MSDS's can also be accessed through the ChemWatch MSDS Program available at http://jr.chemwatch.net/chemgoldusa/.

Chapter 8: Chemical Inventories

8.1 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 as listed in section 8.2.

8.2 Maximum Allowable Quantity of Hazardous Materials per Control Area, Based on the 2006 International Building Codes

		Unsprinklered				Sprinklered				Additional amount permitted if material is stored in Rated Safety Cabinets, Gas Cabinets or Vented Enclosures			
Material	**Class**	**One Floor Above Grade (100%)**	**Two Floors Above Grade (75%)**	**Three Floors Above Grade (50%)**	**Four Floors Above Grade (12.5%)**	**One Floor Above Grade (100%)**	**Two Floors Above Grade (75%)**	**Three Floors Above Grade (50%)**	**Four Floors Above Grade (12.5%)**	**One Floor Above Grade (100%)**	**Two Floors Above Grade (75%)**	**Three Floors Above Grade (50%)**	**Four Floors Above Grade (12.5%)**
Corrosive Liquids		500 gal	375 gal	250 gal	62 ½ gal	1000 gal	750 gal	500 lbs	125 gal	500 gal	375 gal	250 gal	62 ½ gal
Corrosive Solids		5000 lbs	3750 lbs	2500 lbs	625 lbs	10,000 lbs	7500 gal	5000 lbs	1250 lbs	5000 lbs	3750 lbs	2500 lbs	625 lbs
Corrosive Gas		150 ft^3	112 ½ ft^3	75 ft^3	18 ¾ ft^3	810 ft^3	607 ½ ft^3	405 ft^3	101 ¼ ft^3	N/A	N/A	N/A	N/A
Combustible Liquids	II	120 gal	90 gal	60 gal	15 gal	240 gal	180 gal	120 gal	30 gal	120 gal	90 gal	60 gal	15 gal
	IIA	320 gal	240 gal	160 gal	40 gal	640 gal	480 gal	320 gal	80 gal	320 gal	240 gal	160 gal	40 gal
	IIB	13,200 gal	9900 gal	6600 gal	1650 gal	26,400 gal	19,800 gal	13,200 gal	3300 gal	13,200 gal	9900 gal	6600 gal	1650 gal
Explosives		Not Allowed	Not Allowed	Not Allowed	Not Allowed	1 lbs	¾ lb	½ lb	$^1/_8$ lb	2 lbs	1 ½ lbs	1 lb	¼ lb
Flammable Cryogenics		45 gal	33 ¾ gal	22 ½ gal	5 $^3/_5$ gal	90 gal	67 ½ gal	45 gal	11 ¼ gal	N/A	N/A	N/A	N/A
Oxidizing Cryogenics		45 gal	33 ¾ gal	22 ½ gal	5 $^3/_5$ gal	90 gal	67 ½ gal	45 gal	11 ¼ gal	N/A	N/A	N/A	N/A
Flammable Gas	Gaseous or Liquefied	30 gal	22 ½ gal	15 gal	3 ¾ gal	60 gal	45 gal	30 gal	7 ½ gal	30 gal	22 ½ gal	15 gal	3 ¾ gal
Flammable Liquids	1A	30 gal	22 ½ gal	15 gal	3 ¾ gal	60 gal	45 gal	30 gal	7 ½ gal	30 gal	22 ½ gal	15 gal	3 ¾ gal
	1B	60 gal	45 gal	30 gal	7 ½ gal	120 gal	90 gal	60 gal	15 gal	60 gal	45 gal	30 gal	7 ½ gal
	1C	90 gal	67 ½ gal	45 gal	11 ¼ gal	180 gal	135 gal	90 gal	22 ½ gal	90 gal	67 ½ gal	45 gal	11 ¼ gal
Combination of Flammable Liquids (1A, 1B, 1C)	**NOTE: Cannot exceed an individual quantity limitation**	120 gal	90 gal	60 gal	15 gal	240 gal	180 gal	120 gal	30 gal	120 gal	90 gal	60 gal	15 gal
Flammable Solids		125 lbs	93 ¾ lbs	62 ½ lbs	15 $^3/_5$ lbs	250 lbs	187 ½ lbs	125 lbs	31 ¼ lbs	125 lbs	93 ¾ lbs	62 ½ lbs	15 $^3/_5$ lbs

		Unsprinklered				Sprinklered				All Materials Stored in Rated Safety Cabinets, Gas Cabinets or Vented Enclosures – Add An Additional:			
Material	**Class**	**One Floor Above Grade (100%)**	**Two Floors Above Grade (75%)**	**Three Floors Above Grade (50%)**	**Four Floors Above Grade (12.5%)**	**One Floor Above Grade (100%)**	**Two Floors Above Grade (75%)**	**Three Floors Above Grade (50%)**	**Four Floors Above Grade (12.5%)**	**One Floor Above Grade (100%)**	**Two Floors Above Grade (75%)**	**Three Floors Above Grade (50%)**	**Four Floors Above Grade (12.5%)**
Toxic Materials		500 lbs	375 lbs	250 lbs	62 ½ lbs	1000 lbs	750 lbs	500 lbs	125 lbs	500 lbs	375 lbs	250 lbs	62 ½ lbs
Toxic Gas		810 ft^3	607 ½ ft^3	405 ft^3	101 ¼ ft^3	810 ft^3	607 ½ ft^3	405 ft^3	101 ¼ ft^3	N/A	N/A	N/A	N/A
Highly Toxic Materials		10 lbs	7 ½ lbs	5 lbs	1 ¼ lbs	20 lbs	15 lbs	10 lbs	2 ½ lbs	N/A	N/A	N/A	N/A
Highly or Acutely Toxic Gas		20 ft^3	15 ft^3	10 ft^3	2 ½ ft^3	20 ft^3	15 ft^3	10 ft^3	2 ½ ft^3	N/A	N/A	N/A	N/A
Organic Peroxide		5 lbs	3 ¾ lbs	2 ½ lbs	$^3/_5$ lbs	10 lbs	7 ½ lbs	5 lbs	1 ¼ lbs	5 lbs	3 ¾ lbs	2 ½ lbs	$^3/_5$ lb
Oxidizer		10 lbs	7 ½ lbs	5 lbs	1 ¼ lbs	20 lbs	15	10 lbs	2 ½ lbs	10 lbs	7 ½ lbs	5 lbs	1 ¼ lbs
Oxidizing Gas	Gaseous or Liquefied	1500 ft^3	1125 ft^3	750 ft^3	187 ½ ft^3	3000 ft^3	2250 ft^3	1500 ft^3	375 ft^3	1500 ft^3	1125 ft^3	750 ft^3	187 ½ ft^3
Pyrophoric Material		Not Allowed	Not Allowed	Not Allowed	Not Allowed	4 lbs	3 lbs	2 lbs	½ lb	4 lbs	3 lbs	2 lbs	½ lb
Pyrophoric Gas		Not Allowed	Not Allowed	Not Allowed	Not Allowed	50 ft^3	37 ½ ft^3	25 ft^3	6 ¼ ft^3	N/A	N/A	N/A	N/A
Reactive Material other then already listed		5 lbs	3 ¾ lbs	2 ½ lbs	$^3/_5$ lb	10 lbs	7 ½ lbs	5 lbs	1 ¼ lbs	5 lbs	3 ¾ lbs	2 ½ lbs	$^3/_5$ lb
Waste Reactive		50 lbs	37 ½ lbs	25 lbs	6 ¼ lbs	100 lbs	75 lbs	50 lbs	12 ½ lbs	50 lbs	37 ½ lbs	25 lbs	6 ¼ lbs

Below Grade Floors: One floor below grade will meet the requirements for the Second Floor. Two floors below grade with meet the requirements for the third floor. No hazardous materials or chemicals can be stored 3 floors below grade.

Explanations: A control area is not necessarily defined as a laboratory. Usually it is a group of laboratories surrounded by one hour fire rated walls and two hour fire rated floors. There is a maximum number of control areas allow be floor:

Two Floors Below Grade: 2 Two Floors Above Grade: 3 One Floor Below Grade: 3 Three Floors Above Grade: 2
One Floor Above Grade: 4 Four Floors Above Grade: 2

Examples:

Flammable Liquid	1A	Flash Point < 73 °F (23 °C) and a Boiling Point < 100 °F (38 °C)	1-1-Dichloroethylene Ethylamine Ethyl Chloride Ethyl Ether	Isopentane Isopropyl Chloride	Methyl Formate Pentane Propylene Oxide
	1B	Flash Point < 73 °F (23 °C) and a Boiling Point >100 °F (38 °C)	Acetone Benzene Carbon Disulfide 1,2-Dichloroethylene Ethyl Acetate	Ethyl Alcohol Ethyl Benzene Hexane Methyl Acetate Methanol	Methyl Ethyl Ketone Isopropyl Acetate Isopropyl Alcohol Toluene
	1C	Flash Point > 73 °F (23 °C) and a Boiling Point <100 °F (38 °C)	Isoamyl Acetate Amyl Alcohol	Methyl Isobutyl Ketone Propyl Alcohol	Xylene
Combustible Liquid	II	Flash Point > 100 °F (38 °C) and a Boiling Point < 140 °F (60 °C)	Fuel Oil Naphtha		
	IIA	Flash Point > 140 °F (60 °C) and a Boiling Point < 200 °F (93 °C)			
	IIC	Flash Point > 200 °F (93 °C)			

Chapter 9: Safe Handling/General Safety Guidelines

9.1 Facility Safety Equipment

9.1.1 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:

9.1.1.a A plumbed emergency eye wash meeting the current ANSI Z358.1 Standard. Hand held single or double stream hoses are not a substitute for an ANSI approved, hard-plumbed eye wash. These units may be used to supplement the approved showers and eye washes.

9.1.1.b An emergency shower wash meeting the current ANSI Z358.1 Standard, unless a corridor emergency shower is located within 10 seconds or 100 foot travel distance of the hazard area

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

9.1.2.a A Factory Mutual or Underwriters Laboratory approved flammable liquid storage cabinet.

9.1.2.b A Factory Mutual or Underwriters Laboratory approved corrosive liquids cabinet.

9.1.2.c A laboratory chemical fume hood which meets the University's performance standards

9.2 Safe Handling of Chemicals

9.2.1 Know the physical and health hazards associated with the chemical(s) you are 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.

9.2.2 Questions you should consider:

9.2.2.a Is the material flammable, explosive, corrosive, or reactive?

9.2.2.b Is the material toxic, and if so, 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? A mutagen? A teratogen or reproductive toxin?

9.2.2.c What kind of ventilation does one need for protection? What kind of personal protective equipment (i.e. gloves, respirator, and goggles) does one need for protection? What is the legal exposure limit (PEL) or recommended TLV?

9.2.2.d Are you exposed to other chemicals at the same time? Can they have a combined (additive or synergistic) effect?

9.2.2.e Is any type of medical testing recommended?

9.2.2.f Will the process generate other toxic compounds, or could it result in a fire, explosion, etc.?

9.2.2.g Are the proposed storage facilities appropriate for the type of materials required? How can incompatible materials be segregated?

9.2.2.h What possible accidents can occur and what steps should be taken to minimize the likelihood and impact of an accident?

9.2.2.i What are the proper procedures for disposal of the chemical(s)?

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

9.3 General Safety Guidelines

9.3.1 Know the hazards associated with the materials used. Carefully read the label before using a chemical. Review the Material Safety Data Sheet (MSDS) 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 the Department Chemical Hygiene Officer for assistance with the evaluation of hazards associated with a specific material.

9.3.2 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.

9.3.2.a Know the location of safety equipment: emergency shower, eyewash, fire extinguisher, fire alarm pull station.

9.3.2.b Do not work alone in the laboratory when working with hazardous materials.

9.3.2.c Purchase the minimum amount of hazardous materials necessary to accomplish planned work and dispense only the minimum amount necessary for immediate use.

9.3.2.d Use hazardous chemicals only as directed and for their intended purpose.

9.3.2.e Never smell or taste hazardous chemicals.

9.3.2.f Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices.

9.3.2.g Inspect gloves and test fume hoods and glove boxes before use.

9.3.2.h Do not allow release of toxic substances in cold rooms and warm rooms, since these have recirculated atmospheres.

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

9.3.4 Assure ventilation is adequate for the materials used. Refer to the MSDS for information on ventilation requirements, or contact the Department of Environmental Health and Safety. See the "Engineering Controls" section of this plan.

9.3.5 Avoid practical jokes or other behavior which might confuse, startle or distract another worker.

9.3.6 Clothing shall be appropriate to the laboratory; effort must be made to minimize skin exposure (i.e. lab coats, long pants, and regular closed toed shoes are required). Sandals, open-toed or perforated shoes, shorts, leave exposed skin vulnerable to chemical contamination. Unconfined long hair, ties or other dangling clothing or jewelry can pose a snagging or ignition threat in the laboratory.

9.3.7 Keep the work area clean and uncluttered with chemicals and equipment. Clean up the work area on completion of an operation or at the end of each work day.

9.3.8 Use required personal protective equipment. See the "Personal Protective Equipment" section of the Hazardous Material Safety Manual. Remove and properly dispose laboratory coats when contaminated.

9.3.9 Label all secondary containers with appropriate hazard information. Assure labels on primary and secondary containers do not become damaged. Replace them when necessary.

Chapter 10: Activities Requiring Prior Approval

10.1 The Department of Environmental Health and Safety together with the Chemical Hygiene Committee has determined particular laboratory operations, procedures or activities which require approval before implementation. These operations are listed below.

10.2 Note: OSHA requires each employer to identify those activities which the employer believes to be of a sufficiently hazardous nature to warrant prior "employer approval" before implementation. Departments need to identify activities which involve extremely toxic chemicals, select carcinogens and reproductive hazards (http://www.udel.edu/ehs/reproductive.html), and those activities with a high potential for personal injury and property damage. Departments will also need to identify existing activities subject to the requirements of this section. Except for the most hazardous activities, "employer approval" will occur at the local level (e.g. Principal Investigator, Department Safety Committee and/or Department Chemical Hygiene Officer). The University's Chemical Hygiene Officer is available for assistance.

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

10.3.1 Large scale operations (e.g. 22 liter volume or greater)

10.3.2 Unattended operations, or longer than a normal eight-hour shift

10.3.3 High pressure/low pressure operations (explosion/implosion hazards)

10.3.4 After-hours work (before 8:00 am or after 5:00 pm)

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

10.4.1 Reactions using highly toxic, radioactive or carcinogenic chemicals

10.4.2 Installation, removal, moving or changes to a laboratory exhaust ventilation unit (chemical fume hood, exhaust trunk, canopy hood, etc.)

10.4.3 Purchasing refrigerators or freezers for chemical storage.

10.4.4 When specified in project write-up of new capital projects

10.4.5 Purchase of a Class 3B or IV Laser

10.4.6 Potentially explosive laboratory reactions

10.4.7 Experiment or process that impact building or laboratory design, i.e. a large piece of equipment or apparatus that blocks sprinkler heads.

10.4.8 Purchase or use of a respirator. See the Respirator Protection Program for the definition and types of respirators

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

10.5.1 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:

10.5.1.a The minor is employed by the University or has been formally accepted as a volunteer worker; and

1. has been trained in safe laboratory procedures; and

2. has adult supervision at all times; and

3. has received and completed the appropriate State of Delaware, Department of Labor forms and approvals. Contact Human Resources for more information; and

4. has a parental hazard-acknowledgement form on file with the host department; or

10.5.1.b The minor is enrolled in a University class with a laboratory component; or

10.5.1.c The minor is participating in a University-sponsored program; and

1. has been trained in safe laboratory procedures; and

2. has adult supervision at all times; and

3. has a parental hazard-acknowledgement form on file with the host department.

10.5.2 Tours involving minors are covered under Chapter 10.6 and are not subject to section 10.5 of the Chemical Hygiene Plan.

10.5.3 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.

10.5.4 The following must be adhered to:

10.5.4.a 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.

10.5.4.b The minor must attend all applicable safety training sessions, including but not limited to:

a. Right-To-Know

b. Chemical Safety/Hygiene Plan

c. Any or all of the following, based on work performed:

1. Corrosive Chemical Safety
2. Laboratory Ventilation Safety
3. Chemical Waste Disposal
4. Laser Safety
5. Radioactive Materials Safety
6. Biosafety
7. Bloodborne Pathogens
8. X-Ray Device Safety

10.5.4.c The minor is under the responsibility of a faculty member in the laboratory or area where the work will occur.

10.5.4.d 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.

10.5.4.e 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.

10.5.4.f 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.

10.5.4.g The minor must follow all Departmental and University safety procedures and policies.

10.5.4.h The Departmental Safety Committee or Departmental Chemical Hygiene Office should perform spot inspections of the work and assure that all training is complete.

10.5.4.i The minor must follow all applicable state and federal requirements and guidelines.

10.5.4.j The Release of Liability and Waiver Claim Form must be completed by the parent or guardian of the minor.

10.5.4.k The responsible Faculty member must complete the Principal Investigator/Supervisor Commitment Form.

10.6 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.

10.6.1 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.

10.6.2 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.

10.6.3 All unnecessary experiments and procedures must be stopped and the laboratory or area be made safe for the duration of the tour or visit.

10.6.4 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.

10.6.5 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.

10.6.6 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.

10.6.7 Demonstrations for minors require the approval of the University Chemical Hygiene Officer.

10.6.8 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.

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

10.7.1 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.

10.7.2 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/minorsresearchpolicy.pdf .

10.7.3 Tours and visitors to laboratories are covered under Chapter 10.6 of the University Chemical Hygiene Plan and are not subject to section 10.7 of the Chemical Hygiene Plan.

10.7.4 *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*

10.7.5 Volunteer workers are permitted to perform research and teaching activities at the University of Delaware provided the following requirements are met:

10.7.5.a 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.

10.7.5.b The volunteer worker must attend all applicable safety training sessions, including but not limited to:

a. Right-To-Know

b. Chemical Safety/Hygiene Plan

c. Any or all of the following, based on work performed:

1. Corrosive Chemical Safety
2. Laboratory Ventilation Safety
3. Chemical Waste Disposal
4. Laser Safety
5. Radioactive Materials Safety
6. Biosafety
7. Bloodborne Pathogens
8. X-Ray Device Safety

10.7.5.c The volunteer worker is under the supervision of a faculty member in the laboratory or area where the work will occur.

10.7.5.d 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.

10.7.5.e 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.

10.7.5.f 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.

10.7.5.g The volunteer must follow all Departmental and University safety procedures and policies.

10.7.5.h The Departmental Safety Committee or Departmental Chemical Hygiene Officer should perform spot inspections of the work and assure that all training is complete.

10.7.5.i The Release of Liability and Waiver Claim Form (http://www.udel.edu/ehs/VolunteerResearchersPolicy.pdf) must be completed by the volunteer worker.

10.7.5.j The responsible Faculty member must complete the Principal Investigator/Supervisor Commitment Form (http://www.udel.edu/ehs/VolunteerResearchersPolicy.pdf).

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

10.8.1 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.

10.8.2 Visiting Scholars under the age of 18 will be 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/minorsresearchpolicy.pdf .

10.8.3 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.

10.8.4 *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.*

10.8.5 Visiting Scholars are permitted to perform research and teaching activities at the University of Delaware provided the following requirements are met:

10.8.5.a 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.

10.8.5.b The Visiting Scholar must attend all applicable safety training sessions, including but not limited to:

a. Right-To-Know

b. Chemical Safety/Hygiene Plan

c. Any or all of the following, based on work performed:

1. Corrosive Chemical Safety
2. Laboratory Ventilation Safety
3. Chemical Waste Disposal
4. Laser Safety
5. Radioactive Materials Safety
6. Biosafety
7. Bloodborne Pathogens
8. X-Ray Device Safety
9. Department or Laboratory Specific Training
10. Hydrofluoric Acid Safety

10.8.5.c The Visiting Scholar is under the supervision of a faculty member in the laboratory or area where the work will occur.

10.8.5.d 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.

10.8.5.c 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.

10.8.5.d 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.

10.8.5.e The Visiting Scholar must follow all Departmental and University safety procedures and policies.

10.8.5.f The Departmental Safety Committee or Departmental Chemical Hygiene Officer should perform spot inspections of the work and assure that all training is complete.

10.8.5.g The Release of Liability and Waiver Claim Form (http://www.udel.edu/ehs/VisitingResearchersPolicy.pdf) must be completed by the Visiting Scholar.

10.8.5.h The responsible Faculty member must complete the Principal Investigator/Supervisor Commitment Form (http://www.udel.edu/ehs/VisitingResearchersPolicy.pdf).

Chapter 11: Physical Hazards/Special Precautions

11.1 "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.

11.2 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).

11.2.1 Special Precautions for Working with Flammables and Combustibles

11.2.1.a 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.

11.2.1.b 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.

11.2.1.c Minimize the quantity kept in the work area.

11.2.1.d 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.

11.2.1.e 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.

11.2.1.f Refrigerators and freezers used for the storage of flammables shall be explosion proof or lab safe.

11.2.1.g 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.

11.2.1.h Assure appropriate sprinkler system and/or fire extinguishers are in the area.

11.3 Special Precautions for Working with Corrosives

11.3.1 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.

11.3.1.a Containers and equipment used for storage and processing of corrosive materials must be corrosion resistant.

11.3.1.b 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.

11.3.1.c When mixing concentrated acids with water, add the acid slowly to water. Never add water to acid.

11.3.1.d Acids and bases must be stored separately from each other. Organic acids must be stored with flammable materials, separate from oxidizers and oxidizing acids.

11.3.1.e 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.

11.4 Special Precautions for Working with Oxidizers

11.4.1 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.

11.4.1.a 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.

11.4.1.b If the reaction can be violent or explosive, use shields or other methods for isolating the materials or the process.

11.4.1.c Use the minimum amounts necessary for the procedure. Do not keep excessive amounts of the material in the vicinity of the process.

11.4.1.d Store properly, away from organic materials, flammable materials and reducers.

11.5 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.

11.6 Pyrophoric Materials: Materials which ignite spontaneously upon contact with air. Often the flame is invisible. Examples of pyrophoric materials are silane, silicon tetrachloride, white or yellow phosphorous. Pyrophorics should be used and stored in inert environments.

11.7 Special Precautions for Working with Peroxidizables

11.7.1 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. Examples of peroxidizables include ethyl ether, tetrahydrofuran, isopropyl ether, liquid paraffins (alkanes), and olefins (alkenes).

11.7.1.a 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.

11.7.1.b Do not open any container which has obvious crystal formation around the lid.

11.7.1.c Other special precautions are similar to those used for flammables.

11.8 Special Precautions for Working with Light-Sensitive Materials

11.8.1 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.

11.8.1.a Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers which reduce or eliminate penetration of light.

11.8.1.b Date containers on receipt and upon opening, and dispose of surplus material after one year if unopened or 6 months if opened.

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

11.9.1 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.

11.9.1.a 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.

11.9.1.b 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/reactivesop.doc) for the SOP/Approval Form for the Use of High Explosive and Reactives. Chemical Hygiene Committee Approval may be required based on the specifics of the experiment.

11.9.1.c 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.

11.9.1.d Use the minimum amount of materials necessary for a procedure. Keep a minimum amount of material on hand.

11.9.1.e If there is a chance of explosion, use barriers or other methods for isolating the materials or the process.

11.10 Special Precautions for Working with Cryogens

11.10.1 Cryogens: Some of the 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.

11.10.1.a Equipment should be kept clean, especially when working with liquid or gaseous oxygen.

11.10.1.b Mixtures of gases or fluids should be strictly controlled to prevent formation of flammable or explosive mixtures.

11.10.1.c For flammable cryogens the precautions provided in the "Flammable/Combustible Materials" section of this plan should be used.

11.10.1.d 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.

11.10.1.e Containers and systems containing cryogens must have pressure relief mechanisms.

11.10.1.f Containers and systems must be capable of withstanding extreme cold without becoming brittle.

11.10.1.g Bulk filling areas may require oxygen detection and special ventilation.

Chapter 12: Health Hazards/Special Precautions

12.1 "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 (http://www.udel.edu/ehs/reproductive.html), irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system and agents which damage the lungs, skin, eyes, or mucous membranes. For a discussion of industrial toxicology and information on health hazards associated with specific chemicals, refer to the Hazardous Material Safety Manual.

12.2 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.

12.3 The MSDS 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 Office has a complete listing of published TLVs and PELs and other works concerning the subject of industrial toxicology. If you would like to conduct a more thorough review of a particular compound, or if you would like an evaluation of the exposure to a specific material used in your work area, contact the Department of Environmental Health and Safety.

12.4 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.

12.5 Special Precautions for Working with Allergens

12.5.1 Allergens: A wide variety of substances 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.

12.6 Safe Work Environment for Reproductive Health

12.6.1 Materials with undesirable reproductive effects can affect both men and women. 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. 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. 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.

12.6.2 A worker or student in the research environment should consider two principal issues. The first concern is to identify potential hazards that they may be exposed to in their research setting. The second issue involves the adaptation of the work routine to minimize or eliminate these hazards.

12.6.3 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 Material Safety Data Sheet (MSDSs) available in each lab or through the Department of Environmental Health and Safety.

12.6.4 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 and wear proper protective gloves to reduce exposure potential. For work that can not 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. In addition, individuals should consult with co-workers in the lab regarding their use of potentially harmful chemicals.

12.6.5 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:

12.6.5.a 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.

12.6.5.b Review each use of reproductive hazards with research supervisor, the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety.

12.6.5.c Label the containers as follows: REPRODUCTIVE HAZARD: READ SPECIFIC PROCEDURES FOR USE.

12.6.5.d Store these substances in unbreakable containers or unbreakable secondary containers in well-ventilated areas.

12.6.5.e Guard against spills and splashes. Ensure the engineering controls are operating properly before initiating work.

12.6.5.f 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.

12.6.5.g 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.

12.6.5.h See Appendix E of CHP for a Partial List Of Reproductive Toxins.

12.6.6 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.

12.7 Highly Toxic chemicals and Chemical Carcinogens

12.7.1 Definition of Highly Toxic Chemicals:

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

1. 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.

2. 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.

3. 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.

12.7.1.b See Appendix E of the Chemical Hygiene Plan for a partial list of highly toxic chemicals.

12.7.1.c 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 can not be found on the MSDS, please contact DEHS for assistance/clarification.

12.7.2 Definition of Carcinogen:

12.7.2.a 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:

1. It is regulated by OSHA as a carcinogen; or

2. 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

3. 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

4. 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:

   i. 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;

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

   iii. After oral dosages of less than 50 mg/kg of body weight per day.

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

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

1. Obtain prior approval for the purchase and use of the materials

   i. **Highly Toxic Materials:** Receive prior approval from DEHS and the University Chemical Hygiene Committee (CHC) for the possession of highly toxic chemicals. See Appendix H (http://www.udel.edu/ehs/highlytoxicsop.doc) for the SOP/Approval Form for Use of Highly Toxic Material.

ii. **Carcinogenic Materials:** Receive prior approval from DEHS and the local Departmental Chemical Hygiene Officer for the possession and use of the carcinogenic chemicals. See Appendix H (http://www.udel.edu/ehs/carcinogensop.doc) for the SOP/Approval Form for Use of Carcinogenic Material.

2. 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.

3. 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 MSDS; 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.

4. A written standard operating procedure (SOP) must be readily accessible to the laboratory personnel at all times. This is to include initial start up, 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.

5. 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.

12.7.3.b Safe/Prudent work practices:

1. Consult at least three resources (e.g. MSDS'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 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.

12.7.3.h Accident/Emergency procedure:

1. 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.

2. Ensure that the laboratory/hazardous material use area has a University Emergency Procedure Poster in preparation for general spills or exposures procedures.

12.7.4 Exemptions to 12.7.3.a

12.7.4.a The use and purchase of dilute solutions and mixtures of highly toxic or carcinogenic materials will not be required to comply with 12.7.3.a.1 and 12.7.3.a.5. It is important to note that the process of making the stock solution or mixture must comply with all aspects of the CHP, including 12.7.3.a.1 and 12.7.3.a.5. 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} or LC_{50} above the definitions listed in section 12.7.1. 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.

12.7.5 Approval Process for the Use of Highly Toxic Materials

12.7.5.a 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. Chapter 12 of the University Chemical Hygiene Plan
3. Appendix E of the Chemical Hygiene Plan
4. The MSDS for the chemical or substance
5. ChemWatch (EHS's online MSDS Program)
6. Registry of Toxic Effects of Chemical Substances (RTECS)

12.7.5.b 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 MSDS 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) at eich@udel.edu. The CHO will review and make recommendations or changes to your procedure.

12.7.5.c 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 at http://www.udel.edu/ehs/udchcmembers.html. 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.

12.7.5.d 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.

12.7.5.e 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.

12.7.5.f 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.

12.7.5.g PI's must complete the Standard Operating Procedure/Approval Renewal Form For Carcinogens and Highly Toxic Materials (Word Format) to renew the approval.

12.7.6 Approval Process for the Use of Carcinogenic Materials

12.7.6.a 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. Chapter 12 of the University Chemical Hygiene Plan
3. Appendix E of the Chemical Hygiene Plan
4. The MSDS for the chemical or substance
5. ChemWatch (EHS's online MSDS Program)
6. Registry of Toxic Effects of Chemical Substances (RTECS)

12.7.6.b 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 MSDS 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 at http://www.udel.edu/ehs/deptcho.html.

12.7.6.c 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.

12.7.6.d 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.

12.7.6.e 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 (Word Format) to renew the approval.

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

12.8.1 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.

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

12.8.1.a 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/unknowntoxic.doc) for the SOP/Approval Form for the Materials with Unknown Toxicity.

12.8.1.b Review each use of the material with the research supervisor, the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety.

12.8.1.c Label the containers as follows: UNKNOWN TOXICITY: READ SPECIFIC PROCEDURES FOR USE.

12.8.1.d Store these substances in unbreakable containers or unbreakable secondary containers in well-ventilated areas.

12.8.1.e Guard against spills and splashes. Ensure the engineering controls are operating properly before initiating work.

12.8.1.f 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.

12.8.1.g 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.

Chapter 13: Emergency Response

13.1 Plan in advance for an emergency. 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?

13.2 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 in 13.1. 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.

13.3 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.

13.3 Evaluate the work area for the following:

13.4.1 Chemical monitoring systems.

13.4.2 Supplies and equipment required to assist emergency response personnel in emergency activities.

13.4.3 Eyewash.

13.4.4 Safety shower.

13.4.5 Spill control materials.

13.4.6 Personal protective clothing.

13.5 Also consider whether planned work activities are safe to conduct alone. Check to see that all personnel have received emergency training.

13.4 Emergency Response/Fire - Other Emergencies Policy No. 7-6 (http://www.udel.edu/ExecVP/polprod/7-06.html)

Chapter 14: Engineering Controls

14.1 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:

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

14.1.2 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)

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

14.2 Laboratory Exhaust Systems

14.2.1 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.

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

14.2.2.a 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

14.2.2.b 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.

14.2.2.c 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

14.2.2.d 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 build up 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.

14.2.2.e 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.

14.2.2.f 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 mst have permission of EHS to purchase.

14.2.2.g Local Ventilation Systems

1. Canopy Hoods - Usually used for point source removal and operations involving heat generations (ovens, AA Units).

2. Snorkels (Elephant Trunks) – Used for point source removal such as welding and soldering operations. Usually are movable.

3. Trunks – Point source, capture is best the closer you get to the opening. Usually not movable.

4. Slots – Points source for particulates and vapor over baths. Used in photographic operations.

14.2.3 Laboratory Exhaust Certification and Testing Program. All laboratory exhaust units are certified by an outside contactor/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.

14.2.4 Laboratory Ventilation Failures and Maintenance Shutdowns

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

1. Facilities will send out a notice advising all occupants of the scheduled outage.

2. EHS will communicate with the Department Chemical Hygiene Officer, Safety Committee Chair, Laboratory Manager or Building Representative.

3. 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.

4. In general, the follow user shall take the following steps:

    a. All chemicals and hazardous materials must be sealed and closed.
    b. 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.
    c. All gas cylinders valves must be closed.
    d. All processes and reactions involving hazardous materials must be stopped and made safe. No reactions are permitted to occur during the outage.

14.2.4.b 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.

Chapter 15: Ventilation Controls

15.1 Check the MSDS to determine ventilation requirements. Expressions on an MSDS such as those listed below indicate a need for ventilation:

15.1.1 Use with adequate ventilation or avoid vapor inhalation

15.1.2 Use in a fume hood or provide local exhaust ventilation

15.2 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.

15.3 Proper Use of Ventilation Systems

15.3.1 As a rule of thumb, 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.

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

15.3.3 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.

15.4 Laboratory Fume Hood Operating Procedures

15.4.1 Define the hazard level of the proposed work and locate a hood that meets the respective standard. Refer to the yellow 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

15.4.2 Visually check the magnehelic gauge or audible/visual alarm to verify that the system is operational.

15.4.3 Clear the hood deck.

15.4.4 When appropriate, line the deck with plastic backed absorbent paper taking care not to block air foils.

15.4.5 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.

15.4.6 Do not store chemicals or equipment inside your fume hood if they are not needed for the current experiment or process.

15.4.7 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.

15.4.8 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.

15.4.9 To achieve maximum entrainment of room air and to increase the capture capacity of the chemical fume hood:

15.4.9.a Close windows and doors.

15.4.9.b 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.

15.4.9.c 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.

15.4.9.d Lower the hood sash to the operating level.

15.4.9.e Blocked 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.

15.4.9.f Heating and air conditioning vents that negatively impact fume hood/ventilation equipment performance.

15.4.10 A chemical fume hood is to be used in conjunction with the appropriate personal protective equipment.

15.4.11 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 the sash repaired.

Chapter 16: Personal Protective Equipment

16.1 General Requirements

16.1.1 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.

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

1. 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.

    a. All safety glasses must have side shields and be ANSI (American National Standards Institute) approved.

    b. Prescription safety glasses must have side shields as well. Contact your supervisor for more information.

2. Chemical splash goggles shield the entire eye area. They are used for protection against chemical splashes, sprays, mists and/or impact.

    a. Indirect Venting: used mainly in goggles designed for sprays and mists.

    b. Direct Venting: used in goggles designed for high impact areas.

    c. Prescription inserts for goggles are available from the manufacturer. The prescription inserts must be filled by an optometrist. Contact your supervisor for more information.

3. Face and neck shields for head and neck protection from various hazards (must be used in conjunction with safety glasses or goggles)

16.1.2 The necessity for the use of personal protective equipment is usually determined after a job hazard analysis is completed for a specific task.

16.1.3 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/polprod/7-40.html).

16.1.4 Clothing shall be appropriate to the laboratory; effort shall be made to minimize skin exposure (i.e. lab coats, long pants or dresses that come below the knees, 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.

16.1.5 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

16.1.6 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.

16.1.7 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.

16.1.8 Refer to the Hazardous Materials Safety Manual for further guidance.

16.2 Chemical Protective Gloves

16.2.1 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.

16.2.2 Chemical protective gloves are usually task and chemical specific. No one glove protects a work 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 mater of the time it takes.

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

16.2.4 If it is necessary to move chemical or materials from one laboratory to another area, use a chart or carry the chemical in one gloved hand and remove the other to avoid contaminating the door handles or other touch surfaces.

16.3 Respirators

16.3.1 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/respiratory.html). Improper use of respirators can result in an exposure to hazardous materials, aggravation of a preexisting medical condition, serious injury or death.

16.3.2 Examples of respirators include the following:

16.3.1.a Negative Pressure N-95 Particulate

16.3.1.b Negative Pressure P-100 Oil Mist

16.3.1.c Negative Pressure Half-Face Air Purifying

16.3.1.d Negative Pressure Full-Face Air Purifying

16.3.1.e Positive Pressure Self Contained Breathing Apparatus

16.3.1.f Positive Pressure Supplied Air Breathing Apparatus

16.3.3 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.

16.3.4 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.

16.3.5 In addition, see the University of Delaware's Respiratory Protection Program (http://www.udel.edu/ehs/respiratory.html) and contact your Department Chemical Hygiene Officer or the Department of Environmental Health and Safety (831-8475).

16.4 Latex Allergy Information

16.4.1 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.

16.4.2 The National Institute for Occupational Safety and Health (NIOSH) recommends reducing exposure to these proteins by selecting latex-free or low protein products. Go to http://www.udel.edu/ehs/healthtip/latexallergy.html (http://www.udel.edu/ehs/healthtip/latexallergy.html) for more information.

Chapter 17: Administrative Controls

17.1 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:

17.1.1. Careful planning of experiments and procedures with safety in mind. Planning includes the development of written work procedures for safe performance of the work.

17.1.2 Restricting access to areas in which hazardous materials are used.

17.1.3 Using signs or placards to identify hazardous areas (designated areas).

17.1.4 Use of labels on hazardous materials.

17.1.5 Substitution of less toxic materials for toxic materials.

17.1.6 Good housekeeping. Do not limit egress with clutter. Maintain a 36" aisle space through out the laboratory. Do not stockpile chemicals

17.1.7 Good hygiene (e.g., Decontaminate before eating, drinking, smoking, applying cosmetics, lip balm, or going to the bathroom)

17.1.8 Prohibiting eating, drinking, and smoking in areas of chemical use, and providing break areas for this purpose.

17.1.9 No mouth pipetting.

17.1.10 Adding acid to water, never water to acid.

17.1.11 Assuring employees are provided adequate training for safe work with hazardous materials.

17.1.12 Adhering to safe lab practices as taught by instructors.

17.1.13 Disposing of waste in designated containers

17.1.14 Do not block lab windows.

17.1.15 Use secondary containers during storage of liquids

17.1.16 Store chemical by hazard class in appropriate cabinets. Do not store liquids above eye level

17.1.17 Restrict access to laboratory. Lock laboratory doors when no one is present in the laboratory. Challenge all visitors, maintenance staff to assure that they are permitted in the laboratory.

17.1.18 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.

17.1.19 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/safetyglasses.html for more information.

Chapter 18: Restricted/Designated Areas

18.1 Facilities placarded with the following warning signs are restricted access, designated areas:

18.1.1 DANGER – BIOHAZARDS

18.1.2 CANCER HAZARD

18.1.3 DANGER – RADIOACTIVE MATERIAL

18.1.4 DANGER – RADIATION AREA

18.1.5 DANGER – HIGH RADIATION AREA

18.1.6 DANGER – ACUTELY TOXICITY

18.1.7 CAUTION – REPRODUCTIVE TOXIN

18.1.8 DANGER – X-RAY

18.1.9 DANGER – LASER

18.2 A list with names and phone numbers of responsible personnel shall be posted on the door(s) to any restricted access, designated areas.

18.3 Students, faculty, staff and administrators shall not enter a restricted area, except when accompanied by an authorized user of the facility.

18.4 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.

18.5 Custodians are permitted to enter restricted areas to perform routine tasks; however, custodians must not touch labeled waste containers, other research equipment or materials.

18.6 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:

18.6.1 Fume hoods

18.6.2 Biological safety cabinets

18.6.3 Sinks

18.6.4 Placarded equipment

18.6.5 Chemicals or materials on lab benches

18.7 Laboratory Sign Program – At the request of the Risk Management Advisory Council, 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.

18.7.1 Sample Laboratory Warning Sign
(http://www.udel.edu/ehs/samplesign.html)

18.7.2 Laboratory Sign Request Form – See Appendix H, Forms
(http://www.udel.edu/ehs/labhazardcheck.doc)

18.7.3 Sample Emergency Information Insert Card
(http://www.udel.edu/ehs/card.doc)

Chapter 19: Exposure Evaluations

19.1 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.

19.2 The exposure evaluation will be conducted by the University Chemical Hygiene Officer.

19.2.1 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.

19.2.2 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.

19.2.3 Termination of Monitoring - The employer may terminate monitoring in accordance with the relevant standard.

19.2.4 The employee must be notified of the result of the monitoring within 15 days of the employer's receipt of the results.

19.3 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 can not be implemented or made available in another area or laboratory.

Chapter 20: Medical Consultation and Medical Examinations

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

20.1.1 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;

20.1.2 When routine monitoring reveals an exposure above the PEL or action level;

20.1.3 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.

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

20.3 The employer shall provide the following information to the physician:

20.3.1 The identity of the hazardous chemicals to which the employee may have been exposed;

20.3.2 A description of the conditions under which the exposure occurred; and

20.3.3 A description of the signs and symptoms of exposure the employee is experiencing, if any.

20.4 The Physician shall provide a written opinion which shall include:

20.4.1 Any recommendation for further medical follow-up;

20.4.2 The results of the examination and any associated tests;

20.4.3 Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk; and

20.4.4 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.

20.4.5 The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

20.5 All medical consultations shall be coordinated by the Department of Environmental Health and Safety.

Chapter 21: Employee Information and Training

21.1 Employees shall be provided with information and training to ensure that they are appraised of the hazards of chemicals in their work area.

21.2 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.

21.3 Information - Employees shall be Informed of:

21.3.1 The contents of this Chemical Hygiene Plan;

21.3.2 The location and availability of the Chemical Hygiene Plan;

21.3.3 The PELs for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where PELs do not exist; (See appendices.)

21.3.4 Signs and symptoms associated with exposures to the hazardous chemicals used in the laboratory; and

21.3.5 The location and availability of known reference materials such as MSDSs. See your Department Chemical Hygiene Officer or the Department of Environmental Health and Safety Office for additional information.

21.4 Training - Employee Training Shall Include:

21.4.1 Methods and observations that may be used to detect the presence or release of a hazardous chemical;

21.4.2 The physical and health hazards of chemicals in the work area;

21.4.3 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.

21.4.4 The employee shall be trained on the applicable details of the written Chemical Hygiene Plan.

21.5 Training requirements are recorded in the Chemical Hygiene Plan Certificate Form. See the Chemical Hygiene Plan Awareness Certificate Form (http://www.udel.edu/ehs/rtkchemhygcert.pdf).

Chapter 22: Recordkeeping

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

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

Chapter 23: Chemical Waste Management Guidelines for Handling and Disposal of Chemical Waste

23.1 Introduction

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.

23.2 Definition Of Chemical Waste

23.2.1
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.

23.2.3
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.

23.2.3
Chemical waste is a broad term and encompasses many types of materials, Consult your Material Safety Data Sheet (MSDS), 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.

23.3 Selecting A Container

23.3.1 Liquid Chemical Waste

23.3.1.a
Once it is determined that chemical waste will be generated, a container must be selected prior to waste generation.

23.3.1b
Do Not Use glass, plastic-coated glass or other re-used reagent chemical bottles to store or accumulate bulk liquid chemical waste.

23.3.1.c 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.

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

   i. Amyl Chloride

   ii. Bromine

   iii. Butyric Acid

   iv. Carbon Disulfide

   v. Nitrobenzene

   vi. Sulfur Dioxide

   vii. Thionyl Chloride

   viii. Vinylidene Chloride

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

   i. Low density polyethylene

   ii. Either a 53B or 83B screw cap

   iii. Containers with a large handle

   iv. Capacity no larger than 5 gallons

23.3.1.d 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/acidwaste.html) for more information on managing corrosive waste steams.

23.3.1.e 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.

23.3.2 Laboratory Clean Out of Regent Chemicals

23.3.2a All laboratories must, based on the hazards they pose, inspect all of their reagent chemicals. Look for chemicals that are no longer needed, old and out of date or unusable. Try to redistribute unneeded chemicals around 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:

1. Package by hazard class in sturdy cardboard boxes. Go to Chemical Storage (http://www.udel.edu/ehs/chemcompatstorage.html) for guidance on packaging by hazard class.

2. Use sufficient packing material to prevent container damage en route.

3. Place a completed chemical waste label (http://www.udel.edu/ehs/labwastelabel.html) and packing slip on the outside of the box.

23.3.3 Sample Vials - Sealed 15 ml or less

23.3.3a 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/labwastelabel.html) on the outside of the pail.

4. Place only compatible material in pail. Go to Chemical Storage (http://www.udel.edu/ehs/chemcompatstorage.html) for guidance on compatibility.

5. Place the lid on the pail.

6. When full or not actively adding, tightly seal bag with tape or bag closure tie.

23.3.4 Solid Waste Streams

23.3.4.a 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 plasticware. Go to Laboratory Solid Waste Disposal Procedures (http://www.udel.edu/ehs/solidwastedis.html) for a flow chart that helps decide if a material requires management as chemical waste or if it can be placed in the normal trash. Use the following procedures to manage solid chemical waste:

1. Use solid waste containers provided by Environmental Health & Safety. Cardboard boxes, five-gallon poly pails or other sturdy containers may also be acceptable.

2. All containers must have lids.

3. Apply a completed chemical waste label on the outside of the container.

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.

23.3.5 Chemically Contaminated Sharps

23.3.5.a 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. Go to Sharp and Piercing Object Disposal (http://www.udel.edu/ehs/sharpdisp.html) for more information about sharps management. If a sharp is chemically contaminated, simply place it in a sharps container that is labeled with a properly filled out Orange Chemical Waste Label.

23.3.6 Empty Chemical Containers

23.3.6.a Empty chemical containers are still hazardous to the University personnel and the environment until they are properly managed. Go to Glass Only Disposal/Empty Chemical Container Disposal Procedures (http://www.udel.edu/ehs/glassdisp.html) for complete information on empty container management. Below is a summary of the steps required to make empty chemical containers safe for disposal:

1. Triple rinse with copious amounts of water. Collect the first rinseate 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.

23.3.7 Clean, Uncontaminated Broken Glassware

23.3.7.a In an effort to minimize the amount of chemical waste generated on campus. Clean, uncontaminated glassware and plasticware should not be managed as waste. Unwanted clean non-broken glassware and plasticware can be packaged up by the laboratory personnel and taken to the dumpster or recycling area. Broken glassware and plasticware 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 yourself. Remember that 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 plasticware.

23.3.8 Gas Cylinders

23.3.8.a The disposal of gas cylinders is extremely expensive. Unknown gas cylinders may cost in excess of $1,000 to identify and properly manage. Always check to make sure that all labels on gas cylinders are in good condition and legible. Contact the cylinder supplier and arrange a return if possible. It is best to use cylinders that will be returned. If lecture cylinders are required for research, use cylinders supplied by Aldrich and Matheson Tri Gas. Disposal of Aldrich cylinders are inexpensive and Matheson has a lecture bottle return program.

23.3.9 Recycling and Laboratory Wastes

23.3.9.a Certain laboratory materials can be recycled while others cannot. Go to Campus Computer, Electronic Equipment and Office Supplies Recycling (http://www.udel.edu/ehs/comprecycle.html) for complete information on recycling. Below is information specific for laboratories:

1. Laboratory materials that can be recycled:

   i. Brown glass

   ii. Clear glass

   iii. Metal cans

   iv. Computer and electronic equipment

2. Laboratory materials that cannot be recycled:

   i. Any glass bottles that are plastic coated

   ii. Pyrex

   iii. Glass only boxes

23.4 Labeling Chemical Waste

23.4.1 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. There are directions on the back side of the label and 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.

23.4.1.a How to 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.

7. Do not use:

   i. Abbreviations

   ii. Chemical symbols

   iii. Trade names

8. Check the appropriate boxes for the waste stream.

9. If this waste is being moved to a Central Accumulation Area such as the Brown Solvent Shed or Colburn Solvent Shed, fill in the date that it is moved into the facility on the line at the bottom of the waste label.

23.5 Adding Waste to a Container

23.5.1 Waste can be added only after you choose the proper container and it is labeled. The minimum personal protective equipment (PPE) may be dictated in the Chemical Hygiene Plan.

23.5.1.a All personal 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

23.5.2 Procedure for liquid chemical waste management:

23.5.2.a 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.

7. Another option for liquid waste management is to use a specially designed waste funnel called ECO-Funnel. Go to Safety Ecological Funnels (http://www.udel.edu/ehs/ecofunnelswaste.html) for more information.

23.5.3 Procedures for solid waste management:

23.5.3.a Go to Laboratory Solid Waste Disposal Set-Up (http://www.udel.edu/ehs/solidlabsetup.html) and Laboratory Solid Waste Disposal Procedures for information and guidance on how to set up your solid chemical waste management program in your lab.

1. Obtain and label a proper container as described above.

2. Open the lid to the container and unseal the bag.

3. Add the waste.

4. Seal the EHS provided solid waste container with the provided lid. Seal other containers with the lid or seal bag with a bag closure tie or large binder clip.

5. Reseal the lid.

23.6 Storing Your Waste

23.6.1 Proper storage of chemical waste is extremely important. Explosions have occurred on campus that is attributed to improper storage of chemical waste. If you improperly label a container, other laboratory personnel unknowingly may add incompatible material to the container. Go to Chemical Storage for guidance.

23.6.1a 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.

   i. Flammable Cabinets

   ii. Corrosive Cabinets

   iii. Under Fume Hood Cabinets

4. Do not allow excess accumulation of chemical waste to build up in your lab. Go to Hazardous Waste Definitions (http://www.udel.edu/ehs/wastedefinition.html) for more information on the limitations of waste storage.

5. Containers can only be filled to a maximum 90% full. Head space is needed for expansion and/or ease of dispensing.

23.7 Inspecting Your Waste Accumulation Areas

23.7.1 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:

23.7.1.a There are no leaking containers of chemical waste.

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

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

23.7.1.d All liquid chemical wastes are stored in secondary containment bins.

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

23.7.1.f 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.

23.8 How to Have Chemical Waste Removed

23.8.1 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, Colburn and Spencer should take their waste to the CAA. Go to Chemical Waste Removal Process (http://www.udel.edu/ehs/wastepickup.html) for complete information on the CAA's.

23.8.2 Once a chemical waste container is full, DEHS should be contacted to remove the container or it should be moved to the CAA. In addition, if a chemical waste container has been in a laboratory for more than a year, it should be removed. If your building does not have a CAA, follow the procedure below:

23.8.2.a You can request a chemical waste pick-up via the DEHS Web Page. Go to Chemical Waste Pick-Up Form (http://www.udel.edu/ehs/waste/chemwstindex.html) and complete the webform. If you do not have access to a computer or if the webform does not work, contact DEHS. We strongly encourage everyone to use the webform. This assists DEHS with complying with certain federal and state Regulations and tracking programs.

23.8.2.b DEHS will only remove waste that is properly labeled and in a satisfactory container. If the container is not labeled or satisfactory, an attempt will be made to find the laboratory personnel to correct the problems. 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 24: Chemical Spills

24.1 General Information

24.1.1 *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 in 24.3, 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. Go to http://www.udel.edu/ehs/chemspillkit/chemspillkit.html for information on purchasing a spill kit. DEHS approved chemical spill kits are available for purchase at UDMart (http://www.udel.edu/udmart).

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

24.1.2.a Maintaining a neat and organized work area;

24.1.2.b Performing a laboratory procedure review prior to conducting new experimental procedures;

24.1.2.c Storing liquid chemicals in secondary containment bins;

24.1.2.d Keeping reagent chemical containers sealed or closed at all times, except when removing contents;

24.1.2.e Ordering reagent chemicals in plastic or plastic coated glass containers whenever possible;

24.1.2.f Using secondary containment to store and move chemicals.

24.1.6 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 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 / 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

24.1.6.a 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.

24.2.6.b 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.

24.1.7 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.

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

24.2 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 clean up. The following procedures are specific guidelines for using the recommended spill clean up materials. Contact DEHS with any questions or concerns about proper spill clean-up practices.

24.2.1 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.

24.2.2 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.

24.2.3 All tools used in the clean up 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.

24.2.4 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 clean up. Seal bag with tape and attach a completed orange hazardous waste sticker on the bag.

24.2.4 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 clean up. Seal bag with tape and attach a completed orange hazardous waste sticker on the bag.

24.2.5 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 clean up. Seal bag with tape and attach a completed orange hazardous waste sticker on the bag.

24.2.6 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.

24.3 Recommended chemical spill kit contents:

24.3.1 Universal Chemical Absorbent Pads

24.3.1.a High Capacity
24.3.1.b Chemically Inert
24.3.1.c Absorbs aggressive chemicals as well as non-aggressive compounds such as water
24.3.1.d Good for all chemicals; acids, bases, flammable liquids, formaldehyde

24.3.2 Universal Chemical Absorbent Powder

24.3.2.a High Capacity
24.3.2.b Chemically Inert
24.3.2.c Absorbs aggressive chemicals as well as non-aggressive compounds such as water
24.3.2.d Good for all chemicals; acids, bases, flammable liquids, formaldehyde

24.3.3 Polyethylene Bags

24.3.3.a Strong Construction

24.3.3.b Leak Proof

24.3.3.c At least 7-gallon capacity

24.3.3.d 4 mm in thickness

24.3.4 Anti-Static Polypropylene Plastic Scoop

24.3.5 Nitrile/Silver Shield Combination Gloves

24.3.5.a .011 thick Nitrile Gloves under Silver Shield Gloves

24.3.5.b At least two pairs

24.3.6 Two Pairs Indirect Venting Chemical Splash Goggles

24.3.7 DEHS Orange Chemical Waste Labels

Chapter 25: Injury, Illness, Personal Contamination, Minor First Aid

25.1 Serious Injures, Serious Illnesses or Hazardous Materials Exposures

25.1.1 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.

25.1.2 Tell emergency and medical personnel:

25.1.2.a Your name, location and nature of the emergency

25.1.2.b Name of the chemical involved

25.1.2.c The amount involved

25.1.2.d Area of the body effected

25.1.2.c Symptoms

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

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

25.1.4 Follow the appropriate steps outlined in section 25.3, Personal Contamination.

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

25.2.1 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.

25.2.2 Employees and graduate students, after consultation with Environmental Health & Safety should be sent to Christiana Care Occupational Health Services. Graduate Students may also utilize Student Health Services after consultation with Environmental Health and Safety

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

25.3 Personal Contamination

25.3.1 Chemicals Spilled Over a Large Area of the Body

25.3.1.a 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.

25.3.1.b 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

25.3.1.c The "buddy" or lab partner should retrieve the MSDS and provide to EMS

25.3.1.d Seek medical attention promptly.

25.3.1.e Localized spills can be flushed under a faucet. 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.

25.3.1.f Notify your supervisor, teaching assistant or principal investigator.

25.3.2 Chemicals in the Eyes

25.3.2.a The "buddy" or lab partner should assist the person to an eyewash and contact **911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses** immediately.

25.3.2.b 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.

25.3.2.c The "buddy" or lab partner should retrieve the MSDS and provide to EMS.

25.3.2.d Seek medical attention promptly.

25.3.2.e Notify your supervisor, teaching assistant or principal investigator.

25.3.3 Inhalation of Vapors, Mists, Fumes or Smoke

25.3.3.a 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.

25.3.3.b 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:

1. Oxygen depletion

2. Explosive vapors

3. Cyanide gas, hydrogen sulfide, nitrogen oxides, carbon monoxide or other toxic gases, mists, vapors or fumes

25.3.3.c Utilize the safety shower or eyewash and flush effect areas as need for 15 minutes if applicable

25.3.3.d If trained and necessary, provide Rescue Breathing or CPR

25.3.3.e The "buddy" or lab partner should retrieve the MSDS and provide to EMS.

25.3.3.f Seek medical attention promptly.

25.3.3.g Notify your supervisor, teaching assistant or principal investigator.

25.3.4 Burning Chemicals on Clothing

25.3.4.a Extinguish burning clothing by using the drop-and-roll technique or by dousing with cold water or use an emergency shower.

25.3.4.b Remove contaminated clothing; however, avoid further damage to the burned area. Do not remove any clothing or material that is stuck to the victim

25.3.4.c 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.

25.3.4.d Cover injured person to prevent shock.

25.3.4.e Get medical attention promptly.

25.3.5 Ingestion of Hazardous Chemicals

25.3.5.a Identify the chemical ingested and obtain the MSDS

25.3.5.b The "buddy" or lab partner should contact **911 on the Newark Campus or 9-911 on the Lewes and Georgetown Campuses** immediately.

25.3.5.c Call the Poison Information Center (1-800-722-7112).

25.3.5.d Provide the ambulance crew and physician with the Material Safety Data Sheet, the chemical name and any other relevant information. If possible, send the container or the label with the victim.

25.4 Minor First Aid

25.9.1 First Aid Kits

25.9.1.a Departments should obtain a first aid kit for treatment of minor first aid cases (cuts, scratches, minor burns).

25.9.1.b First aid kits may be purchased from the Department of Environmental Health and Safety.

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

25.9.1.d First aid kits must be fully stocked at all times.

25.9.1.e Do not dispense or administer any medications, including aspirin.

25.9.1.f Do not put any ointments or creams on wounds or burns. Use ice, cold pack or cold water.

25.9.1.g The MSDS contains special first aid information.

25.9.1.h After giving first aid, direct or transport the victim to a medial facility for evaluation.

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

25.9.1.j Non-emergent employee, including graduate and postdoctoral students, first aid cases are treated at the Christiana Care Occupational Health Services after consultation with EHS.

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

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

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

Chapter 26: Transporting Hazardous Materials

26.1 Procedures for Transporting Hazardous Materials in University Owned Vehicles for Research Purposes

26.1.1 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. 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. 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.

26.1.2 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. To date many chemicals including types of the most common and hazardous solvents, acids and alkalis are available to users in break-resistant containers. Vendors continue to increase the available selection of these break resistant containers. 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.

26.1.3 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. During the transport of several types of chemicals, segregation must be accomplished by using two 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.

26.1.4 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.

26.1.5 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. 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. During the transport of organic solvents, fuming acids, caustics, air reactive compounds or odorous compounds you must use a vehicle with a separate cargo space (i.e. pick-up truck). Situations may arise that have not been anticipated by this procedure; these will be dealt with on a case-by-case basis. Common sense will be applied depending on the physical state of the material (liquid vs. solid); volume of container and hazard of the material (flammable, toxic, corrosive, reactive, etc.). In general, no extremely hazardous materials shall be transported in university vehicles (i.e. explosives, shock sensitive, temperature sensitive, highly toxic).

Chapter 27: Laboratory and Laboratory Equipment Decontamination, Close Out and Decommissioning Procedures

27.1 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.

27.1.1 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.

27.1.2 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 a laboratory decontamination.

27.1.3 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.

27.1.4 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.

27.1.4.a 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;

27.1.4.b DEHS will review the historical use of chemical, biological and radioactive materials within the laboratory;

27.1.4.c DEHS will inspect the laboratory;

27.1.4.d 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;

27.1.4.e DEHS will coordinate with a qualified contractor to schedule and perform the cleaning, if needed;

27.1.4.f DEHS will confirm that the contractor adequately cleaned the laboratory and will provide written confirmation to the requesting Department contact;

27.1.4.g Laboratories may not be renovated or reoccupied until the DEHS has confirmed that the area is adequately cleaned; and

27.1.4.h 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.

27.2 It is important that researchers properly decontaminate their laboratory equipment from hazardous materials (flammable, corrosive, reactive, toxic, radioactive, 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.

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

27.2.1.a 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 27.2.3 for a list of recommended decontamination solutions.

27.2.1.b 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.

27.2.1.c For items used with radioactive materials, no radioactivity must be detected with survey equipment or swipe tests. Contact the Radiation Safety Officer. See section 27.2.3 for a list of recommended decontamination solutions.

27.2.1.d Where infectious materials were used, disinfect all surfaces with an effective disinfectant. See section 27.2.3 for a list of recommended decontamination solutions.

27.2.1.e 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.

27.2.1.f 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.

27.2.1.g 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.

27.2.1.e 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

27.2.1.f 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.

27.2.2 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.

27.2.2.a 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, 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.

27.2.2.b 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.

27.2.2.c Incubators - Remove any remaining samples and drain the water from the jacket. Remove mercury thermometers.

27.2.2.d Centrifuges - Inspect for centrifuge tubes holding water or samples to insure they have been removed from the rotor system.

27.2.2.e Water baths - Drain the water from the unit and remove any remaining samples or mercury thermometers.

27.2.2.f Balances or scales - Wipe clean to remove any remaining chemical contamination inside the balance or on the scale.

27.2.2.g 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.

27.2.2.h 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.

27.2.2.i 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).

27.2.2a.j 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.

27.2.2.k 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.

27.2.2.l 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.

27.2.2.m 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.

27.2.2.n Gas chromatographs (GC) which have electron capture detectors contain a radioactive source. Contact the Radiation Safety Officer.

27.2.2.o 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.

27.2.2.p 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.

27.2.2.q Colorimeters may contain cuvets holding liquids (remove them).

27.2.2.r Spectrophotometers may have automatic sample feeders holding sample containers or standards (remove them).

27.2.2.s Desiccators may contain drying agents (Drierite, NaOH, phosphorus pentoxide). Discard the spent drying agents through Occupatioanal Health & Safety as chemical waste.

27.2.2.t Transformers or high voltage regulators may contain oil. Outdated transformers may hold toxic PCB contaminated oil. Contact Occupatioanl 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.

27.2.2.u Water purification systems - Remove all the free standing water from the water purification cartridges.

27.2.2.v 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.

27.2.3 Recommended Decontamination Solutions

27.2.3.a 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.

27.2.3.b 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.

27.2.3.c 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.

27.2.3.d 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.

27.2.4 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.

27.2.5 All waste materials, decontamination solutions and other discard products or materials must be handled through the appropriate waste disposal program.

27.2.6 Engineering controls, such as fume hoods and elephant trunks should be used when decontaminating and servicing all laboratory equipment.

Chapter 28: Special Precautions for Working with Compressed Gasses

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

28.2 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.

28.3 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.

28.4 Ordering and Storage

28.4.1 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.

28.4.2 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 can not 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 Material Safety Data Sheet, container label and tags, manufacturers' literature and Compressed Gas Association publications.

28.4.3 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.

28.4.4 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.

28.4.5 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.

28.4.6 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 1/2 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.

28.5 Quantity Limitations – All classes of gases must be below these quantity limitations per laboratory.

28.5.1 Research Laboratories

28.5.1.a Pyrophoric Gas – 20 ft^3 (total volume of gas)

28.5.1.b Corrosive Gas – 810 ft^3 (total volume of gas)

28.5.1.c Flammable Gas (based on internal cylinder volume at 70°F and 1atm)

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

28.5.1.d Liquefied Flammable Gas (based on internal cylinder volume at 70°F and 1atm)

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

28.5.1.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)

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 of total gas volume or which ever is less

28.5.1.f Oxidizing Gas (based on internal cylinder volume at 70°F and 1atm)

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

28.5.2 Teaching and Instructional Laboratories

28.5.2.a Pyrophoric Gas – 20 ft^3 (total volume of gas)

28.5.2b Highly Toxic Gas (Health Hazard Rating of 3 of 4) – 20 ft^3

28.5.2.c Corrosive Gas – 810 ft^3 (total volume of gas)

28.5.2.d Flammable Gas (based on internal cylinder volume at 70°F and 1atm) – 6.0 ft^3

28.5.2.e Liquefied Flammable Gas(based on internal cylinder volume at 70°F and 1atm) – 1.2 ft^3

28.5.2.f Oxidizing Gas(based on internal cylinder volume at 70°F and 1atm) – 6.0 ft^3

28.5.2.g 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) – 0.3 ft^3

28.6 Transporting Gas Cylinders

28.6.1 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.

28.6.2 Be aware of the mechanical hazards of gas cylinders which are usually of steel or aluminum construction. 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.

28.6.3 Interior elevators are a confined space hazard 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.

28.6.4 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.

28.6.5 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.

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

28.7 Using Gases in the Laboratory

28.7.1 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.

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

28.7.3 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.

28.7.4 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

28.7.5 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.

28.7.6 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.

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

28.7.8 Pressure Reducing Regulator

28.7.8.a Slow 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 TeflonTM thread tape will stop a leak caused by a fitting flaw. Return leakers to the vendor for overhaul.

28.7.8.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 failing ballistically. 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.

28.7.8.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.

28.7.8.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.

28.7.8.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.

28.7.8.f Regarding gaskets and thread tape, always replace the gasket washer on flat-faced CGA fittings. Do not use TeflonTM 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.

28.7.8.g A 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.

28.7.8.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.

28.7.8.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.

28.7.8.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.

28.7.8.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.

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

28.7.8.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.

28.7.8.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 MSDS. This document should be read completely before proceeding.

1. Safety Precautions
   i. WEAR APPROVED EYE PROTECTION AND SAFETY APPAREL AS RECOMMENDED BY THE MSDS.

   ii. Know the specific hazards associated with gas to be used. Consult the MSDS that was shipped with the gas or obtain a copy from Environmental Health & Safety.

   iii. Leak test the system on which the gas is to be used.

   iv. 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

   i. A single-stage regulator will usually require delivery pressure adjustment as the cylinder pressure decreases.

   ii. Two-stage regulators will usually require no adjustment.

3. Installation and Operation

   i. Properly secure the cylinder to a stable surface.

   ii. Remove the cap from the cylinder.

   iii. Make sure the cylinder valve is tightly closed.

   iv. Remove the cylinder valve cap or plug if present.

   v. 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.

vi. Close the regulator by turning the adjusting knob or handle **counterclockwise.**

vii. Close the outlet valve fully in a **clockwise** direction. If a valve is not present, one should be purchased.

viii. 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.

ix. NEVER use lubricants or Teflon tape to aid in the connection or sealing of the CGA fitting.

x. 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.

xi. Hex nuts on the CGA connection with notches in the middle indicate left hand threads and are tightened in a counterclockwise direction.

xii. 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.

xiii. 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.

xiv. 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.

xv. 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.

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

xvii. 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.

xviii. Check the system for leaks.

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

4. Shutdown and Removal

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

ii. 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.

iii. 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.

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

28.7.9 Special Precautions and Provisions:

28.7.9.a Toxic 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:

    i. Cabinet and equipment must be designed specifically for the gases to be used and stored.

    ii. Exhaust ventilation fans and gas cabinet equipment must be on emergency power.

    iii. Fire extinguishing system inside

    iv. Should be construct of compatible material not less than 0.097 inches (2.5 mm) steel.

    v. Self enclosing limited access ports

    vi. Outfitted with self closing doors

    vii. 200 fpm at access ports with minimum 150 fpm at any point of the access port

    viii. 200 fpm – across unwelded fittings and connections in piping systems

    ix. Non - combustible material

    x. Remote manual shutdown of process gas flow

    xi. 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 laboratorian 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

28.7.9.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 inerts are used in your laboratory.

28.7.9.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.

28.7.9.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.

28.7.9.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.

28.7.9.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, ventilated and sprinklered 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 the laboratorian 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 sprinklered, continuously mechanically ventilated enclosure.

4. Compressed gas Cabinets should meet the following specifications:

   i. Cabinet and equipment must be designed specifically for the gases to be used and stored.

   ii. Exhaust ventilation fans and gas cabinet equipment must be on emergency power.

   iii. Fire extinguishing system inside

   iv. Should be construct of compatible material not less than 0.097 inches (2.5 mm) steel.

   v. Self enclosing limited access ports

   vi. Outfitted with self closing doors

   vii. 200 fpm at access ports with minimum 150 fpm at any point of the access port

   viii. 200 fpm – across unwelded fittings and connections in piping systems

   ix. Non - combustible material

   x. Remote manual shutdown of process gas flow

   xi. Purge panels – automated purge panel

5. 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.

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

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

8. Piping, tubing, valves, fittings, and related items - must be:

    i. Designed and installed in accordance with approved standards

    ii. Compatible with material

    iii. Adequate strength and durability to withstand pressure and stress

    iv. Shall not be located with in corridors, within any portion of a means of egress required to be enclosed in Fire resistance- rated construction or concealed spaces.

    v. Shall have welded, threaded or flanged connections throughout

    vi. Piping and tubing shall be identified in accordance with ANSI-A13.1

    vii. Pressure tested to approved standards

    viii. Readily accessible manual valves or automated remotely activated valves.

    ix. Fail safe approved Emergency shut off valve installed on supply piping and tubing at the following locations:

        a. Point of use

        b. The source

    x. Shall be identified and the location clearly visible, accessible and indicated by means of a sign

    xi. Backflow prevention or check valves

xii. 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.

9. Depending on performance specification of the system, install a Pyrolyzer or burn box for effluent for consideration of thermal destruction.

28.7.9.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:

i. Monitoring points in gas cabinet, equipment and rooms

ii. Alarms will shut off gas supply by solenoids

iii. Alarms to trigger building alarms

iv. Separate annunciation for gas detection

v. Alarm to report to Public Safety

vi. Must be able to monitor gas levels from outside hazard area

Chapter 29: Shipping Research Samples, Products and Chemicals

29.1 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:

29.1.1 Biological Shipments: http://www.udel.edu/ehs/transportbio.html

29.1.2 Chemical Shipments: http://www.udel.edu/ehs/transhazmat.html

29.2 Examples (not an inclusive list):

29.2.1 Dry Ice

29.2.2 Liquid Nitrogen

29.2.3 Synthesized Products and Samples

29.2.4 Materials of Biological Origin

29.2.5 Formaldehyde and Formalin

29.2.6 Flammable and Combustible Liquids

29.2.7 Anything Capable of Incapacitating a Pilot or Driver

29.2.9 Equipment Containing or Contaminated with Chemicals

29.2.10 Material Preserved with a Chemical

29.3 Shipping Process

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

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

29.3.4 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.

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

29.5 Unwanted or Improper Reagents Received from a Vendor

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

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

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

29.6 Transportation Security and Safety

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

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

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

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

29.6.5 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.

29.6.6 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.

Chapter 30 Shipping Research Samples, Products and Chemicals

29.1 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:

29.1.1 Biological Shipments: http://www.udel.edu/ehs/transportbio.html

29.1.2 Chemical Shipments: http://www.udel.edu/ehs/transhazmat.html

Appendix A

Hazardous Materials Safety Manual

- Available in the Front Pocket of the Chemical Hygiene Plan
- Available Online at http://www.udel.edu/ehs/hazmatman.pdf
- Request Printed Copies from Environmental Health and Safety

Appendix B

Resources – Available at the Websites Listed

B1 – 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 Permissable Exposure Limits (PEL) – 29 CFR 1910.1450 subpart Z – http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10147
- 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

B2 – 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

B3 – ACGIH Guide to Occupational Exposure Values – Request from the Department of Environmental Health & Safety or order online at http://acgih.org/store/

B4 – Material Safety Datasheets – http://udel.chemwatchna.com/

B5 – Prudent Practices in the Laboratory – http://www.nap.edu/readingroom/books/prudent/

B6 – Environmental Health and Safety Online Resources

- Chemical Hygiene Program – http://www.udel.edu/ehs/chemindex.html
- Chemical Storage Guidelines – http://www.udel.edu/ehs/chemcompatstorage.html
- Chemical Shipping Program – http://www.udel.edu/ehs/transhazmat.html
- Safety and Compliance Guide for Research Faculty and Laboratory Coordinators – http://www.udel.edu/ehs/facultycomplianceguide.pdf
- Standard Operating Procedures for Working with Chemicals – http://www.udel.edu/ehs/labsop.html

Appendix C

University of Delaware Respirator Protection Manual – Available at http://www.udel.edu/ehs/respiratoryprotmanual.pdf

Appendix D

CHRISTIANA CARE
Occupational Health Services

501 West 14th Street
Wilmington, Delaware 19801

302-428-4250 phone
302-428-4280 fax

200 Hygeia Drive
Newark, Delaware 19713

302-428-4250 phone
302-623-0161 fax

November 22nd, 2005

Kevin M. Eichinger, CHMM
University Chemical Hygiene Officer
University of Delaware
Department of Occupational Health and Safety
222 S. Chapel Street, Rm 132
Newark, DE 19716

Dear Mr Eichinger,

This letter is to confirm that the Christiana Care Occupational Health Services 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 the OSHA Standard 29CFR1910.1450.

Please do not hesitate to contact with me with questions or concerns.

Sincerely,

Lalitha Kambhamettu, M.D.

Appendix E

Chemicals Requiring Special Handling Procedures.

The following is an alphabetical compilation of chemical substances that meet the University of Delaware's definition of a Reproductive Hazard, Highly Toxic or Carcinogenic Chemical for the purpose of the University Chemical Hygiene Plan. This list requires special procedures and approval prior to purchase and use. See Chapter 12 for more information. This list is not all inclusive.

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
ACEMETACIN	53164-05-9									
ACETALDEHYDE		ANTICIPATED	GROUP 2B							
ACETAMIDE	60-35-5		GROUP 2B							
ACETATO-ORTHO-PHENYLMERCURY*										
ACETAZOLAMIDE	56-66-5				YES					
ACETIC ACID-4,6-DINITRO-o-CRESYL ESTER	18461-55-7								0.2	
ACETOHYDROXAMIC ACID	546-88-3			YES						
ACETONE CYANOHYRDIN*	75-86-5							1	5 (C)	
ACETONYL CHLORIDE	78-95-5				YES					X
3(alpha-ACETONYLFURFURYL)-4-HYDROXYCOUMARIN	117-52-2									
ACETOXYCYCLOHEXIMIDE	2885-39-4				YES					
ACETOXYTRIETHYLSTANNANE	1907-13-7								0.1	
2-ACETYLAMINOFLUORENE		ANTICIPATED								
ACETYLENE TETRABROMIDE	79-27-6							1	14	
1-ACETYL-2-THIOUREA*										
ACROLEIN *	107-02-8							0.01	0.025	
ACRYLAMIDE	79-06-1		GROUP 2A							
ACRYLIC ACID	Reprotox									
ACRYLONITRILE*		ANTICIPATED	GROUP 2B							
ACTYLYL CHLORIDE										

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
ACTIDIONE (CYCLOHEXYLAMINE SULFATE)	66-81-9			YES						X
ACTINOMYCIN	1402-38-6			YES						
ACTINOMYCIN 23-21	8506-83-5									
ACTINOMYCIN C	8052-16-2			YES						
ACTINOMYCIN D	50-76-0			YES						
ACTINOMYCIN S	12623-78-8									
ACTINOMYCIN S3	11097-67-9									
1-ADRENALINE CHLORIDE	55-31-2			YES						
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							
ALDOXYCARB	1646-88-4									
ALDRIN	309-00-2								0.025	X
ALUMINUM PHOSPHIDE	20859-73-8									
5-ALLYL-5-BENZYL-2-THIOBARBITURIC ACID	64058-13-5									
ALLYL ALCOHOL	814-68-6									
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									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
ALLYL PROPYL DISULFIDE	2179-59-1							2	12	
ALPHA-NAPHTHYLAMINE										
ALPRAZOLAM	28981-97-7			YES						
ALTRETAMINE	645-05-6				YES					
AMIKACIN SULFATE	39831-55-5			YES						
AMANTADINE HYDROCHLORIDE	665-66-7				YES					
2-AMINOANTHRAQUINONE		ANTICIPATED								
P-AMINOAZOBENZENE	60-09-3		GROUP 2B							
O-AMINOAZOTOLUENE	97-56-3		GROUP 2B							
4-AMINOBIPHENYL	92-67-1	KNOWN	GROUP 1							
1-AMINO-2,4-DIBROMOANTHRAQUINONE		ANTICIPATED								
2-AMINO-3,4-DIMETHYLIMIDAZO[4,5-F]QUINOLINE (MEIQ)		ANTICIPATED								
2-AMINO-3,4-DIMETHYLIMIDAZO[4,5-F]QUINOXALINE (MEIQX)		ANTICIPATED								
AMINOGLUTETHIMIDE	125-84-8			YES						
AMINOGLYCOSIDES				YES						
1-AMINO-2-METHYLANTHRAQUINONE		ANTICIPATED								
2-AMINO-3-METHYLIMIDAZO[4,5-F]QUINOLINE (IQ)		ANTICIPATED								
2-AMINO-1-METHYL-6-PHENYLIMIDAZO[4,5-B]PYRIDINE (PHIP)		ANTICIPATED								
2-AMINO-5-(5-NITRO-2-FURYL)-1,2,4THIADIAZOLE	712-68-5		GROUP 2B							
AMINOPTERIDINE	54-62-6			YES						

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
2-AMINOPYRIDINE	504-29-0							0.5	2	
4-AMINOPYRIDINE	504-24-5									
AMIODARONE HYDROCHLORIDE	19774-82-4			YES						
AMITRAZ	33089-61-1			YES						
AMITROLE	Reprotox	ANTICIPATED								
AMOXAPINE	14028-44-5			YES						
AMSACRINE	51264-14-3		GROUP 2B							
t-AMYL METHYL ETHER	Reprotox									
ANABOLIC STEROIDS				YES						
ANGIOTENSIN CONVERTING ENZYME (ACE)				YES						
ANISIDINE (O-,P-ISOMERS)	29191-52-4	ANTICIPATED	GROUP 2B						0.05	X
ANISINDIONE	117-37-3			YES						
ANTIMONY TRICHLORIDE										
ANTIMONY TRIOXIDE			GROUP 2B							
ARISTOLOCHIC ACID			GROUP 2A							
ARSENIC AND ARSENIC COMPOUNDS	7440-38-2	KNOWN	GROUP1	YES						
ARSENIC ACID, SODIUM SALT	7631-89-2									
ARSENIC ACID, SOLUTION	7778-39-4									
ARSENIC IODIDE	7784-45-4									
ARSENIC PENTAFLUORIDE	7784-36-3									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
ARSENIC PENTASULFIDE	103-34-0									
ARSENIC PENTOXIDE	1303-28-2									
ARESNIC TRICHLORIDE	7784-34-1									
ARSENIC TRIOXIDE	1327-53-3									
ARSENIC TRISULFIDE	1303-33-9									
ARSENIOUS ACID	1327-53-3									
ARSENIOUS OXIDE	1327-53-3									
ARSINE	7784-42-1							0.005	0.02	
ASPIRIN (ACETOSALIC ACID)	50-78-2			YES						
ATENOLOL	29122-68-7			YES						
AURANOFIN	34031-32-8									
AZACITIDINE	320-67-2	ANTICIPATED	GROUP 2A							
AZASERINE	115-02-6		GROUP 2B							
AZATHIOPRINE	446-86-6	KNOWN	GROUP 1	YES						
AZINPHOS-METHYL	86-50-0			YES					0.02	X
AZIRIDINE	151-56-4		GROUP 2B							
BARBITURATES				YES						
BECLOMETHASONE DIPROPIONATE	5535-09-8			YES						
BENOMYL	17804-35-2			YES	YES	YES				
BENZ[J]ACEANTHRYLENE	202-33-5		GROUP 2B							

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
BENZAL CHLORIDE	98-87-3		GROUP 2A							
BENZENE	71-43-2	KNOWN	GROUP 1	YES				1		
BENZIDINE	92-87-5	KNOWN	GROUP 1							
BENZIDINE-BASED DYES		KNOWN	GROUP 2A							
BENZEDRINE	300-62-9									
BENZENETHIOL (PHENYL MERCAPTAN, THIOPHENOL)	108-98-5							0.5		X
BENZO[A]ANTHRACENE		ANTICIPATED	GROUP 2B							
BENZODIAZEPINES				YES						
BENZO[B]FLUORANTHRACENE		ANTICIPATED	GROUP 2B							
BENZO[J]FLUORANTHRACENE		ANTICIPATED	GROUP 2B							
BENZO[K]FLUORANTHRACENE		ANTICIPATED	GROUP 2B							
BENZOFURAN	271-89-6		GROUP 2B							
BENZO[C]PHENANTHRENE	195-19-7		GROUP 2B							
BENZO[A]PYRENE	50-32-8	ANTICIPATED	GROUP 1							
BENZOTRICHLORIDE		ANTICIPATED								
BENZPHETAMINE HYDROCHLORIDE	5411-22-3					YES				
BENZYL CHLORIDE		ANTICIPATED								
BERYLLIUM AND COMPOUNDS	7440-41-7	KNOWN	GROUP 1						2	
BENZOYL CHLORIDE	98-88-4		GROUP 2A							
BETA- NAPHTHYLAMINE	91-59-8	KNOWN								

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
BIDRIN	141-66-2				YES				0.25	X
2,2-BIS-(BROMOETHYL)-1,3-PROPANEDIOL		ANTICIPATED	GROUP 2B							
N,N-BIS(2-CHLOROETHYL)-2-NAPHTHYLAMINE (CHLORNAPHAZINE)	494-03-1		GROUP 1							
BIS-CHLOROETHYL NITROSOUREA (BCNU) (CARMUSTINE)	154-93-8	ANTICIAPTED	GROUP 2A			YES				
BIS-CHLOROMETHYL ETHER	542-88-1	KNOWN	GROUP1							
BLEOMYCINS	11056-06-7		GROUP 2B							
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			YES						
BROMODICHLOROMETHANE		ANTICIPATED	GROUP 2B							
BROMOFORM	*75-25-2*							*0.05*	*5*	*X*
1-BROMOPROPANE (1-BP)	106-94-5					YES				
2-BROMOPROPANE (2-BP)	75-26-3					YES				
BROMOXYNIL	1689-84-5			YES						
BROMOXYNIL OCTANOATE	1689-99-2			YES						
BUSULFAN (1,4-BUTANEDIOL DIMETHANESULFONATE)	55-98-1			YES	YES					
BUTABARBITAL SODIUM	143-81-7			YES						
1,3-BUTADIENE	106-99-0	KNOWN	GROUP 1	YES				1		

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
1,4-BUTANEDIOL DIMETHYL SULFONATE (MYLERAN)	55-98-1	KNOWN	GROUP 1	YES						
N-BUYTL ACRYLATE	Reprotox									
BUTYLATED HYDROXYANISOLE (BHA)		ANTICIPATED	GROUP 2B							
BUTYL BENZYL PHTHALATE (BBP)	85-68-7			YES						
2-sec-BUTYL-4,6-DINITROPHENOL (DNBP)	88-85-7									
N-BUTYL MERCAPTAN	Reprotox									
BUTYRIKACTONE	3068-88-0		GROUP 2B							
CADMIUM AND COMPOUNDS	7440-43-9	KNOWN	GROUP 1	YES		YES				
CALCIUM CYANIDE	592-01-8									
CAPTAFOL	2425-06-1		GROUP 2A							
CARBAMAZEPINE	298-46-4			YES						
CARBARYL (SEVIN)	63-25-2			Reprotox					5	
CARBON DISULFIDE	75-15-0			YES		YES				
CARBON MONOXIDE	630-08-0			YES						
CARBON TETRACHLORIDE		ANTICIPATED	GROUP 2B							
CARBONYL CHLORIDE	75-44-5									
CARBONYL FLUORIDE	353-50-4									
CARBONYL OXYFLUORIDE	353-50-4									
CARBOPLATIN	41575-94-4			YES		YES	YES			
CATECHOL	120-80-9		GROUP 2B							

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
CEREMIC FIBERS (RESPIRABLE SIZE)		ANTICIPATED								
CHENODIOL (CHENODEOXYCHOLIC ACID)	474-25-9			YES						
CHLORAMBUCIL	305-03-3	KNOWN	GROUP 1	YES	YES					
CHLORAMPHENICOL	56-75-7	ANTICIPATED								
CHLORCYCLIZINE HYDROCHLORIDE	1620-21-9			YES						
CHLORDANE	57-74-9		GROUP 2B						0.05	X
CHLORDECONE (KEPONE)	143-50-0	ANTICIPATED	GROUP 2B	YES		YES				
CHLORENDIC ACID		ANTICIPATED	GROUP 2B							
CHLORINATED CAMPHENE	8001-35-2								0.05	X
CHLORDIAZEPOXIDE	58-25-3			YES						
CHLORINATED DIPHENYL OXIDE	55720-99-5								0.05	
CHLORINATED PARAFFINS		ANTICIPATED								
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			GROUP 2B							
CHLOROBIPHENYLS										

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
1-CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)FURANONE	77439-76-0		GROUP 2B							
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					
(2-CHLOROETHYL-3-(4-METHYLCYCLOHEXYL-1-NITROSOUREA (MeCCNU)	13909-09-6	KNOWN	GROUP 1							
CHLOROFORM	Reprotox	ANTICIPATED	GROUP 2B							
CHLOROMETHYL METHYL ETHER, TECH-GRADE	107-30-2	KNOWN	GROUP 1							
3-CHLORO-2-METHYLPROPENE		ANTICIPATED	GROUP 2B							
CHLOROMETHYL SILANE										
4-CHLORO-O-PHENYLENEDIAMINE		ANTICIPATED	GROUP 2B							
CHLOROPHENOXY HERBICIDES			GROUP 2B							
CHLOROPICRIN	76-06-2							0.01	7	
ß-CHLOROPRENE	Reprotox	ANTICIPATED	GROUP 2B							
1-CHLORO-2-PROPANOL	Reprotox									
2-CHLORO-1-PROPANOL	Reprotox									
4-CHLORO-ORTHO-TOLUIDINE		ANTICIPATED	GROUP 2A							
CHLOROPROPIONIC ACID	Reprotox									
CHLOROTHALONIL	1897-45-6		GROUP 2B							
CHLOROZOTOCIN	54749-90-5	ANTICIPATED	GROUP 2A							
CHLORSULFURON	64902-72-3			YES		YES				

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
CHROMIUM, HEXAVALENT COMPOUNDS		KNOWN	GROUP 1							
CHRYSENE	21801-9		GROUP 2B							
CICLOSPORIN	79217-60-0		GROUP 1							
CIDOFOVIR	113852-37-2			YES						
CISPLATIN	15663-27-1	ANTICIPATED	GROUP 2A	YES					0.002	
13-CIS-RETINOIC ACID (ISOTRETINOIN AND ACCUTANE)				YES						
CLADRIBINE (2-CHLORO-2'-DEOXYADENOSINE)	4291-63-8					YES				
CLARITHROMYCIN	81103-11-9			YES						
CLOBETASOL PROPIONATE	25122-46-7			YES						
CLOMIPHENE CITRATE	50-41-9			YES		YES				
CLOPIDOL	2971-90-6								5	
CLORAZEPATE DIPOTASSIUM	57109-90-7			YES		YES				
COBALT AND COMPOUNDS	7440-48-4	ANTICIPATED	GROUP 2B						0.01	
CODEINE	52-28-8			YES		YES				
COLCHICINE	64-86-8			YES						
CONJUGATED ESTROGENS				YES	YES	YES	YES			
COUMADIN (WARFARIN)	81-81-2			YES					0.1	
CRAG HERBICIDE (SESONE)	136-78-7									
P-CRESIDINE		ANTICIPATED	GROUP 2B							
CRESOL, ALL ISOMERS	1319-77-3								5	

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
CROTONALDEHYDE	123-73-9							5	22	X
CUPFERRON		ANTICIPATED								
CYANAZINE	21725-46-2			YES						
CYANIDES (AS CN)										
CYANOGEN	460-19-5									
CYANOGEN CHLORIDE	506-77-4									
CYANURIC FLUORIDE										
CYASIN	14901-08-7		GROUP 2B							
CYCLOATE	1134-23-2					YES				
CYCLOHEXIMIDE	66-81-9			YES						
CYCLOPENTAL[CD]PYRENE	27208-37-3		GROUP 2A							
CYCLOPHOSPHAMIDE	50-18-0	KNOWN	GROUP 1	YES						
CYCLOSPORIN A	79217-60-0	KNOWN	GROUP 1							
CYHEXATIN	13121-70-5			YES						
CYTARABINE (CYTOSINE ARABINOSIDE)	147-94-4			YES	YES					
DAUNOMYCIN	20830-81-3		GROUP 2B			YES				
DACARBAZINE	4342-03-4	ANTICIPATED	GROUP 2B	YES	YES					
DANAZOL	17230-88-5					YES				
DANTHRON (1,8-DIHYDROXYANTHRAQUINONE)		ANTICIPATED	GROUP 2B							
DASANIT	115-90-2									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
DAUORUBICIN HYDROCHLORICE	23541-50-6			YES	YES					
o,p'-DDT	789-02-6	ANTICIPATED	GROUP 2B			YES				
p,p'-DDT	50-29-3	ANTICIPATED	GROUP 2B			YES				
DECABORANE	17702-41-9									
DEMETON (SYSTOX)	8065-48-3							0.005	0.03	X
N,N'-DIACETYLBENZIDINE	613-35-4		GROUP 2B							
2,4-DIAMINOANIZOLE SULFATE		ANTICIPATED	GROUP 2B							
4,4'-DIAMINODIPHENYL ETHER	101-80-4		GROUP 2B							
2,4-DIAMINOTOLUENE		ANTICIPATED	GROUP 2B							
DIAZOMETHANE	334-88-3									
DIAZOAMINOBENZENE		ANTICIPATED								
DIBENZ[A,H]ACRIDINE		ANTICIPATED	GROUP 2B							
DIBENZ[A,J]ACRIDINE		ANTICIPATED	GROUP 2B							
DIBENZ[A,H]ANTHRACENE	53-70-3	ANTICIPATED	GROUP 2A							
DIBENZO[C,G]CARBAZOLE		ANTICIPATED	GROUP 2B							
DIBENZO[A,E]PYRENE		ANTICIPATED								
DIBENZO[A,H]PYRENE		ANTICIPATED	GROUP 2B							
DIBENZO[A,I]PYRENE		ANTICIPATED	GROUP 2B							
DIBENZO[A,L]PYRENE	191-30-0	ANTICIPATED	GROUP 2A							
DIBORANE	19287-45-7									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
1,2-DIBROMO-3-CHLOROPROPANE		ANTICIPATED	GROUP 2B							
1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)		ANTICIPATED								
2,3-DIBROMO-1-PROPANOL		ANTICIPATED	GROUP 2B							
TRIS(2,3-DIBROMOPROPYL) PHOSPHATE		ANTICIPATED	GROUP 2A							
DIBUTYL PHOSPHATE	107-66-4									
DIBUTYL PHTHALATE	84-74-2							1	5	
DIOCHLOROACETIC ACID	79-43-6		GROUP 2B							
DICHLOROACETYLENE										
1,4-DICHLOROBENZENE		ANTICIPATED	GROUP 2B							
3,3'-DICHLOROBENZIDINE		ANTICIPATED	GROUP 2B							
3,3'-DICHLOROBENZIDINE DIHYDROCHLORIDE		ANTICIPATED	GROUP 2B							
3,3'-DICHLORO-4,4'-DIAMINODIPHENYL ETHER	28434-86-8		GROUP 2B							
1,3-DICHLORO-5, 5-DIMETHYL HYDANTOIN	118-52-5								0.02	
DICHLORODIPHENYLTRICHLOROEHTANE (DDT)		ANTICIPATED								
1,2-DICHLOROETHANE (EHTYLENE DICHLORIDE)		ANTICIPATED	GROUP 2B							
DICHLOROMETHANE (METHYLENE CHLORIDE)		ANTICIPATED	GROUP 2B							
2,2'-DICHLORO-N-METHYLDIETHYLAMINE	51-75-2	KNOWN		YES						X
2,4-DICHLOROPHENYL-P-NITROPHENYL ETHER		ANTICIPATED								
1,2-DICHLOROPROPENE		ANTICIPATED	GROUP 2B							
DICHLORVOS (DDVP)	62-73-7		GROUP 2B							

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
DICROTOPHOS	141-66-2									
DICYCLOPENTADIENYL IRON (RESPIRABLE FRACTION)	102-54-5								5	
DIELDRIN	60-57-1								0.025	X
DIEPOXYBUTANE		ANTICIPATED								
DI(2-ETHYLHEXYL) PHTHALATE		ANTICIPATED								
1,2-DIETHYLHYDRAZINE	1615-80-1		GROUP 2B	YES						
o,o-DIETHYL-o-(p-(METHYLSULFINYL)PHENYL)PHOSPHOROTHIOATE (BAY 25141, FENSULFOTHION)	115-90-2								0.1	
o-DIETHYL S-[2-(ETHYLTHIO)ETHYL]PHOSPHORODITHIOATE (DISULFOTON)	298-04-04								0.05	X
DIETHYLSTILBOESTROL	56-53-1	KNOWN	GROUP 1							
DIETHYL SULFATE	64-67-5	ANTICIPATED	GROUP 2A							
DIGLYCIDYL ETHER (DGE)	123639							.5 (C)	2.8 (C)	
DIGLYCIDYL RESORCINOL EHTER		ANTICIPATED	GROUP 2B							
DIHYRDROSAFROLE	94-58-6		GROUP 2B							
DIISOPROPYL SULFATE	2973-10-6		GROUP 2B							
DIISOPROPLY FLUOROPHOSPHATE	55-91-4									
3,3'-DIMETHOXYBENZIDINE		ANTICIPATED	GROUP 2B							
N,N'-DIMETHYLACETAMIDE	Reprotox									
4-DIMETHYLAMINO-AZOBENZENE		ANTICIPATED	GROUP 2B							
[4,4'-(DIMETHYLAMINO)BENZOPHENONE]		ANTICIPATED								

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
(N,N-DIMETHYLANILINE)	121-69-7		GROUP 2B					5	25	X
3,3'-DIMETHYLBENZIDINE		ANTICIPATED	GROUP 2B							
DIMETHYLCARBAMOYL CHLORIDE	79-44-7	ANTICIPATED	GROUP 2A							
DIMETHYL-1,2-DIBROMO-2, 2-DICHLOROETHYL PHOSPHATE	300-76-5								3	
DIMETHYL DISULFIDE										
DIMETHYLHYDRAZINE		ANTICIPATED	GROUP 2A							
DIMETHYLSULFATE		ANTICIPATED	GROUP 2A							
DIMETHYLSULFIDE										
DIMETHYL MERCURY	593-74-8									
DIMETHYLSULFATE										
DIMETHYLVINYL CHLORIDE		ANTICIPATED								
DINITROBENZENE (ALL ISOMERS)									1	X
3,7-DINITROFLUORANTHENE	105735-71-5		GROUP 2B							
3,9-DINITROFLUORANTHENE	22506-53-2		GROUP 2B							
DINITRO-O-CRESOL	534-52-1								0.02	X
1,6-DINITROPYRENE		ANTICIPATED	GROUP 2B							
1,8-DINITROPYRENE		ANTICIPATED	GROUP 2B							
DINITROTOLUENE	Reprotox		GROUP 2B							
DINOSEB	88-85-7									
1,4-DIOXANE		ANTICIPATED	GROUP 2B							

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
DIOXATHION	78-34-2								0.1	X
1,3-DIOXOLANE	Reprotox									
DIPHENYL (BIPHENYL)	92-52-4							0.02	1	
DIPHENYLHYDANTOIN AND TRIMETHADIONE				YES						
DYOHINATE (FONOFOS)	944-22-9								0.1	X
ENDOSULFAN (BENZOEPIN, THIODAN)	115-29-7			YES	YES				0.1	X
ENDRIN	72-20-8								0.01	X
EPICHLOROHYDRIN		ANTICIPATED	GROUP 2A							
1,2-EPOXYBUTANE	106-88-7		GROUP 2B							
ERIONITE	66733-21-9	KNOWN	GROUP 1							
ETHIDIUM BROMIDE	Reprotox									
ETHION	563-12-2									
2-ETHOXYETHANOL	Reprotox									
2-ETHOXYETHYL ACETATE	Reprotox									
ETHOXY-4-NITROPHENOXYPHENYLPHOSPHINE (EPN)	2104-64-5								0.5	X
ETHYL ACRYLATE	140-88-5		GROUP 2B							
ETHYL BENZENE	100-41-4		GROUP 2B							
ETHYL T-BUTYL ETHER	Reprotox									
ETHYL CARBAMATE (URETHANE)	51-79-6		GROUP 2A							
N-ETHYLMALEIMIDE	128-53-0									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
ETHYLENE DIBROMIDE	106-93-4	ANTICIPATED	GROUP 2A							
ETHYLENE CHLOROHYDRIN	107-07-3							5	16	X
ETHYLENE FLUOROHYDRIN										
ETHYLENE GLYCOL DINITRATE	628-96-6							.02 (C)	1 (C)	X
ETHYLENEIMINE				YES				0.5	0.88	X
EHTYLENE OXIDE	75-21-8	KNOWN	GROUP 1	Reprotox						
ETHYLENE THIOUREA		ANTICIPATED								
2-ETHYLHEXANOIC ACID	Reprotox									
ETHYL METHANESULFONATE		ANTICIPATED	GROUP 2B							
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 2A							
ETRETINATE				YES						
FENSULFOTHION	2224-92-6								0.1	X
FERROVANADIUM DUST	12604-58-9								1	
FLUORINE	7782-41-4							0.01	0.02	
FLUOROACETAMIDE*										
FLUORACETIC ACID*	62-74-8									
FONOFOS	944-22-9									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
FORMALDEHYDE	50-00-0	ANTICIPATED	GROUP 1							
FURAN		ANTICIPATED	GROUP 2B							
FURFURAL	98-01-1							5	20	X
GALLIUM ARSENIDE	1303-00-0		GROUP 1							
GLASS WOOL (RESPIRABLE SIZE)		ANTICIPATED								
GLYCIDOL	556-52-5	ANTICIPATED	GROUP 2A							
GLYCOLONITRILE	107-16-4									
GUTHION (AZINPHOS METHYL)	86-50-0								0.2	X
HALOTHANE	Reprotox									
HEPTACHLOR	76-44-8		GROUP 2B						0.05	X
HEPTACHLOR EPOXIDE	1024-57-3									
HEXACHLOROBENZENE		ANTICIPATED	GROUP 2B							
HEXACHLOROCYCLOHEXANE		ANTICIPATED	GROUP 2B							
HEXACHLOROETHANE		ANTICIPATED	GROUP 2B							
HEXACHLORONAPHTHALENE	1335-87-1								0.02	X
HEXAFLUOROACETONE	Reprotox									
HEXAMETHYLENE DIISOCYANATE										
HEXAMETHYLPHOSPHORAMIDE		ANTICIPATED	GROUP 2B							
HYDRAZINE		ANTICIPATED	GROUP 2B							
HYDRAZINE SULFATE		ANTICIPATED								

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
HYDRAZOBENZENE		ANTICIPATED								
HYDROCYANIC ACID	74-90-8									
HYDROFLUORIC ACID (GAS AND LIQUID)	7664-39-3									
HYDROGEN CHLORIDE GAS	7647-01-0									
HYDROGNE CYANIDE	74-90-8									
HYDROQUINONE	123-31-9								2	
HYDROXYACETONITRILE (GLYCOLONITRILE)	107-16-4								5	
HYDROXY-3(3-OXO-1-PHENYLBUTYL)-2H-1-BENZOPYRAN-2-ONE	81-81-2									
INDIUM PHOSPHIDE	22398-80-7		GROUP 2A							
INDENOL[123-CD]PYRENE		ANTICIPATED	GROUP 2B							
IRON DEXTRAN COMPLEX		ANTICIPATED	GROUP 2B							
IRON PENTACARBONYL	13463-40-6							0.1		
ISOPRENE		ANTICIPATED	GROUP 2B							
ISOPROPYL FORMATE										
KEPONE (CHLORDECONE)		ANTICIPATED								
LANNATE (METHOMYL)	16752-77-5								2.5	
LEAD AND INORGANIC LEAD COMPOUNDS	Reprotox	ANTICIPATED	GROUP 2A							
LEAD ARSENATE	Reprotox	ANTICIPATED	GROUP 2A							
LEAD CHROMATE	Reprotox	ANTICIPATED	GROUP 2A							
LINDANE		ANTICIPATED								

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
MALONONITRILE	2698-41-1							0.005	0.04	
MANGANESE	Reprotox									
MELPHALAN (1-PHENYLALANINE MUSTARD)	148-82-3	KNOWN	GROUP 1							
MERCURIC CHLORIDE	7439-97-6									
MERCURY AND COMPOUNDS	7439-97-6			YES		YES			2	
METHYLACRYLONITRILE										
METHACRYLOYL CHLORIDE										
METHYL ACRYLONITRILE	126-98-7									
METHACRYLOXYETHYL ISOCYANATE										
METHIMAZOLE				YES						
2-METHOXY ETHANOL	Reprotox									
2-METHOXYETHYL ACETATE	Reprotox									
8-METHOXYPSORALEN (METHOXSALEN)	298-81-7		GROUP 2A							
METHYLACRYLONITRILE										
2-METHYLAZIRIDINE (PROPYLENEIMINE)	75-55-8	ANTICIPATED	GROUP 2B							
METHYL T-BUTYL ETHER	Reprotox									
METHYL CHLORIDE	Reprotox									
METHYLCHLORORFORMATE										
METHYL CHLOROMETHYL ETHER										
METHYLCHRYSENE		ANTICIPATED	GROUP 2B							

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
2-METHYL CYCLOPENTADIENYL MANGANESE TRICARBONYL	12108-13-3								0.1	X
METHYLENE BIPHENYL ISOCYANATE										
METHYLFLUOROACETATE										
METHYLFLUOSULFATE										
METHYL HYDRAZINE (MONOMETHYL HYDRAZINE)	60-34-4							0.02 (C)	0.035 (C)	X
METHYL IODIDE	74-88-4									
METHYL ISOCYANATE	624-83-9							2	0.005	X
METHYLENEBIS(CHLOROANILINE) (MOCA)	101-14-4	ANTICIPATED	GROUP 1							
4-4'METHYLENEBIS(N,N'-DIMETHYL)BENZENAMINE		ANTICIPATED								
METHYLENE BISPHENYL ISOCYANATE (MDI)	101-68-8							0.002 (C)	0.02 (C)	
METHYLENEDIANILINE		ANTICIPATED	GROUP 2B							
METHYLEUGENOL		ANTICIPATED								
METHYLFLUOROSULFATE	421-20-5									
METHYLHYDRAZINE	60-34-4									
N-METHYLMALEIMIDE	930-88-1									
METHYL METHANESULFONATE		ANTICIPATED								
METHYL MERCURY	593-74-8		GROUP 2B							
METHYL METHANESULFONATE			GROUP 2A							
N-METHYL-N-NITROSO-METHANAMINE	62-75-9									
N-METHYL-N'-NITRO-N-NITROSOGUANIDINE (MNNG)	7025-7	ANTICIPATED	GROUP 2A							

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
N-METHYL-N-NITROSOUREA	684-93-5		GROUP 2A							
METHYLPARATHION	298-00-0								0.2	
2-(1-METHYLPROPYL)-4,6-DINITRO-PHENOL	88-85-7									
METHYLTRICHLOROSILANE										
METHYL VINYL KETON (2-BUTEN-2-ONE)	78-94-4				YES				0.2 (STEL)	X
METRONIDAZOLE		ANTICIPATED								
MEVINPHOS (PHOSDRIN)	7786-34-7								0.1	X
MIREX		ANTICIPATED	GROUP 2B							
MITOMYCIN C	50-07-7		GROUP 2B		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							
MYLERAN	55-98-1									
NAPHTHALENE		ANTICIPATED	GROUP 2B							
2-NAPHTHYLAMINE	91-59-8	KNOWN	GROUP 1							
NAPHTHYL METHYLCARBAMATE						YES				
N-(1-NAPHTHYL)-2-THIOUREA	86-88-4								0.3	
NICKEL CARBONYL										
NICKEL COMPOUNDS AND METALLIC NICKEL		KNOWN	GROUP 1							

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
NITRILOTRIACETIC ACID		ANTICIPATED	GROUP 2B							
O-NITROANISOLE		ANTICIPATED	GROUP 2B							
NITROBENZEN		ANTICIPATED	GROUP 2B							
4-NITROBIPHENYL										
NITROGEN MUSTARD	51-75-2	ANTICIPATED	GROUP 2A							
P-NITROANILINE	100-01-6							1	6	X
P-NITROCHLOROBENZENE	100-00-5								1	X
6-NITROCHRYSENE		ANTICIPATED	GROUP 2B							
NITROFEN		ANTICIPATED	GROUP 2B							
NITROMETHANE		ANTICIPATED	GROUP 2B							
2-NITROPROPANE		ANTICIPATED	GROUP 2B							
1-NITROPYRENE		ANTICIPATED	GROUP 2B							
4-NITROPYRENE		ANTICIPATED	GROUP 2B							
NITROGEN TETROXIDE										
NITROGEN TRIOXIDE										
N-NITROSODI-N-BUTYLAMINE		ANTICIPATED	GROUP 2B							
N-NITROSODIETHANOLAMINE		ANTICIPATED	GROUP 2B							
N-NITROSODIETHYLAMINE	55-18-5	ANTICIPATED	GROUP 2A							
N-NITROSODIMETHYLAMINE	62-75-9	ANTICIPATED	GROUP 2A							
N-NITROSODI-N-PROPYLAMINE		ANTICIPATED								

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
N-NITROSO-N-ETHYLUREA		ANTICIPATED								
4-(N-NITROSOMETHYLAMINO)-1-(3-PYRIDYL)-1-BUTANONE		ANTICIPATED								
N-NITROSO-N-METYLUREA		ANTICIPATED								
N-NITROSOMETHYLVINYLAMINE		ANTICIPATED	GROUP 2B							
N-NITROSOMORPHOLINE		ANTICIPATED	GROUP 2B							
N-NITROSONORNICOTINE	16543-55-8	ANTICIPATED	GROUP 1							
N-NITROSOPIPERIDINE		ANTICIPATED	GROUP 2B							
N-NITROSOPYRROLIDINE		ANTICIPATED	GROUP 2B							
N-NITROSOSARCOSINE		ANTICIPATED	GROUP 2B							
NITROTOLUENE (ALL ISOMERS)								5	30	X
NITROUS OXIDE	Reprotox									
NORETHISTERONE		ANTICIPATED								
OCHRATOXIN A		ANTICIPATED	GROUP 2B							
ORGANO TIN COMPOUNDS										
OSMIUM TETROXIDE	20816-12-2							0.0002		
OXYGEN DIFLUORIDE	7783-41-7							0.005	0.01	
4,4'-OXYDIANILINE		ANTICIPATED								
OXYMETHOLONE		ANTICIPATED								
OZONE	10028-15-6							0.01	0.02	
PARAMETHADIONE					YES					

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
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	
PENTACHLORONAPHTHALENE	1321-64-8								0.05	X
PENTACHLOROPHENOL	87-86-5								0.05	X
PERCHLOROMETHYL MERCAPTAN	594-42-3								5	
PERCHLORYL FLUORIDE	7616-94-6			YES					2	
PERFLUOROISOBUTYLENE	382-21-8									
PHENACETIN	62-44-2	ANTICIPATED	GROUP 2A					0.01	0.06	
PHENAZOPYRIDINE HYDROCHLORIDE		ANTICIPATED	GROUP 2B							
PHENOLPHTHALEIN		ANTICIPATED	GROUP 2B							
PHENOXYBENZAMINE HYDROCHLORIDE		ANTICIPATED	GROUP 2B							
PHENYL MERCAPTAN	108-98-5									
PHENYL PHOSPHINE	638-21-1			Reprotox				0.05		
PHENYTOIN		ANTICIPATED								
PHORATE	298-02-2								0.05	X
PHOSDRIN	7786-34-7									
PHOSGENE (CARBONYL CHLORIDE)	75-44-5	ANTICIPATED		YES				0.01	0.04	
PHOSPHINE	7803-51-2							0.03	0.04	
PHOSHONOTHIOIC ACID	2104-64-5									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
PHOSPHORUS (YELLOW)	7723-14-0								0.01	
PHOSPHORUS OXYCHLORIDE										
PHOSPHORUS PENTACHLORIDE	10026-13-8								1	
PHOSPHORUS PENTAFLUORIDE	7641-19-0									
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	
POLYBROMINATED BIPHENYLS		ANTICIPATED								
POLYCHLORINATED BIPHENYLS		ANTICIPATED								
POLYCYCLIC AROMATIC HYDROCARBONS		ANTICIPATED								
POTASSIUM CYANIDE, SOLID	151-50-8									
PREMERGE	88-85-7									
PROCARBAZINE		ANTICIPATED	GROUP 2A							
PROGESTERONE		ANTICIPATED								
PROPANENITRILE (PROPIONITRILE)	107-12-0			YES						
1,3-PROPANE SULTONE	1120-71-4	ANTICIPATED	GROUP 2B							
PROPIOLACTONE	57-57-8	ANTICIPATED	GROUP 2B							
PROPYLENEIMINE	75-55-8	ANTICIPATED						2	5	X

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
PROPYLENE OXIDE	75-56-9	ANTICIPATED	GROUP 2B							
PROPYLTHIOURACIL	51-52-5	ANTICIPATED	GROUP 2B							
RESERPINE		ANTICIPATED								
RETINOIC ACID, 1,3-CIS-				YES						
SAFROLE	94-59-7	ANTICIPATED	GROUP 2B							
SELENIUM HEXAFLUORIDE										
SELENIUM SULFIDE		ANTICIPATED								
SILICA, CRYSTALLINE (Respirable Size - 2-10 MICRONS)	14808-60-7	KNOWN	GROUP 1							
SILICON TETRAFLUORIDE	7783-61-1									
SODIUM AZIDE	26628-22-8								0.3	
SODIUM DICHROMATE	7789-12-0		GROUP 1			YES				
SODIUM FLUOROACETATE	115-90-2								0.05	X
SODIUM CYANIDE, SOLID	143-33-9									
STILBINE	10025-91-9									
STREPROZOTOCIN		ANTICIPATED	GROUP 2B							
STRYCHNINE	57-24-9								0.015	
STYRENE	100-42-5		GROUP 2B						2	
STYRENE-7,8-OXIDE		ANTICIPATED	GROUP 2A							
SULFALLATE		ANTICIPATED	GROUP 2B							
SULFOTEP	3689-24-5									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
SULFUR DIOXIDE	7446-09-5							5	13	
SULFUR MONOCHLORIDE										
SULFUR PENTAFLUORIDE										
SULFUR TETRAFLUORIDE	7783-60-0									
SULFURYL CHLORIDE										
SYSTOX	8065-48-3									
2,4,5-T				YES						
TAMOXIFEN		KNOWN	GROUP 1							
TELLURIUM HEXAFLUORIDE	7783-80-4		GROUP 1					0.002	0.02	
TENIPOSIDE	29767-20-2		GROUP 2A							
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							
2,3,7,8-TETRACHLORODIBENZO-PARA-DIOXIN (TCDD)	1746-01-6	KNOWN	GROUP 1							
TETRACHLORONAPHTHALENE	1335-88-2								2	X
TETRAETHYL DITHIOPYROPHOSPHATE (TEDP)	3689-24-5									
TETRAETHYL LEAD	78-00-2	ANTICIPATED		YES					0.75	X
TETRAETHYLPYROPOSPHATE, LIQUID	107-49-3									
TETRAFLUOROETHYLENE		ANTICIPATED	GROUP 2B							
TETRAMETHYL SUCCINONITRILE	3333-52-6							0.05	3	X

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
TETRANITROMETHANE		ANTICIPATED	GROUP 2B							
THALIDOMIDE				YES						
THIOACETAMIDE		ANTICIPATED	GROUP 2B							
THIODAN	115-29-7									
4,4'-THIODIANALINE		ANTICIPATED	GROUP 2B							
THIONYL CHLORIDE										
THIOPHENOL	108-98-5									
THIOTEPA	52-24-4	KNOWN	GROUP 1							
THIOUREA		ANTICIPATED								
THIRAM	137-26-8								5	
THORIUM DIOXIDE	1314-20-1	KNOWN	GROUP 1						0.01	X
TOLUENE	108-88-3			YES				20		
TOLUENE DIISOCYANATE (TDI)	584-84-9	ANTICIPATED	GROUP 2B							
o-TOLUIDINE	95-53-4	ANTICIPATED	GROUP 1							
TOXAPHENE		ANTICIPATED								
TOXINS (INCLUDING PROTEINS AND DERIVATIVES) AND MATERIALS OF BIOLOGICAL ORIGIN. INCLUDING, BUT NOT LIMITED TO:										
ABRIN TOXIN	1393-62-0									
AFLATOXINS	1402-68-2	KNOWN	GROUP 1							
BOTULINUM NEUROTOXIN	58319-92-9									
CHOLERA TOXIN	9012-63-9									

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
CLOSTRIDIUM PERFRINGENS EPSILON TOXIN										
CONOTOXIN										
DIACETOXYSCIRPENOL	2270-40-8									
RICIN	9009-86-8									
SAXITOXIN	35554-08-6									
SHIGA-LIKE RIBOSOME INACTIVATING PROTEINS	57-67-0, 6190-55-2									
SHIGATOXIN										
STAPHYLOCOCCAL ENTEROTOXIN										
T-2 TOXIN	21259-20-1									
TETANUS TOXIN										
TETRODOTOXIN	4368-28-9									
TREOSULFAN	299-75-2		GROUP 1							
TRICHLOROETHYLENE		ANTICIPATED	GROUP 2A							
2,4,6-TRICHLOROPHENOL		ANTICIPATED								
1,2,3-TRICHLOROPROPANE		ANTICIPATED	GROUP 2A							
TRICHLOROSILANE										
N,N',N''-TRIETHYLENETHIOPHORAMIDE	52-24-4									
1,3,5-TRIGLYCIDYL-S-TRIAZINETRIONE	Reprotox									
N,N',N''-TRIMETHYLENETRINITRAMINE	52-24-4			YES						
TRIORTHOCRESYL PHOSPHATE	78-30-8		GROUP 1						0.01	

		Carcinogen Information		Reproductive Hazard Information				Exposure Limits (PEL)		
Chemical Agent	**CAS #**	**NTP**	**IARC**	**Teratogenic**	**Mutagenic**	**Sterilizer**	**Lactation**	**PPM**	**Mg/M3**	**SKIN**
TRIPHENYL PHOSPHATE	115-86-6								3	
URACIL MUSTARD	66-75-1		GROUP 2B							
URETHANE		ANTICIPATED	GROUP 2A							
VANADIUM AND COMPOUNDS	1314-02-1									
VANADIUM PENTOXIDE	1314-62-1		GROUP 2B							
VAPATONE	107-49-3									
VINYL BROMIDE	593-60-2	ANTICIPATED	GROUP 2A							
VINYL CHLORIDE	75-01-4	KNOWN	GROUP 1		YES	YES				
4-VINYL CYCLOHEXENE			GROUP 2B							
4-VINYL-1-CYCLOHENENE DIEPOXIDE		ANTICIPATED	GROUP 2B							
VINYL CYCLOHEXENE DIOXIDE	Reprotox									
VINYL FLUORIDE	75-02-5	ANTICIPATED	GROUP 2A							
WARFARIN	81-81-2									
XYLIDINE	1300-73-8							5	25	
YTTRIUM	7440-65-5				YES	YES			2	

Appendix F

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 Deficiencies – 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 Deficiencies

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 too:

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.

Appendix G

http://www.udel.edu/ehs/inspectorsoncampus.pdf

Procedures for Regulatory Inspections at the University of Delaware

On occasion the University may be visited by federal or state regulatory inspectors. This could include, but is not limited to, representatives from the Nuclear Regulatory Commission, Delaware Department of Natural Resources and Environmental Control, US Department of Agriculture, the Environmental Protection Agency, Delaware Department of Agriculture, US Department of Transportation, the Federal Aviation Administration, Centers for Disease Control and Prevention, or the Department of Health and Human Services. Some of these groups may contact the Department of Environmental Health and Safety (DEHS) or the Research Office to initiate an inspection, but others may just present themselves at a lab or building. If this occurs, it is recommended that you follow these procedures:

- Request identification or credentials from the inspector. Write down the inspector's name and affiliation. If satisfactory credentials are not provided, do not offer any further assistance and contact Public Safety immediately.
- Contact DEHS at x8475 to inform them of the inspection. Provide the affiliation of the inspector when calling to assure the proper response from DEHS.
- As per your lab or department's policy, contact your PI, department chair and/or building manager to inform them of the inspector's presence. The department chair and the director of DEHS should advise the administration that the inspector is on site and arrange for any close-out conferences requested.
- Do not decline the inspection, however ask the inspector if they can wait until one or more of the above individuals can join the inspection. At a minimum, the PI or DEHS representative should be present before proceeding. If DEHS is not present before the inspection starts, please take notes of what is said and/or visited until they arrive.
- Answer the inspector's questions, but only provide the information or files that are specifically requested. Do not volunteer information. If the inspector asks to take pictures, do not allow it unless you are able to also take the same pictures for the university's records or verify that they will make them available to the university as well.
- The inspector's status does not authorize him/her to handle any hazardous material in your facility so do not permit this.
- The inspector must always be accompanied by you or other University personnel during the inspection so do not allow them unescorted access to your facility.
- Assure that the inspector wears all appropriate or required personal protective equipment.

If you are contacted to schedule an inspection, please inform DEHS and allow the appropriate personnel to be present to assist with the inspection.

If you have any questions regarding these procedures, please contact DEHS at 831-8475.

Appendix H

Chemical Hygiene Forms

- Chemical Hygiene Plan and Right-To-Know Training Guidance and Certification Form – http://www.udel.edu/ehs/chptraining.html
- DOT Shipping Request Form – http://www.udel.edu/ehs/dotshippingrequest.doc
- Laboratory Close Out/Decontamination/Decommissioning Checklist – http://www.udel.edu/ehs/LabDecommission0605.pdf
- General Process and Experiment Standard Operating Procedure – http://www.udel.edu/ehs/chpsop/generalprocesssop.doc
- Laboratory Inspection Form – http://www.udel.edu/ehs/chemical/labinfor.doc
- Laboratory Warning Sign Request Form – http://www.udel.edu/ehs/labhazardcheck.doc
- Pressure and Vacuum Processes and Experiments Standard Operation Procedure – http://www.udel.edu/ehs/chpsop/pressureandvacuumsop.doc
- Standard Operation Procedures for Use of Highly Toxic and Carcinogenic Materials – http://www.udel.edu/ehs/chpsop/toxicsop.doc
- Minors Involved in Laboratory Operations Form – http://www.udel.edu/ehs/minorsresearchpolicy.pdf
- Volunteer Workers Involved in Laboratory Research and Teaching Activities Form – http://www.udel.edu/ehs/VolunteerResearchersPolicy.pdf
- Visiting Scholars Involved in Laboratory Research and Teaching Activities Form – http://www.udel.edu/ehs/VisitingResearchersPolicy.pdf
- Use of High Explosives and Reactive Material Standard Operating Procedure – http://www.udel.edu/ehs/reactivesop.doc