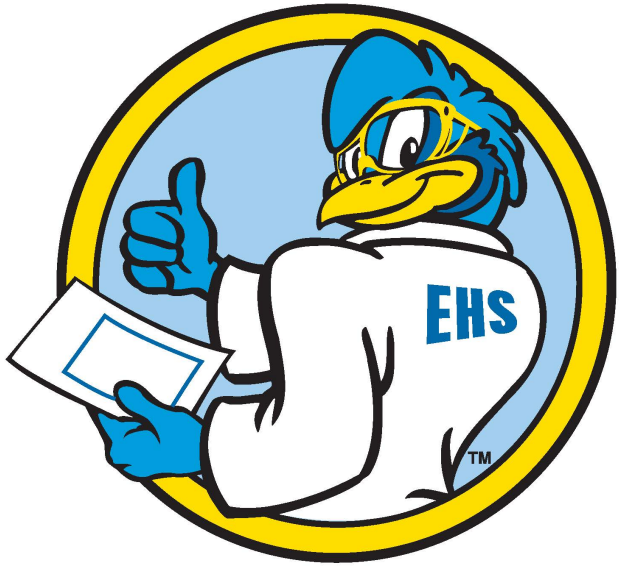
HAZARDOUS MATERIALS

SAFETY MANUAL



UNIVERSITY OF DELAWARE

ENVIRONMENTAL HEALTH & SAFETY

Emergency Phone Numbers

Newark Campus:

Fire 911
University Police 911
Ambulance 911
Student Health Center 2226

Lewes Campus

Fire 9-911
Police Emergency 9-911
Ambulance 9-911
University Police 4333

Georgetown Campus

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

Wilmington Campus

Fire 9-911
Police Emergency 9-911
Ambulance 9-911
University Police 2222

Dover Campus

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

Poison Information Center

Local 1-800-722-7112
National 1-800-222-1222

July 2007

Environmental Health and Safety
General Services Bldg., Room 132
222 S. Chapel Street
Newark, DE 19716
(302) 831-8475

http://www.udel.edu/ehs

University Of Delaware
Safety Policy
Number 7-1

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.

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 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 the supervisory staff.

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

The Department of Environmental Health and Safety (DEHS) has the authority to assure overall compliance with the intent of this policy. The DEHS 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 which experiences an occupational health or safety problem.

University policies referenced in this manual can be found on the Web under
http://www.udel.edu/ExecVP/polprod

Contents

1.0 Purpose of the Delaware Hazardous Chemical Information Act

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.

Many employers in the State of Delaware have established suitable information programs for their employees as required of all manufacturing employers by November 1985 under the Federal Occupational Safety and Health Administration's Hazard Communication Standard. Refer to University Policy 7-27. 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.

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

Exemptions to the Act

- The Hazardous Chemical Information Act does not apply to chemicals in the following categories:
    - Consumer products or hazardous substances which are used in the workplace for the purpose intended by the manufacturer of the product and where the exposure limit does not exceed that of a consumer using the product for the intended purpose and does not pose a physical hazard or health risk to employees:
        - Products intended for personal consumption
        - Any food, food additive, drug or cosmetic
        - Distilled spirits, wines or malt beverages

If you are not sure a chemical in your work area is exempted, contact your supervisor, instructor or the DEHS.

2.0 Purpose of the OSHA Laboratory Standard

In January 1990, the Occupational Safety and Health Administration (OSHA) published the Laboratory Standard. They found after a 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 Laboratory 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. Copies of the University CHP are found in each department and in the Department of Environmental Health and Safety (DEHS).

At the University of Delaware, all faculty, staff, and graduate students working in laboratories must comply with this standard. Refer to University Policy 7-37. Undergraduate students assigned to a research laboratory are covered by both regulations. Students in undergraduate teaching laboratories are only covered by the Delaware Right-to-Know Law, but should be informed of the CHP.

3.0 Employee and Student Rights

- Employees and students who may be exposed to hazardous chemicals are guaranteed access to the following:
    - Chemical Exposure Information
    - Workplace Chemical Lists
    - Safety Data Sheets (SDS)

- The University is required to advise you of your rights regarding the Hazardous Chemical Information Act and the OSHA Laboratory Standard. This pamphlet meets the requirement in part.

- In addition, standard "Notice to Employee" forms will be posted at locations where notices are normally posted. It is to your advantage to know your rights. Take time to read the "Notice to Employee" form posted in your work area.

- In addition, employees and students shall receive training on the hazards of chemicals and on the measures they can take to protect themselves from those hazards as well as the contents of the Chemical Hygiene Plan where applicable.

- The University must provide employees with appropriate personal protective equipment. Students may be required to purchase common items such as lab aprons, goggles, face shields, and gloves. However, special items such as respirators will be provided by the University.

- Employees have the right to request a medical evaluation by a licensed physician when they develop symptoms which may be attributed to chemical exposure or following an incident which results in the likelihood of a hazardous exposure.

- You have the right to file a complaint against the University regarding alleged violations of the Hazardous Chemical Information Act. If you file a complaint, the Act protects you from:
    - Discharge or Cause for discharge
    - Discipline
    - Discrimination
    - Loss of pay, position, seniority or benefits

- Alleged violations of the Act and/or Standard should be referred to your supervisor, instructor, departmental CHO, or the DEHS. However, you always have the right to file a complaint with the State of Delaware for violation of the Hazardous Chemical Information Act.

- Providing you with hazardous chemical information does not affect the liability of the University with regard to the health and safety of employees and students. The University still has the responsibility to take action to prevent the occurrence of occupational disease and unnecessary exposure.

4.0 Educational Programs

- The University must provide, at least annually, an education and training program for employees using or handling chemicals. This training must cover the contents of the CHP for research laboratory personnel.

- Additional instruction is required whenever the potential for exposure to hazardous chemicals is altered or whenever new information concerning a chemical is received.

- New or newly assigned employees must be provided training before working with or in a work area containing hazardous chemicals. For students, training may be required for each course.

- Training programs shall include, as appropriate, the following:

    - Interpreting labels and MSDS's
    - Location of hazardous chemicals
    - Acute and chronic effects of chemicals
    - Safe handling procedures
    - Personal protective equipment
    - First aid
    - Clean up procedures
    - Waste disposal
    - CHP requirements

- In the event a large variety of hazardous chemicals are stored or in use, the University may substitute generic training for chemical specific training. The contents of this pamphlet meet, in part, the generic training requirements. Your supervisor or instructor will provide additional training as necessary.

- The University is required to keep a record of training sessions provided to employees and students. You will be required to sign a ledger verifying your attendance at a training session. Refer to Appendix A for copies of the RTK and RTK/CHP training certification forms.

- If you do not understand the material provided or discussed, contact your supervisor, instructor, departmental CHO, or the DEHS.

5.0 Workplace Chemical Lists and Chemical Inventories

- The University is required to compile and maintain a Workplace Chemical List in each department or work area where individual hazardous chemicals (including compressed gases) are normally used or stored in excess of 55 gallons or 500 pounds.

- The Workplace Chemical List contains the following information:

    - The chemical name or the common name
    - The work area where the chemical is normally used or stored

- The Workplace Chemical List provides you with information regarding large quantities of hazardous chemicals in your work area. It must be readily available to employees, their representatives, and students.

- New or newly assigned employees and students will be made aware of the Workplace Chemical List before working with hazardous chemicals or in a work area containing large quantities of hazardous chemicals.

- Departments will update the list as necessary but not less than annually.

- 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. At a minimum, a laboratories chemical inventory should contain the common chemical name, amount, location in the laboratory and any special hazards (carcinogenic, reproductive toxin, reactive, etc.) for all chemical used or stored in the space.

6.0 Hazardous Chemicals (Definition)

- The Hazardous Chemical Information Act defines a hazardous chemical as any element, chemical compound or mixture of elements and/or compounds which poses a physical hazard or a health hazard.

- The Act applies to all hazardous chemicals regardless of quantity.

- A chemical is a **physical hazard** if there is scientifically valid evidence that it is any of the following:

  *** A combustible liquid**
  *** An explosive**
  *** An organic peroxide**
  *** A pyrophoric**
  *** A compressed gas**
  *** A flammable**
  *** An oxidizer**
  *** An unstable material (reactive) or a water reactive**

- A chemical is a **health hazard** if there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Included are:

  *** Carcinogens**
  *** Reproductive toxins**
  *** Sensitizers**
  *** Neurotoxins (nerve)**
  *** Hepatotoxins (liver)**
  *** Agents that damage the lungs, skin, eyes, or mucus membranes**
  *** Irritants**
  *** Corrosives**
  *** Radioactive material**
  *** Biohazards**
  *** Nephrotoxins (kidney)**

- A chemical is considered a **carcinogen or potential carcinogen** if it is listed in any of the following:

  - National Toxicology Program, "Annual Report of Carcinogens" (latest edition)
  - International Agency for Research on Cancer, "Monographs" (latest edition)
  - OSHA, 29CFR1910, Subpart Z, Toxic and Hazardous Substances

- A chemical is considered **hazardous** if it is listed in any of the following:

  - OSHA, 29CFR1910, Subpart Z, Toxic and Hazardous Substances
  - "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment", ACGIH (latest edition)
  - "The Registry of Toxic Effects of Chemical Substances", NIOSH (latest edition)

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

- Certain chemicals such as: extremely toxic, select carcinogens, reproductive hazards, and radioactive materials require approval of the Departmental Chemical Hygiene Officer (CHO), the University Chemical Hygiene Committee or the DEHS prior to their use. Refer to the University CHP.

- If you are not sure whether a chemical you are using is hazardous, review the **Safety Data Sheet (SDS)** or contact your supervisor, instructor, departmental CHO, or the DEHS.

7.0 LABELS

- A label is any written, printed, or graphic material displayed on or affixed to containers of hazardous chemicals.

- Existing labels on new containers of hazardous chemicals or containers in storage shall not be removed or defaced.

- Employees and students are not required to work with a hazardous chemical from an unlabeled container except for a portable container intended for the immediate use by the employee or student who performs the transfer. This requirement does not apply to students assigned unknown chemicals for analysis. However, hazard information may not be withheld.

- Labels or other forms of hazard warnings, such as tags or placards, provide immediate warning of potential danger. They may be used to warn of a variety of potential physical hazards or health hazards.

- When it is impractical to print all the hazard information on the label, manufacturers are required to generate an **SDS**.

- Read all the information on the label carefully. If you do not understand something, contact your supervisor or instructor for an explanation or request the **SDS**.

- All chemical container labels must contain the following information:

    - Contents of the container (common chemical name)
    - Name and address of the manufacturer
    - Physical and health hazards (e.g. carcinogen, flammables)
    - Recommended personal protective equipment

- Every six months check chemical inventory to make sure container labels are in good condition.

8.0 Handling Chemicals

- Carefully read the label before using a chemical. The SDS will provide any special handling information.
- Do not work alone in the laboratory.
- Use required personal protective equipment and safety glasses.
- Label all containers with full chemical name and health and physical hazard information (e.g. carcinogen or flammable solid).
- Keep your hands and face clean. Wash thoroughly with soap and water after handling any chemical.
- Keep chemicals off your hands, face, clothing, and shoes.
- Clothing shall be appropriate to the laboratory; effort should be made to minimize skin exposure (i.e. lab coats, long pants, and regular shoes are recommended). Sandals, open-toed or perforated shoes and 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.
- Never smell, inhale or taste a hazardous chemical.
- Smoking, drinking, eating and the application of cosmetics is forbidden in areas where hazardous chemicals are in use.
- Do not dispense more of a hazardous chemical than is needed for immediate use.
- Always use chemicals with adequate ventilation or in a chemical fume hood, as appropriate. Refer to the SDS.
- Use hazardous chemicals only as directed or for their intended purpose.
- Inspect equipment or apparatus for damage before adding a hazardous chemical. Do not use damaged equipment.
- Never use mouth suction to fill a pipette. Use a pipette bulb or other pipette filling device. Refer to University Policy 7-25.
- Electrically ground and bond containers using approved methods before transferring or dispensing a flammable liquid from a large container.
- For specific information regarding chemical handling, contact your supervisor, instructor, departmental CHO, or the DEHS.

9.0 Personal Protection

General Considerations

- Safety glasses are required to be worn in laboratories at all times.

- Personal protective devices are to be used only where engineering and administrative controls cannot be used or made adequate, or while controls are being instituted. Refer to University Policy 7-40.

- Engineering and administrative controls to reduce or eliminate exposures to hazardous chemicals include:

  - Substitution of a less hazardous substance (e.g. substitute Cyclohexane for benzene)
  - Substitution of a less hazardous equipment or process (e.g. safety cans for glass bottles)
  - Isolation of the operator or the process
  - Local and general ventilation (e.g. use of fume hoods)
  - Hazard education
  - Job rotation

- The SDS will list the personal protective equipment recommended for use with the chemical. The SDS addresses "worse case" conditions.

- Your supervisor, instructor or the DEHS will determine which personal protective devices are required for each task. However, use common sense; there is no harm in being overprotected.

- Departments must provide personal protective equipment to employees. In addition the University must respond to personnel requests for medical evaluations of personal exposure to chemicals. On going medical monitoring may be required in certain circumstances.
- Check the SDS for special ventilation requirements, such as:
  - Use with adequate ventilation
  - Use in a fume hood
  - Avoid inhalation of vapors
  - Provide local ventilation

- Ventilation recommendations must be adapted to the worksite and the specific process.

- Supervisors and Teaching Assistants are especially urged to set a personal example of safe practices by always wearing appropriate PPE.

Respiratory Protection

- Respirators are designed to protect only against certain specific types of substances and in certain concentration ranges, depending on the type of equipment used.

- Respirator selection is based on the hazard and the protection factors required.

- Types of respiratory protective equipment include:
    - Particle-removing air purifying respirators
    - Gas and vapor-removing air purifying respirators
    - Atmosphere supplying respirators

- You should familiarize yourself with the limitations of each type of respiratory protective equipment used and the signals for respirator failure (odor breakthrough, filter clogging, etc.).

- Respirators are not to be used except in conjunction with a complete respiratory protection program.

- If your work requires the use of a respirator, contact the DEHS. You will be required to receive special training and may be required to participate in the medical monitoring program.

- Do not use respiratory protective equipment until you have received proper training. Refer to University Policy 7-32, Respiratory Protection.

Protective Clothing/Eye Protection

- Skin and body protection involves protective clothing and may pertain to either specific body parts or the entire body.

- Eye and face injuries are prevented by the use of the following:
    - Safety glasses with side shields for dust and flying object protection
    - Chemical splash goggles for chemical splash, spray and mist protection
    - Face and neck shields for head and neck protection from various hazards (must be used with safety glasses or goggles)

- Refer to University Policy 7-23, Eye Protection Policy.

- When there is no immediate danger to the skin due to contact with a hazardous chemical, your clothes can be protected from chemical contamination by wearing lab coats, coveralls, aprons or protective suits. These garments should not leave the work site. General categories of contaminants include:

    * Dirt and grease * Toxic dust (asbestos) * Bacteriological agents
    * Lab chemicals * Radioactive materials

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

- Exposures to strong acids, acid gases, organic chemicals, strong oxidizing agents, radioactive material, etiological agents, carcinogens, and mutagens require the use of protective equipment that prevent skin contamination. Impervious chemical protective equipment must be utilized. Examples include:

*Chemical protective gloves	* Chemical protective boots
* Chemical protective suits	* Special protective equipment

<u>Protective Clothing/Gloves</u>

- Before using a chemical, you should 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, or calling the DEHS. Listed below are types of gloves depending on the chemical used.

Chemical Resistance	Neoprene	Vinyl Plastic	Rubber Latex	Nitrile	Syn. Latex	Natural Latex
Alcohols	E	E	G	E	E	G
Caustics	E	E	E	E	E	E
Chlorinated Solvents	G	F	NR	E	G	NR
Ketones	G	NR	G	G	G	G
Petroleum Solvents	E	G	F	S	E	F
Organic Acids	E	E	E	E	E	E
Inorganic Acids	E	E	E	E	E	E
Non-Chlorinated Solvents	G	F	NR	G	G	NR
Insecticides	E	E	F	S	E	F
Inks	E	E	F	S	E	F
Formaldehyde	E	E	E	S	S	E
Acrylonitrile	E	G	E	S	E	E
Hydraulic Fluid	E	E	F	S	E	F
Carbon Disulfide	NR	F	G	F	NR	G
Paint Remover	F	F	NR	E	F	NR

S - Superior **E** – Excellent **G** – Good **F** – Fair **NR** – Not Recommended

- Determine what chemicals are to be used and then contact your supervisor, instructor or the DEHS for information regarding chemical protective clothing.

- It has become well known that gloves containing natural rubber latex can cause allergic reactions in some individuals. Contact the DEHS for more information on latex allergies or if you develop a sensitivity to any other PPE. The DEHS web site may also be referenced for additional information on latex allergies.

- Additional information to glove guidance may be obtained through the following:

    - http://www.bestglove.com
    - Environmental Health & Safety Glove Guide (request from DEHS)

10.0 Chemical Storage

- Carefully read the label before storing a hazardous chemical. The MSDS will provide any special storage information and incompatibilities.

- Do not store unsegregated chemicals in alphabetical order.

- Do not store incompatible chemicals in close proximity to each other.

- Separate hazardous chemicals in storage as follows:

* Solids:	* Oxidizers * Water reactive	* Flammable solids * Others
* Liquids:	* Acids * Oxidizers * Flammable/combustible	* Caustics * Perchloric acid
* Gases:	* Toxic * Oxidizers and inert	* Flammable
*Classes:	*Inorganic	* Organic

- Once separated into hazard classes, chemicals may be stored alphabetically.

- Use approved storage containers and safety cans for flammable liquids.

- Use spill trays under containers of liquid reagents.

- Dispose of old chemicals promptly. See waste disposal section of this pamphlet. (See Section 22.0, page 21.)

- Do not store liquids above eye level.

- Do not store flammable or combustible materials in ordinary refrigerators. Refer to University Policy 7-14, Purchase and Safe Use of Refrigeration Units.

- Assure all containers are properly labeled.

- For more information on chemical storage contact your supervisor, instructor or the DEHS. Also see http://www.udel.edu/ehs/chemcompatstorage.html.

11.0 Chemical Stability

- Stability refers to the susceptibility of the chemical to dangerous decomposition. Ethers, liquid paraffins, and olefins form peroxides on exposure to air and light. Since these chemicals are packaged in an air atmosphere, peroxides can form even though the containers have not been opened.
- Peroxidizable chemicals such as those listed below should be dated upon receipt. Storage and use should be limited to the time indicated for each class or list. Containers which show signs of iron oxide or copper oxide should be handled with extra precaution since many metal oxides promote peroxide formation.

- The most hazardous compounds - those that form peroxides without being concentrated, which can accumulate a hazardous level of peroxides simply on storage after exposure to air - are in List A. Compounds forming peroxides that are hazardous only when concentrated are in List B. List C consist of vinyl monomers that may form peroxides which can initiate explosive polymerization of the monomers.

- Common compounds that form peroxides during storage:

LIST A (Three Months) PEROXIDE HAZARD ON STORAGE	LIST B (Twelve Months) PEROXIDE HAZARD ON CONCENTRATION	LIST C (Twelve Months) HAZARD DUE TO PEROXIDE INITIATION OF POLYMERIZATION
Isopropyl Ether	Ethyl Ether	Styrene
Divinyl Acetylene	Tetrahydrofuran	Butadiene*
Vinylidene Chloride	Dioxane	Tetrafluorethylene*
Potassium Metal	Acetal	Chlorotrifluorethylene
Sodium Amide	Vinyl Ethers	Vinyl Acetylene
	2-Butanol	Vinyl Acetate
	2-Propanol	Vinyl Chloride
	Cyclohexene	Vinyl Pyridine
	Cumene	Chloroprene*
	Methylcyclopentane	
	Methyl Acetylene	
	Diacetylene	
	Dicyclopentadiene	

* When stored as a liquid, the peroxide-forming potential increases and certain monomers (butadiene, chloroprene, and tetrafluoroethylene) should be considered a List A compound.

- Unless an inhibitor was added by the manufacturer, closed containers of ethers should be discarded after 1 year.

- Open containers of ethers should be discarded within 6 months of opening.
- The label and SDS will indicate if a chemical is unstable.
- For additional information on chemical stability contact your supervisor, instructor or the DEHS.

12.0 Incompatible Chemicals

- Certain hazardous 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.

- The label and MSDS will contain information on incompatibilities. Also see http://www.udel.edu/ehs/chemcompatstorage.html.

- The following is a table containing examples of incompatible chemicals:

Chemical	**Keep Out of Contact With:**
Acetic acid	chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	chlorine, bromine, copper, fluorine, silver, mercury
Alkali metals	water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia, anhydrous	mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium nitrate	acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	nitric acid, hydrogen peroxide
Bromine	same as chlorine
Carbon, activated	calcium hypochlorite, all oxidizing agents
Chlorates	ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic acid	acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol, flammable liquids in general
Chlorine	ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals

Chlorine dioxide	ammonia, methane, phosphine, hydrogen sulfide
Copper	acetylene, hydrogen peroxide
Cumene hydroperoxide	acids, organic or inorganic flammable liquids ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons	fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	nitric acid, alkali/caustic chemicals
Hydrofluoric acid	ammonia, aqueous or anhydrous
Hydrogen peroxide	copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, oxidizing gases
Hydrogen sulfide	fuming nitric acid, oxidizing gases
Iodine	acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	acetylene, fulminic acid, ammonia
Nitric acid	acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases
Oxalic acid	silver, mercury
Perchloric acid	acetic anhydride, bismuth and its alloys, alcohol, paper, wood
Potassium	carbon tetrachloride, carbon dioxide, water
Potassium chlorate	sulfuric and other acids
Potassium permanganate	glycerin, ethylene glycol, benzaldehyde, sulfuric acid
Silver	acetylene, oxalic acid, tartaric acid, ammonium compounds
Sodium	carbon tetrachloride, carbon dioxide, water

Sodium peroxide	ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfuric acid	potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)

(from Manufacturing Chemists' Association, Guide for Safety in the Chemical Laboratory, pp. 215-217.)

13.0 Shock Sensitive Chemicals

- Shock sensitive refers to the susceptibility of the chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated.

- Some chemicals become increasingly shock sensitive with age. Write the date received and date opened on all containers of shock sensitive chemicals.

- Unless an inhibitor was added by the manufacturer, unopened containers of shock sensitive materials should be discarded after 1 year.

- Open containers of shock sensitive materials should be discarded within 6 months of opening.

- The label and SDS will indicate if a chemical is shock sensitive.

- The following are examples of materials which should be considered shock sensitive:
    - Call the DEHS at x8475 for safety precautions.

* aluminum ophorite explosive
* amatol
* ammonal
* ammonium nitrate
* ammonium perchlorate
* ammonium picrate
* ammonium salt lattice
* butyl tetryl
* calcium nitrate
* copper acetylide
* cyanuric trazide
* cyclotrimethylenetrinitramine
* cyclotetramethylene-tranitramine
* dinitroethyleneurea
* dinitroglycerine
* dinitrophenol
* dinitrophenolates
* dinitrophenyl hydrazine
* dinitrotoluene
* dipicryl sulfone
* dipicrylamine
* erythritol tetranitrate
* fulminate of mercury
* fulminate of silver
* fulminating gold
* fulminating mercury
* fulminating platinum
* mononitrotoluene
* nitrated carbohydrate
* nitrated glucoside
* nitrated polyhydric alcohol
* nitrogen trichloride
* nitrogn tri-iodide
* nitroglycerin
* nitroglycide
* nitroglycol
* nitroguanidine
* nitroparaffins
* nitronium perchlorate
* nitrourea
* organic amine nitrates
* organic nitramines
* organic peroxides
* picramic acid
* picramide
* picratol
* picric acid
* picryl chloride
* picryl fluoride
* polynitro aliphatic compounds
* potassium nitroamino-tetrazole
* silver acetylide
* silver azide

* fulminating silver
* gelatinized nitrocellulose
* germane
* guanyl nitrosamino guanyl-tetrazene
* guanyl nitrosamino-guanylidene hydrazine
* heavy metal azides
* hexanite
* hexanitrodiphenylamine
* hexogen
* hydrazinium nitrate
* hydrazoic acid
* lead azide
* lead mannite
* lead mononitroresorcinate
* lead picrate
* lead salts
* lead styphnate
* trimethylolethane
* magnesium ophorite
* mannitol hexanitrate
* mercury oxalate
* methyl and ethyl azides
* silver styphnate
* silver tetrazene

* sudatol
* sodium amatol
* sodium dinitro-ortho-cresolate
* sodium nitrate-potassium explosive mixtures
* sodium picramate
* tetrazene
* tetranitrocarbazole
* tetrytol
* trimonite
* trinitroanisole
* trinitrobenzene
* trinitrobenzoic acid
* trinitrocresol
* trinitro-meta-cresol
* trinitronaphthalene
* trinitrophenetol
* trinitrophloroglucinol
* trinitroresorcinol
* tritonal
* urea nitrate

14.0 Solvents

- Many of the commonly used solvents are volatile and are readily absorbed through the skin. Most are flammable. Solvents should be used within an operating fume hood or in a well ventilated area.

- Flammable liquids are more hazardous at elevated temperatures due to more rapid vaporization.
- Electrically ground and bond containers using approved methods before transferring or dispensing a flammable liquid from a large container or drum.

- Purchase only the amount necessary for immediate use.

- Use approved flammable liquid containers and storage cabinets.

- Keep flammable liquids from heat, flame, and direct sunlight.

- Do not store flammable liquids near oxidizing agents such as chromic acid, permanganates, chlorates or perchlorates.

- Avoid skin contact and inhalation of solvents.

- Use assigned personal protective equipment.

- Do not dispose of solvents down sinks or drains.

- Use with adequate ventilation or in a fume hood.

- Common solvents that are relatively toxic include:

    - Aromatic hydrocarbons, especially benzene
    - Esters of acetic or other organic acids
    - Glycols, glycol esters and glycol ethers
    - Halogenated hydrocarbons
    - Methyl alcohol (Methanol)
    - Nitrogenous bases such as amines
    - Carbon disulfide

- The label and SDS will indicate any special hazards involving a solvent.

- For additional information contact your supervisor, instructor or the DEHS.

15.0 Compressed Gases

- Carefully read the label before using or storing compressed gas. The SDS will provide any special hazard information.
- University of Delaware Policy 7-24 discusses in detail the procedures required for using compressed gases.
- Always use the minimum size cylinder required to perform the work.
- Utilize a gas cylinder supplier that will accept the cylinders back when they are no longer needed.
- Cylinders of compressed gases must be handled as high energy sources.
- When storing or moving a cylinder, have the cap securely in place to protect the stem and use a gas cylinder cart.
- Do not expose cylinders to temperature extremes.
- Use an approved regulator that is compatible with the gas to be used and inspect it regularly. Do not use a regulator adapter. Contact the DEHS for additional procedures on regulator use and inspection.
- Never ride an elevator with a compressed gas cylinder. (Elevators are considered a confined space.)
- Use suitable racks, straps, chains or stands to support cylinders.
- Cylinders of toxic, flammable or reactive gases should be stored and used in a fume hood or gas cylinder cabinet.
- Use an approved flow restrictor between the cylinder and regulator when using flammable, oxidizing or poisonous gases.
- Use an appropriate cart to move cylinders.
- Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
- Oil or grease on the high pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder.
- Always wear safety glasses and leather gloves when handling compressed gases.

- Store flammable gases 20 feet from all other gases or separate by wall having fire rating of one hour.

- Unknown gas cylinders can present a very serious health hazard. Replace all worn and damaged labels.

- For more information contact your supervisor, instructor or the DEHS.

16.0 Radioactive Material

- Only persons, projects and facilities approved by the Radiation Safety Committee are authorized for the use of radioactive material or other sources of ionizing radiation. Refer to University Policy 7-9.

- Individuals interested in using radioactive material or other sources of ionizing radiation should contact the DEHS.

- Individuals authorized to use sources of ionizing radiation shall do so in accordance with USNRC, State and University regulations, policies and procedures.

- Radioactive material utilized in undergraduate and graduate teaching laboratories shall be under the direct supervision of an individual approved by the Radiation Safety Committee.

- Individuals authorized to use sources of ionizing radiation will receive specific training from their supervisor or instructor and the DEHS.

17.0 Biohazardous Materials

- Persons using biohazards in the laboratory are required to follow University Policy 7-19, Control of Biohazards in Research and Education.

- The use of certain microorganisms and toxins are restricted by the Centers for Disease Control and Prevention (CDC) and require registration. Contact the DEHS or visit their web site for the list of restricted select agents.

- All recombinant DNA work must be approved by the University Institutional Biosafety Committee established by the Provost.

- Safety precautions for working with biohazardous agents are described in the publication, CDC/NIH Biosafety in Microbiological and Biomedical Laboratories available from the Government Printing Office or the DEHS website.

- Infectious wastes generated during the use of biohazardous materials or other laboratory operations are regulated by the State of Delaware Department of Natural Resources and Environmental Control and managed according to University Policy 7-38, Infectious Waste Management.

18.0 Restricted Areas

- Facilities placarded with following warning signs are restricted areas:

    - CAUTION - BIOHAZARDS
    - CAUTION - OSHA DESIGNATED AREA
    - CAUTION - RADIOACTIVE MATERIAL
    - CAUTION - RADIATION AREA
    - CAUTION - X-RAY
    - CAUTION - LASER

- A list with names and phone numbers of responsible personnel should be posted on the door(s) to any facilities where hazardous materials are stored or utilized.
- Students, faculty, staff and administrators shall not enter a restricted area, except when accompanied by an authorized user of the facility.

- Custodians are permitted to enter restricted areas to perform routine tasks. However, they are instructed not to touch labeled waste containers, other research equipment or materials.

- Other support personnel, such as University Police and Security, Facility Management personnel, etc., are permitted to enter restricted areas provided the work to be performed does not involve disturbing a use area within the facility, equipment or materials. Examples include:

    * fume hoods * biological safety cabinets * sinks
    * placarded equipment * chemicals or materials on lab benches

- Support personnel shall contact an authorized user of the facility or the DEHS before performing work which may involve any of the above items.

- Contact the DEHS if emergency response or service is required in a restricted area.

- Immediately report any unusual conditions to the DEHS or the University Police, such as:

    * spills * leaks * contamination
    * injury * fires

- For additional information regarding restricted areas, contact your supervisor, instructor or the DEHS.

19.0 Waste Disposal

- All chemicals must be disposed of in accordance with procedures established by the DEHS, University Policy 7-18. Consult the "Chemical Waste Management Guidelines For Handling and Disposal of Chemical Waste", Chapter 23 of Chemical Hygiene Plan prior to disposing of chemical waste or the chemical waste webpage at http://www.udel.edu/ehs/chemical.html.

- No chemicals can be disposed of via the sanitary sewer unless pre-approved by the DEHS. No chemicals can be disposed of via the general solid waste stream.

- All waste containers must be accurately labeled with their contents using the DEHS orange chemical waste label. Descriptions must include chemical names (e.g. methanol, trichloracetic acid, trichloroethylene). You will also have to list hazard information and physical state. Do not use abbreviations, acronyms or trade names. If the waste stream is a mixture, list each compound on the label along with the percentage of that compound in the waste stream.

- Unknowns or unlabeled containers are unacceptable. Examples:

Organic Waste Stream		Inorganic Waste Stream	
Methanol	5%	10% Hydrochloric Acid	12%
Xylene	25%	1 Molar Sulfuric Acid	25%
Toluene	45%	Water	65%
Acetone	20%	Chromium	25 PPM
Water	3%	Selenium	40 PPM
Acetonitrile	2%	5% Phosphoric Acid	Remainder

- Contact your supervisor, instructor or the DEHS before disposing of any hazardous chemical.

- Your department may have additional procedures you are required to follow.

- Chemical waste containers must be closed at all times except when adding waste to the containers.

- Waste must be compatible with the waste container (e.g. do not use metal containers to store acids or caustics). All waste must be stored in a DEHS approved container. Do not reuse glass or plastic chemical bottles.

- Disposal of radioactive material and etiological agents/cultures requires special procedures. Contact the DEHS before proceeding.

- Contact the DEHS for chemical waste labels.

- Contact DEHS to schedule a chemical waste training session.

20.0 Chemical Spills

- All waste debris collected during a spill clean-up must be packaged, labeled and disposed of as chemical waste. Refer to chemical Waste Disposal section for more information.

General Information

- Anticipate spills by having the proper safety equipment on hand. There are spill kits available on the through DEHS. Consult the chemical spill kit guidelines at http://www.udel.edu/ehs/chemspillkit/chemspillguide.html.

- Alert personnel in the area that a spill has occurred.

- Do what is necessary to protect life first.

- The SDS will contain special spill clean-up information, if applicable.

- Confine the spill if possible.

- If the spill is too large for you to handle; 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:

    - DEHS ext. 8475
    - Newark Campus University Police, ext. 911
    - Georgetown, Lewes, and Wilmington Campuses, dial 9-911
    - Dover, dial 99-911

- The DEHS is equipped to handle most spills that can occur at the University. If there is the slightest doubt as to how to proceed, do not hesitate to call for assistance.

- For specific spill clean-up information, contact your supervisor, instructor, DEHS, or consult the Laboratory Chemical Spill Clean Up Procedures.

- If you spill a highly toxic material immediately contact the University Police: on the Newark Campus dial 911; on the Georgetown, Lewes and Wilmington Campuses dial 9-911; on the Dover Campus dial 99-911. Keep others from entering the area until help arrives.

- Low Hazard Material Spills (Consult the Laboratory Chemical Spill Clean Up Procedures) – No fire hazard, not particularly volatile, toxic or corrosive (e.g. salt solutions).

    - Wear appropriate chemical protective gloves and splash goggles
    - Use a dustpan and brush to clean up solid spills or spill absorbent pads for liquid spills.
    - Decontaminate area with water after clean-up.
    - Place residue in a container for waste collection.
    - Contact your supervisor, instructor or the DEHS for disposal information.

- Volatile, Flammable or Toxic Material Spills

    - Notify all personnel in the area.
    - Extinguish flames and all sources of ignition such as brush-type motors.
    - Maintain fume hood ventilation.
    - Vacate the area and call for assistance.

    - The following compounds are very hazardous. You should not clean them up yourself.

* aromatic amines	* nitro compounds	* organic halides
* bromine	* carbon disulfide	* ethers
* hydrazine	* cyanides	* nitriles

- Acid Chloride Spills

    - Refer to the Laboratory Chemical Spill Clean Up Procedures.
    - Avoid contact with skin.
    - Place residue in container for waste collection.
    - For specific clean-up information contact your supervisor, instructor or the DEHS.

- Mercury Spills

    - Mercury can be absorbed through the skin, inhaled or ingested. Mercury vapors are odorless, colorless and tasteless.
    - Do not use a domestic or commercial vacuum cleaner
    - Contact the DEHS to come and clean-up.
    - Place residue, broken equipment, gloves, suction bulbs, etc. in heavy plastic bag or container for waste collection. Seal container and label. Call the DEHS. This will be disposed of as hazardous waste.

- Alkali Metal Spills (Li, Na, K, Rb, CS, Fv)

    - Smother with powdered graphite or "Met-L-X".
    - Call University Police: on the Newark Campus dial 911; on the Georgetown, Lewes and Wilmington Campuses dial 9-911; on the Dover Campus dial 99-911 for assistance.
    - For specific clean-up information, contact your supervisor, instructor or the DEHS.

- White Phosphorus

    - Smother with wet sand or wet absorbent.
    - Call University Police: on the Newark Campus dial 911; on the Georgetown, Lewes and Wilmington Campuses dial 9-911; on the Dover Campus dial 99-911 for assistance.
    - For specific clean-up information contact your supervisor, instructor or the DEHS.

21.0 Injury and Illness

- Employees and students must notify their immediate supervisor or instructor of all illnesses and injuries related to exposure to hazardous chemicals. Refer to University Policy 7-3, Occupational Injuries and Illnesses.

- Employees should report to the occupational health facility designated by DEHS. Contact DEHS at ext. 8475 for the current provider service. 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.

- If transportation is necessary, dial the University Police on the Newark Campus at ext. 911; on the Georgetown, Lewes, Wilmington Campuses at ext. 9-911; and on the Dover Campus at ext. 99-911 to transport the victim. Use local red phone or dial direct.

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

- In cases of serious injury or illness, it is imperative that appropriate actions be followed immediately.

- When in doubt as to what should be done, telephone the University Police on the Newark Campus ext. 911; on the Georgetown, Lewes, Wilmington Campuses ext. 9-911; and on the Dover Campus ext. 99-911. Be prepared to give them the following information:

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

- Stay at the scene until emergency responders release you.

- Accident reports must be completed as soon as possible after attending to the injured person. Reports on employees shall be sent to Labor Relations and student reports shall be sent to the DEHS.

- Accident Investigation Reports must also be completed and sent to the DEHS. These investigations will require the identification of defective conditions and corrective actions as appropriate.

- If you have any questions regarding injury and illness procedures, contact your supervisor, instructor or the DEHS. For additional assistance in accident reporting or investigation, refer to the DEHS web site.

- Always contact DEHS immediately, after calling 911, when someone is exposed to a chemical. EHS will provide guidance on decontamination measures and where a person should be transported.

22.0 Personal Contamination

General Information

- Do what is necessary to protect life. Remain calm.

- The SDS will contain special first aid information.

- Do not move an injured person unless they are in further danger.
- A blanket should be used following decontamination to protect the victim from shock and exposure.

- Get medical attention promptly by dialing:

    - New Castle County Fire Board: 911 on the Newark Campus and 9-911 on the Wilmington Campus
    - University Police: 911 on the Newark Campus; on the Georgetown, Lewes, Wilmington Campuses dial 9-911; on the Dover Campus dial 99-911.
    - Ambulance: 911 on the Newark Campus; on the Georgetown, Lewes, Wilmington Campuses dial 9-911; on the Dover Campus dial 99-911.
    - Student Health Services, Newark Campus: ext. 2226
    - Poison Information Center: 1-800-722-7112 local or 1-800-222-1222 national

- For specific instruction regarding personal contamination, contact your supervisor, instructor or the DEHS.

Chemicals Spilled Over a Large Area of the Body

- Quickly remove all contaminated clothing while using the safety shower or other available source of water.
- Immediately flood the affected body area in tepid water for at least 15 minutes.
- Call University Police, dial 911 on the Newark Campus; on the Georgetown, Lewes, and Wilmington Campuses dial 9-911; and on the Dover Campus dial 99-911 for assistance.
- Wash off chemical with water but do not use neutralizing chemicals, unguents, creams, lotions or salves.
- Provide the ambulance crew and physician with the chemical name and any other relevant information. If possible, send the container label or the SDS with the victim.
- Contact Environmental Health & Safety at 302-831-8475

Chemicals on the Skin in Confined Areas

- Immediately flush with cold water.
- If there is no visible burn, remove jewelry to facilitate removal of any residual material and scrub area with warm water and soap.
- If a delayed reaction is noted (often the next day), report immediately for medical attention and explain carefully what chemicals were involved.
- If the incident involves hydrofluoric acid (HF), seek immediate medical attention. Users of Hydrofluoric Acid (HF) must receive specialized training from DEHS prior to using.
- If there is any doubt, seek immediate medical attention.
- Provide the ambulance crew and physician with the chemical name and any other relevant information. If possible, send the container label or the SDS with the victim.
- Contact Environmental Health & Safety at 302-831-8475

Chemicals in the Eyes

- Irrigate with plenty of cool water for at least 15 minutes. Use eyewash or other water source.
- Call University Police, dial 911 on the Newark Campus; on the Georgetown, Lewes, and Wilmington Campuses dial 9-911; and on the Dover Campus dial 99-911 for assistance.
- Provide the ambulance crew and physician with the chemical name and any other relevant information. If possible, send the container label or the SDS with the victim.
- Contact Environmental Health & Safety at 302-831-8475

Smoke and Fumes

- Anyone overcome with smoke or chemical fumes should be removed to uncontaminated air and treated for shock.
- Call University Police, dial 911 on the Newark Campus; on the Georgetown, Lewes, and Wilmington Campuses dial 9-911; and on the Dover Campus dial 99-911 for assistance.
- Do not enter the area if a life threatening condition still exists:
    - Oxygen depletion
    - Explosive vapors
    - Cyanide gas, hydrogen sulfide, nitrogen oxides,
    - Carbon monoxide

- If certified, follow standard CPR protocols.

- Provide the ambulance crew and physician with the chemical name and any other relevant information. If possible, send the container label or the SDS with the victim.

- Contact Environmental Health & Safety at 302-831-8475

Burning Chemicals on Clothing

- Extinguish burning clothing by using the drop-and-roll technique or by dousing with cold water or use safety shower.
- Call University Police, dial 911 on the Newark Campus; on the Georgetown, Lewes, and Wilmington Campuses dial 9-911; and on the Dover Campus dial 99-911 for assistance.

- Remove contaminated clothing; however, avoid further damage to the burned area. If possible, send clothing with the victim.
- Remove heat with cool water or ice packs until tissue around burn feels normal to the touch.
- Cover injured person to prevent shock.
- Provide the ambulance crew and physician with the chemical name and any other relevant information. If possible, send the container label or the SDS with the victim.
- Contact Environmental Health & Safety at 302-831-8475

Ingestion of Hazardous Chemicals

- Identify the chemical ingested.
- Call an ambulance; dial 911 on the Newark Campus; on the Georgetown, Lewes, and Wilmington Campuses dial 9-911; and on the Dover Campus dial 99-911 for assistance.
- Call the Poison Information Center (1-800-722-7112 local; 1-800-222-1222 national).
- Cover injured person to prevent shock.
- Provide the ambulance crew and physician with the chemical name and any other relevant information. If possible, send the container label or the SDS with the victim.
- Contact Environmental Health & Safety at 302-831-8475

23.0 Minor First Aid

First Aid Kits

- Departments should obtain a first aid kit for treatment of minor first aid cases (cuts, scratches, minor burns). Refer to University Policy 7-4.
- First aid kits may be purchased from the DEHS.
- First aid kits must be readily accessible. If the kit is not visible, the area where it is stored must be clearly marked.
- First aid kits must be fully stocked at all times.

General Information

- Do not dispense or administer any medications, including common pain relievers.
- Do not put any ointments or creams on wounds or burns. Use ice, a cold pack or cold water.
- Users of Hydrofluoric Acid (HF) must receive specialized training from DEHS prior to using.
- The SDS contains special first aid information.
- The University requires only individuals who have been trained in first aid and Bloodborne Pathogens to provide first aid to injured persons.
- Students requiring first aid are treated at Student Health Services (ext. 2226). Students should be accompanied by a friend, teaching assistant or instructor. Employees requiring first aid should be treated at the occupational health facility designated by DEHS. Contact DEHS at ext. 8475 for the current provider service.
- After giving first aid, direct or transport the victim to a medical facility for evaluation. Call University Police, 911 on the Newark Campus; on the Georgetown, Lewes, and Wilmington Campuses dial 9-911; and for the Dover Campus dial 99-911 for assistance.
- For specific first aid information, contact your supervisor, instructor or the DEHS.

24.0 Fire And Fire Related Emergencies

- If you discover a fire or fire-related emergency such as abnormal heating of material, hazardous gas leaks, hazardous material or flammable liquid spill, smoke, or odor of burning, immediately follow these procedures:

    - Activate the building alarm (fire pull station). If not available or operational, verbally notify persons in the building.

    - Notify University Police: ext. 911 on the Newark Campus; on the Georgetown, Lewes, and Wilmington Campuses dial 9-911; and on the Dover Campus dial 99-911. Use emergency phones identified by a blue light and/or a red phone.

    - Isolate the area and evacuate the building:
        - Shut down equipment in the immediate area, if possible.
        - Close doors to isolate the area.

    - Use a portable fire extinguisher to:
        - Assist oneself to evacuate
        - Assist another to evacuate
        - Extinguish or control a small fire, if you are properly trained

- Provide the fire/police teams with the details of the problem upon their arrival. Special hazard information you may know is essential.

- If the fire alarms are ringing in your building:
    - Evacuate the building
    - Move at least 200 feet away from the building and proceed to the emergency gathering point
    - Go to the designated emergency gathering point and report your supervisor or other designated individual
    - Stay clear of driveways, sidewalks and other access ways to the building

- If you are a supervisor, try to account for your employees and report any missing persons to the emergency personnel at the scene.

- Assist emergency personnel as may be requested.

- Do not re-enter the building until directed to do so.

- Follow any special procedures established for your unit.

- For Delegation of Authority in Emergency Situations refer to University Policy 7-6.

25.0 Industrial Toxicology - Overview

Chemical Toxicity

- Toxicology is the study of the nature and action of poisons.

- Toxicity is the ability of a chemical molecule or compound to produce injury once it reaches a susceptible site in or on the body.

- Toxicity hazard is the probability that injury will occur considering the manner in which the substance is used.

Dose-Response Relationships

- The potential toxicity (harmful action) inherent in a substance is manifest only when that substance comes in contact with a living biological system. A chemical normally thought of as "harmless" will evoke a toxic response if added to a biological system in sufficient amount. The toxic potency of a chemical is thus ultimately defined by the relationship between the dose (the amount) of the chemical and the response that is produced in a biological system.

Hygienic Standards

- The DEHS has a comprehensive listing of published hygienic standards such as Threshold Limit Values (TLV), Permissible Exposure Limits (PEL), and other works concerning the subject of industrial toxicology. If you would like to conduct a more thorough review of a particular compound, contact the DEHS.

- The Morris Library subscribes to an on-line computer based abstract service. Hazard information is available through the service. Also, many manufacturers and distributors have developed on-line hazard information for their products; contact your sales representative for more information.

- Safety Data Sheets will list applicable standards for the hazardous chemical or each component of a mixture.

Check the reference list in this pamphlet for selected works on toxicology.

Routes of Entry into the Body

- There are four main routes by which hazardous chemicals enter the body:

    - Absorption through the respiratory tract through inhalation. Most important in terms of severity.
    - Absorption through the skin. Runs first in the production of occupational disease (dermatitis).
    - Absorption through the digestive tract. Can occur through eating or smoking with contaminated hands or in contaminated work areas.

- Injection through the skin by a puncture with a sharp object like a needle/syringe or broken glass.

- Most exposure standards, Threshold Limit Values (TLVs) and Permissible Exposure Limits (PELs), are based on the inhalation route of exposure. They are normally expressed in terms of either parts per million (ppm) or milligrams per cubic meter (mg/m3) concentration in air.

- If a significant route of exposure for a substance is through skin contact, the MSDS will have a "skin" notation. Examples: pesticides, carbon disulfide, carbon tetrachloride, dioxane, mercury, thallium compounds, xylene, hydrogen cyanide.

Types of Effects

- **Acute Poisoning** is characterized by rapid absorption of the substance and the exposure is sudden and severe. Normally, a single large exposure is involved. Examples: carbon monoxide or cyanide poisoning.

- **Chronic Poisoning** is characterized by prolonged or repeated exposures of a duration measured in days, months or years. Symptoms may not be immediately apparent. Examples: lead or mercury poisoning, pesticide exposure.

- **Local** refers to a site of action where a chemical has made direct contact and causes irritation and/or damage at the site. Depending on the chemical and location of contact, effects may be immediate or delayed. For example, sulfuric acid that comes in contact with the skin will cause severe irritation and possible skin and tissue damage at the point of contact. Examples: strong acids or alkalis.

- **Systemic** refers to a site of action other than the point of contact and presupposes absorption has taken place. For example, an inhaled material may act on the liver. Examples: arsenic affects the blood, nervous system, liver, kidneys and skin; benzene affects bone marrow.

- **Cumulative Poisons** are characterized by materials that tend to build up in the body as a result of numerous chronic exposures. The effects are not seen until a critical body burden is reached. Example: heavy metals.

- **Substances in Combination:** When two or more hazardous materials are present at the same time, the resulting effect can be greater than the effect predicted based on the individual substances. This is called a synergistic or potentiating effect. Example: exposure to alcohol and chlorinated solvents.

Other Factors Affecting Toxicity

- Rate of entry and route of exposure; that is, how fast is the toxic dose delivered and by what means.

- Age can affect the capacity to repair tissue damage.
- Previous exposure can lead to tolerance, increased sensitivity or make no difference.
- State of health, physical condition and life style can affect the toxic response. Pre-existing disease can result in increased sensitivity.
- Environmental factors such as temperature and pressure.
- Host factors including genetic predisposition and the sex of the exposed individual.

26.0 Classification Of Toxic Materials

Physical Classifications

- The term **gas** applies to a substance which is in the gaseous state at room temperature and pressure.

- A **vapor** is the gaseous phase of a material which is ordinarily a solid or a liquid at room temperature and pressure.

- When considering the toxicity of gases and vapors, the solubility of the substance is a key factor. Highly soluble materials like ammonia irritate the upper respiratory tract. On the other hand, relatively insoluble materials like nitrogen dioxide penetrate deep into the lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body.

- An **aerosol** is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium. The toxic potential of an aerosol is only partially described by its concentration in milligrams per cubic meter (mg/m3). For a proper assessment of the toxic hazard, the size of the aerosol's particles is important. Particles above 1 micrometer tend to deposit in the upper respiratory tract. Particles below 1 micrometer in size enter the lung. Very small particles (<0.2 um) are generally not deposited.

Physiological Classifications

- **Irritants** are materials that cause inflammation of the mucous membranes they contact. Inflammation of tissue results from concentrations far below those needed to cause corrosion. Examples include:

* ammonia	* alkaline dusts and mists	* halogens
* hydrogen chloride	* hydrogen fluoride	* phosgene
* nitrogen dioxide	* arsenic trichloride	* ozone
* phosphorus chlorides	* diethyl/dimethyl sulfate	

  - Irritants can also cause changes in the mechanics of respiration and lung function. Examples include:

* sulfur dioxide	* acetic acid	* acrolein
* formaldehyde	* formic acid	* iodine
* sulfuric acid		

  - Long term exposure to irritants can result in increased mucous secretions and chronic bronchitis.

- A **primary irritant** exerts no systemic toxic action either because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. Example: hydrogen chloride.

- **A secondary irritant's** effect on mucous membranes is overshadowed by a systemic effect resulting from absorption. Exposure to a secondary irritant can result in pulmonary edema, hemorrhage and tissue necrosis. Examples include:

  * hydrogen sulfide * aromatic hydrocarbons

- **Asphyxiants** have the ability to deprive tissue of oxygen.

  - **Simple asphyxiants** are inert gases that displace oxygen. Examples include:

    * nitrogen * nitrous oxide * helium
    * carbon dioxide * hydrogen

  - **Chemical asphyxiants** render the body incapable of utilizing an adequate oxygen supply. They are active at very low concentrations (few PPM's). Examples include:

    * carbon monoxide * cyanides

- **Primary anesthetics** have a depressant effect upon the central nervous system, particularly the brain. Examples include:

  * halogenated hydrocarbons * alcohols

- **Hepatotoxic agents** cause damage to the liver. Examples include:

  * carbon tetrachloride * tetrachloroethane * nitrosamines

- **Nephrotoxic agents** damage the kidneys. Examples include:

  * halogenated hydrocarbons * uranium compounds

- **Neurotoxic agents** damage the nervous system. The nervous system is especially sensitive to organometallic compounds and certain sulfide compounds. Examples include:

  * triakyl tin compounds * tetraethyl lead * methyl mercury
  * carbon disulfide * manganese * thallium
  * organic phosphorus insecticide

- Some toxic agents act on the **blood** or **hematopoietic system**. The blood cells can be directly affected or bone marrow can be damaged. Examples include:

  * nitrites * aniline * benzene
  * toluidine * nitrobenzene

- There are toxic agents that produce damage of the **pulmonary tissue** (lungs) but not by immediate irritant action. Fibrotic changes can be caused by free silica and asbestos. Other dusts can cause a restrictive disease called **pneumoconiosis**. Examples include:

  * coal dust * cotton dust * wood dust

- A **carcinogen** commonly describes any agent that can initiate or speed the development of malignant or potentially malignant tumors, malignant neoplastic proliferation of cells, or that possesses such material. Known human carcinogens include:

  * asbestos
  * alpha-naphthylamine
  * 3,3'-dichlorobenzidine
  * vinyl chloride
  * ethylene oxide
  * N-nitrosodimethylamine
  * 4-nitrobiphenyl
  * methyl chloromethyl ether
  * bis-chloromethyl ether
  * inorganic arsenic
  * 1,2-dibromo-3-chloropropane (DBCP)
  * coal tar pitch volatiles

- A **mutagen** affects the chromosome chains of exposed cells. The effect is hereditary and becomes part of the genetic pool passed on to future generations.

- A **teratogen** (embryotoxic or fetotoxic agent) is an agent which interferes with normal embryonic development without damage to the mother or lethal effect on the fetus. Effects are not hereditary. Examples include:

  * lead
  * toluene
  * ethyl tert-butyl ether
  * dibromodichloropropane
  * benzene
  * mercury

- A **sensitizer** causes a substantial proportion of exposed people to develop an allergic reaction in normal tissue after repeated exposure to the chemical. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock. Examples include:

  * epoxies * toluene diisocyanate * latex
  * nickel compounds * chromium compounds * poison ivy
  * chlorinated hydrocarbons

27.0 Target Organ Effects

- The following is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects.

* hepatotoxics	causes liver damage
signs and symptoms	jaundice; liver enlargement
example chemicals	carbon tetrachloride, nitrosamines, chloroform, toluene, perchloro-ethylene, cresol, dimethylsulfate
* nephrotoxics	produce kidney damage
signs and symptoms	edema; proteinuria
example chemicals	halogenated hydrocarbons, uranium, chloroform, mercury, dimethylsulfate
* neurotoxins	affect the nervous system
signs and symptoms	narcosis; behavioral changes; decreased muscle coordination
example chemicals	mercury, carbon disulfide, benzene, carbon tetrachloride, lead, mercury, nitrobenzene
* hematopoietic agents	decreased blood functions
signs and symptoms	cyanosis; loss of consciousness
example chemicals	carbon monoxide, cyanides, nitro-benzene, aniline, arsenic, benzene, toluene
* pulmonary agents	irritate or damage the lungs
signs and symptoms	cough; tightness in chest, shortness of breath
example chemicals	silica, asbestos, ozone, hydrogen sulfide, chromium, nickel, alcohols
* reproductive toxins	affect the reproductive system (mutations and teratogenesis)
signs and symptoms	birth defects; sterility
example chemicals	lead, dibromodichloropropane
* skin hazards	affect the dermal layer of the body
signs and symptoms	defatting of skin; rashes; irritation
example chemicals	ketones, chlorinated compounds, alcohols, nickel, phenol, trichloroethylene
* eye hazards	affect the eye or vision
signs and symptoms	conjunctivitis; corneal damage
example chemicals	organic solvents, acids, cresol, quinone, hydroquinone, benzoyl chloride, butyl alcohol, bases

28.0 Reproductive Hazards

- Materials with undesirable reproductive effects can affect both men and women. 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 should consider the reproductive effects of the materials with which they are routinely in contact.

- 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.

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

- 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 DEHS for a job hazard analysis. In addition, individuals should consult with co-workers in the lab regarding their use of potentially harmful chemicals.

- Additional safety measures should include:

    - Review each use of reproductive hazards with research supervisor, the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety (DEHS).

    - Label the containers as follows: REPRODUCTIVE HAZARD: READ SPECIFIC PROCDURES FOR USE.

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

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

    - Notify your supervisor or the Department Chemical Hygiene Officer and the Department of Environmental Health and Safety of all incidents of exposure or spills. The DEHS department will arrange for a medical consultation if necessary.

- Some common chemicals that are known or are highly suspected to be reproductive hazards:

  - acrylic acid
  - amitrole
  - tert-amyl methyl ether
  - benomyl
  - benzene
  - N-butyl acrylate
  - N-butyl mercaptan
  - carbon monoxide
  - chloroform
  - β-chloroprene
  - 2-chloropropionic acid
  - carbaryl
  - 1-chloro-2-propanol
  - 2-chloro-1-propanol
  - 1,3-dioxolane
  - dibutyl phthalate diglycidyl ether
  - N,N-dimethylacetamide dinitrotoluene
  - ethidium bromide
  - ethyl tert-butyl ether
  - ethylene oxide
  - 2-ethoxyethanol
  - 2-ethoxyethyl acetate
  - 2-ethylhexanoic acid
  - halothane
  - hexafluoroacetone
  - lead
  - lead arsenate
  - lead chromate
  - manganese mercury 2-methoxy ethanol
  - 2-methoxyethyl acetate
  - methyl tert-butyl ether
  - methyl chloride
  - nitrous oxide
  - phenylphosphine
  - 1,3,5-triglycidyl-s-triazinetrione
  - vinyl cyclohexene dioxide
  - 4-vinyl cyclohexene

- For more information, contact the Department of Environmental Health and Safety x8475 or www.udel.edu/ehs.

29.0 Safety Data Sheets (SDS's)

- A Safety Data Sheet (SDS) is a document containing the chemical hazard and safe handling information pertaining to a specific chemical or compound and is prepared in accordance with the OSHA Hazard Communication Standard.

- Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals in Delaware with an appropriate SDS for each hazardous chemical purchased.

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

- The University must assure the SDS's on file are current.

- Upon request, the University must make SDS's available to employees or their designated representatives and/or students.

- DEHS, General Services Building, Room 132, 222 S. Chapel Street (ext. 8475), is the central repository for SDS's. To receive an SDS, contact your supervisor, instructor or call the DEHS.

- DEHS has purchased a subscription to an online SDS provider. You can access this service from DEHS' main webpage at http://www.udel.edu/ehs.

- Section I of the SDS lists information identifying the manufacturer and the product.

    - Manufacturer's name, address and telephone number
    - Number to call in case of emergency
    - Chemical name and synonyms
    - Trade name and synonyms
    - Chemical family and formula
    - CAS Number (Chemical Abstract Service) for pure materials

    - If your work requires an understanding of this chemical information, contact your supervisor, instructor or the DEHS.

- Section II describes the various hazardous ingredients contained in the product, the percentages, and exposure limits when appropriate.

    - Pigments, catalysts, vehicle, solvents, additives, others
    - Base metal, alloys, metallic coatings, fillers
    - Hazardous mixtures of other liquids, solids or gases
    - CAS# of components

- All hazardous chemicals which comprise 1% or greater of the mixture will be identified.

- Section III describes the hazard information, potential health effects and carcinogenic status.

- Section IV describes the first aid measures for treating an exposure.

- Section V describes the fire and explosion hazard data for the material. Based on the flash point and other fire and explosion data, the appropriate extinguishing agent for fires involving the material will be listed. Special procedures may also be listed.

    - Flash point
    - Lower and upper explosive limits (LEL/UEL)
    - Extinguishing agent - water, dry chemical, foam, halon, etc.
    - Special fire fighting procedures
    - Unusual fire and explosion hazards, toxic fumes

- Section VI gives instructions to be taken in case of an accidental release or spill. The steps normally include information on containment, evacuation procedures and any special notification requirements. The statements on the MSDS are general; more specific information is available from your supervisor, instructor or the DEHS.

- Section VII describes handling and storage procedures to be taken with the material. Information may include statements such as keep container closed; store in a cool, dry, well ventilated area; keep refrigerated; avoid exposure to sunlight; etc.

- Section VIII describes the protective equipment and exposure controls for the individual who might have to work with the substance. This section normally describes worst case conditions; therefore, the extent to which personal protective equipment is required is task dependent. Contact your supervisor or instructor for instructions.

    - Respiratory equipment: dust mask, chemical cartridge respirator,
    - Self-contained breathing apparatus
    - Ventilation: local, general, special
    - Protective gloves: type
    - Eye protection
    - Other protective equipment

- Section IX describes the physical properties of the material.

* boiling point	* specific gravity
* vapor pressure	* percent volatile
* vapor density	* evaporation rate
* solubility in water	* appearance and odor

- Section X describes reactivity data; that is, the material's ability to react and release energy or heat under certain conditions or when it comes in contact with certain substances.

    - Stability: stable, unstable, conditions to avoid
    - Incompatibility: materials to avoid
    - Hazardous decomposition products
    - Hazardous polymerizations: conditions to avoid

- Section XI describes the known health hazard data, toxicological information and exposure limits for the material. Symptoms or the health effects of an overexposure are listed. This information will help the user and medical personnel recognize if an overexposure has occurred.

    - Threshold limit value
    - Effects of overexposure: headache, nausea, narcosis, irritation, weakness, etc.
    - Primary routes of exposure: inhalation, skin, ingestion
    - Cancer or other special health hazards
    - Emergency and first aid procedures: ingestion, inhalation, skin contact, eye contact
    -

- Section XII describes ecological information.

- Section XIII describes disposal information.

- Section XIV describes transport information: e.g., DOT shipping name, hazard class, etc.

- Section XV describes regulatory information, Toxic Substances Control Act (TSCA) information, Comprehensive Environmental Responsibility Compensation Liability Act (CERCLA) information, and Superfund Amendments and Reauthorization Act (SARA) information.

- Section XVI describes any special precautions or miscellaneous information regarding the material.

- In some cases, manufacturers may choose to withhold certain information on a SDS provided the information is a trade secret. However, the SDS must still contain all relevant hazard, protection and health information.

- Some SDSs may not contain all 16 sections or the information may be in a slightly different order. However, the basic information described above must be provided.

- Some SDSs are more complete than others. Do not assume everything you need to know is contained on the SDS. Always try to consult two different SDS's.

ACETONE

Chemwatch Material Safety Data Sheet (REVIEW)
Chemwatch 1090

HAZARD ALERT CODE HIGH

CD 2007/2

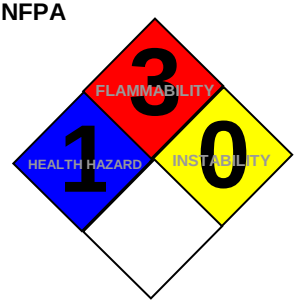
Issue Date: 26-Mar-2007 Revision No: 2

Section 1 – CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: ACETONE
STATEMENT OF HAZARDOUS NATURE

CONSIDERED A HAZARDOUS SUBSTANCE ACCORDING TO OHSA 29 CFR 1910.1200

NFPA



SUPPLIER
ChemWatch Pty Ltd
+61 3 9573 3112 or
Toll Free +800 2436 2255
Email: chemwatch@chemwatch.net

HAZARD RATINGS

	Min	Max
Flammability: 3		
Toxicity: 2		
Body Contact: 2		
Reactivity: 1		
Chronic: 2		

Min/Nil = 0
Low = 1
Moderate = 2
High = 3
Extreme - 4

PRODUCT USE

Solvent for fats, oils, waxes, resins, rubber, plastics, lacquers. Used in manufacture of methyl isobutyl ketone, mesityl oxide, acetic acid, diacetone alcohol, isoprene. Used in solvent extraction processes. Solvent in the manufacture of explosives and rayon. Component of adhesives, glues, cleaning solvents, lacquer thinners, nail polish, paint removers. Storing acetylene gas (takes up about 24 times its volume of the gas). Purifying paraffin and biomedical hardening and dehydrating tissues. Minor food additive, permitted in USA.

SYNONYMS

C3-H6-O, CH3COCH3, propanone, "pyroacetic acid", "pyroacetic ether", 2-propanone, 2-propanone, beta-ketopropane, "methyl ketone", propan-2-one, propan-2-one, "dimethyl ketone", "ketone, dimethyl ketone propane", "dimethyl formaldehyde", "RF Services", "RCRA Waste No. U002", EM000739, "APS RETL00020006", UCH00002546, RDEH06009000, SPOL00000585, AR0000006, UL0000007, M&B00004946, "Ashland Acetone ECD", "Mobil 878033", 971934, J.T.Baker, Chem-Supply

Section 2 – HAZARDS IDENTIFICATION

CANADIAN WHMIS SYMBOLS

EMERGENCY OVERVIEW

RISK

- Irritating to eyes.
- HARMFUL - May cause lung damage if swallowed.
- Highly flammable.
- Repeated exposure may cause skin dryness and cracking.
- Vapors may cause dizziness or suffocation.
- Cumulative effects may result following exposure*.
- Inhalation, skin contact and/or ingestion may produce health damage*.
- May produce discomfort of the respiratory system and skin*.

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED

Accidental ingestion of the material may be damaging to the health of the individual.

EYE

Evidence exists, or practical experience predicts, that the material may cause severe eye irritation in a substantial number of individuals and/or may produce significant ocular lesions which are present twenty-four hours or more after instillation into the eye(s) of experimental animals. Eye contact may cause significant inflammation with pain. Corneal injury may occur; permanent impairment of vision may result unless treatment

is prompt and adequate. Repeated or prolonged exposure to irritants may cause inflammation characterized by a temporary redness (similar to windburn) of the conjunctiva (conjunctivitis); temporary impairment of vision and/or other transient eye damage/ ulceration may occur. The liquid may produce eye discomfort and is capable of causing temporary impairment of vision and/or transient eye inflammation, ulceration.

SKIN

Skin contact with the material may damage the health of the individual; systemic effects may result
following absorption. The material may produce mild skin irritation; limited evidence or practical experience suggests, that the material either produces mild inflammation of the skin in a substantial number of individuals following direct contact, and/or produces significant, but mild, inflammation when applied to the healthy intact skin of animals (for up to four hours), such inflammation being present twenty-four hours or more after the end of the exposure period. Skin irritation may also be present after prolonged or repeated exposure; this may result in a form of contact dermatitis (non allergic). The dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to blistering (vesiculation), scaling and thickening of the epidermis. At the microscopic level there may be intercellular edema of the spongy layer of the skin (spongiosis) and intracellular edema of the epidermis. Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected. The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

INHALED

Inhalation may produce health damage*. Inhalation of vapors or aerosols (mists, fumes), generated by the material during the course of normal handling, may be damaging to the health of the individual. Limited evidence or practical experience suggests that the material may produce irritation of the respiratory system, in a significant number of individuals, following inhalation. In contrast to most organs, the lung is able to respond to a chemical insult by first removing or neutralizing the irritant and then repairing the damage. The repair process, which initially evolved to protect mammalian lungs from foreign matter and antigens, may however, produce further lung damage resulting in the impairment of gas exchange, the primary function of the lungs. Respiratory tract irritation often results in an inflammatory response involving the

recruitment and activation of many cell types, mainly derived from the vascular system. Inhalation of vapors may cause drowsiness and dizziness. This may be accompanied by narcosis, reduced alertness, loss of reflexes, lack of coordination and vertigo. Exposure to ketone vapors may produce nose, throat and mucous membrane irritation. High concentrations of vapor may produce central nervous system depression characterized by headache, vertigo, loss of coordination, narcosis and cardiorespiratory failure. Some ketones produce neurological disorders (polyneuropathy) characterized by bilateral symmetrical paresthesia and muscle weakness primarily in the legs and arms. Systemic effects of acetone inhalation exposure include central nervous system depression, lightheadedness, incoherent speech, ataxia, stupor, hypotension, tachycardia, metabolic acidosis, hyperglycemia and ketosis. Rarely, convulsions and tubular necrosis may be evident. Other symptoms of exposure may include restlessness, headache, vomiting, low blood-pressure and rapid and irregular pulse, eye and throat irritation, weakness of the legs and dizziness. Inhalation of high concentrations may produce dryness of the mouth and throat, nausea, uncoordinated movement, loss of coordinated speech, drowsiness and, in severe cases, coma. Inhalation of acetone vapors over long periods causes irritation of the respiratory tract, coughing and headache. Rats exposed to 52200 ppm vapor for 1 hour showed clear signs of narcosis; fatalities occurred at 126600 ppm.

CHRONIC HEALTH EFFECTS

Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems. Workers exposed to 700 ppm acetone for 3 hours/day for 7-15 years showed inflammation of the respiratory tract, stomach and duodenum, attacks of giddiness and loss of strength. Exposure to acetone may enhance liver toxicity of chlorinated solvents.

Section 3 – COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
Acetone	67-64-1	95-99.5

Section 4 - FIRST AID MEASURES

SWALLOWED

For advice, contact a Poisons Information Centre or a doctor at once. Urgent hospital treatment is likely to be needed. If swallowed do NOT induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration. Observe the patient

carefully. Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious. Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink. Transport to hospital or doctor without delay.

EYE

If this product comes in contact with the eyes: Wash out immediately with fresh running water. Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids. If pain persists or recurs seek medical attention. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

SKIN

If skin contact occurs: Immediately remove all contaminated clothing, including footwear. Flush skin and hair with running water (and soap if available). Seek medical attention in event of irritation.

INHALED

If fumes or combustion products are inhaled remove from contaminated area. Lay patient down. Keep warm and rested. Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures. Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary. Transport to hospital, or doctor.

NOTES TO PHYSICIAN

Any material aspirated during vomiting may produce lung injury. Therefore emesis should not be induced mechanically or pharmacologically. Mechanical means should be used if it is considered necessary to evacuate the stomach contents; these include gastric lavage after endotracheal intubation. If spontaneous vomiting has occurred after ingestion, the patient should be monitored for difficult breathing, as adverse effects of aspiration into the lungs may be delayed up to 48 hours.

For acute or short term repeated exposures to acetone:

Symptoms of acetone exposure approximate ethanol intoxication. About 20% is expired by the lungs and the rest is metabolized. Alveolar air half-life is about 4 hours following two hour inhalation at levels near the Exposure Standard; in overdose, saturable metabolism and limited clearance, prolong the elimination half-life to 25-30 hours. There are no known antidotes and treatment should involve the usual methods of decontamination followed by supportive care.

[Ellenhorn and Barceloux: Medical Toxicology] Management: Measurement of

serum and urine acetone concentrations may be useful to monitor the severity of ingestion or inhalation.

Inhalation Management:

Maintain a clear airway, give humidified oxygen and ventilate if necessary. If respiratory irritation occurs, assess respiratory function and, if necessary, perform chest X-rays to check for chemical pneumonitis. Consider the use of steroids to reduce the inflammatory response. Treat pulmonary edema with PEEP or CPAP ventilation.

Dermal Management:

Remove any remaining contaminated clothing, place in double sealed, clear bags, label and store in secure area away from patients and staff. Irrigate with copious amounts of water. An emollient may be required.

Eye Management:

Irrigate thoroughly with running water or saline for 15 minutes. Stain with fluorescein and refer to an ophthalmologist if there is any uptake of the stain.

Oral Management:

No GASTRIC LAVAGE OR EMETIC. Encourage oral fluids.

Systemic Management:

Monitor blood glucose and arterial pH. Ventilate if respiratory depression occurs. If patient unconscious, monitor renal function. Symptomatic and supportive care.

The Chemical Incident Management Handbook:

Guy's and St. Thomas' Hospital Trust, 2000

BIOLOGICAL EXPOSURE INDEX

These represent the determinants observed in specimens collected from a healthy worker exposed
at the Exposure Standard (ES or TLV):

Determinant	Sampling Time	Index	Comments
Acetone in urine	End of shift	50 mg/L	Non-specific determinant; also observed after exposure to other material.

Section 5 - FIRE FIGHTING MEASURES

- Flash Point (°F): 1.4
- Lower Explosive Limit (%): 2.6
- Upper Explosive Limit (%): 12.8
- Autoignition Temp (°F): 869

EXTINGUISHING MEDIA

- Alcohol stable foam.
- Dry chemical powder.
- BCF (where regulations permit).
- Carbon dioxide.
- Water spray or fog - Large fires only.

FIRE FIGHTING

- Alert Fire Brigade and tell them location and nature of hazard.
- May be violently or explosively reactive.
- Wear breathing apparatus plus protective gloves.
- Prevent, by any means available, spillage from entering drains or water course.
- Consider evacuation (or protect in place).
- Fight fire from a safe distance, with adequate cover.
- If safe, switch off electrical equipment until vapor fire hazard removed.
- Use water delivered as a fine spray to control the fire and cool adjacent area.
- Avoid spraying water onto liquid pools.
- Do not approach containers suspected to be hot.
- Cool fire exposed containers with water spray from a protected location.
- If safe to do so, remove containers from path of fire.

GENERAL FIRE HAZARDS/HAZARDOUS COMBUSTIBLE PRODUCTS

- Liquid and vapor are highly flammable.
- Severe fire hazard when exposed to heat, flame and/or oxidizers.
- Vapor may travel a considerable distance to source of ignition.
- Heating may cause expansion or decomposition leading to violent rupture of containers.
- On combustion, may emit toxic fumes of carbon monoxide (CO). Combustion products include: carbon dioxide (CO2), other pyrolysis products typical of burning organic material.

FIRE INCOMPATIBILITY

Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.

PERSONAL PROTECTION

- Glasses: Chemical goggles.
- Gloves: 1.BUTYL/NEOPRENE 2.PE/EVAL/PE
- Respirator: Type AX Filter of sufficient capacity

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS

- Remove all ignition sources.
- Clean up all spills immediately.
- Avoid breathing vapours and contact with skin and eyes.
- Control personal contact by using protective equipment.
- Contain and absorb small quantities with vermiculite or other absorbent material.
- Wipe up.
- Collect residues in a flammable waste container.

MAJOR SPILLS

- Clear area of personnel and move upwind.
- Alert Fire Brigade and tell them location and nature of hazard.
- May be violently or explosively reactive.
- Wear breathing apparatus plus protective gloves.
- Prevent, by any means available, spillage from entering drains or water course.
- Consider evacuation (or protect in place).
- No smoking, naked lights or ignition sources.
- Increase ventilation.
- Stop leak if safe to do so.
- Water spray or fog may be used to disperse /absorb vapor.
- Contain spill with sand, earth or vermiculite.
- Use only spark-free shovels and explosion proof equipment.
- Collect recoverable product into labeled containers for recycling.
- Absorb remaining product with sand, earth or vermiculite.
- Collect solid residues and seal in labeled drums for disposal.
- Wash area and prevent runoff into drains.
- If contamination of drains or waterways occurs, advise emergency services.

ACUTE EXPOSURE GUIDELINE LEVELS (AEGL) (in ppm)

AEGL 1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure. AEGL 2: The airborne concentration of a substance

above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape. AEGL 3: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

SAFE STORAGE WITH OTHER CLASSIFIED CHEMICALS

+	X	X	X	X	+

X: Must not be stored together
O: May be stored together with specific preventions +: May be stored together

Section 7 – HANDLING AND STORAGE

PROCEDURE FOR HANDLING

- Avoid all personal contact, including inhalation.
- Wear protective clothing when risk of exposure occurs.
- Use in a well-ventilated area.
- Prevent concentration in hollows and sumps.
- DO NOT enter confined spaces until atmosphere has been checked.
- Avoid smoking, naked lights, heat or ignition sources.
- When handling, DO NOT eat, drink or smoke.
- Vapor may ignite on pumping or pouring due to static electricity.
- DO NOT use plastic buckets.
- Earth and secure metal containers when dispensing or pouring product.
- Use spark-free tools when handling.
- Avoid contact with incompatible materials.
- Keep containers securely sealed.
- Avoid physical damage to containers.
- Always wash hands with soap and water after handling.
- Work clothes should be laundered separately.
- Use good occupational work practice.
- Observe manufacturer's storing and handling recommendations.
- Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
- DO NOT allow clothing wet with material to stay in contact with skin.

RECOMMENDED STORAGE METHODS

- Packing as supplied by manufacturer.
- Plastic containers may only be used if approved for flammable liquid.

- Check that containers are clearly labeled and free from leaks.
- Where combination packages are used, and the inner packages are of glass, there must be sufficient inert cushioning material in contact with inner and outer packages
- In addition, where inner packaging is glass and contain liquids of packing group I there must be sufficient inert absorbent to absorb any spillage, unless the outer packaging is a close fitting molded plastic box and the substances are not incompatible with the plastic.

STORAGE REQUIREMENTS

- Store in original containers in approved flame-proof area.
- No smoking, naked lights, heat or ignition sources.
- DO NOT store in pits, depressions, basements or areas where vapors may be trapped.
- Keep containers securely sealed.
- Store away from incompatible materials in a cool, dry well ventilated area.
- Protect containers against physical damage and check regularly for leaks.
- Observe manufacturer's storing and handling recommendations.

Section 8 - EXPOSURE / PERSONAL PROTECTION EXPOSURE CONTROLS

SOURCE	MATERIAL	TWA (ppm)	TWA mg/m^3	STEL ppm	STEL mg/m^3
US - Minnesota Permissible Exposure Limits (PELs)	acetone	750	1800	1000	2400
Canada – British Columbia Occupational Exposure Limits	acetone	250		500	
US - Hawaii Air Contaminant Limits	acetone	750	1780	1000	2375
US OSHA Permissible Exposure Levels (PELs) - Table Z1	acetone	1000	2400		
US NIOSH Recommended Exposure Limits (RELs)	acetone	250	590		
US ACGIH Threshold Limit Values (TLV)	acetone	500		750	

NOTES

Values marked LEL indicate that the IDLH was based on 10% of the lower explosive limit for safety considerations even though the relevant toxicological data indicated that irreversible health effects or impairment of escape existed only at higher concentrations.

PERSONAL PROTECTION

Consult your EHS staff for recommendations

EYE

- Safety glasses with side shields.
- Chemical goggles
- Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lens or restrictions on use, should be created for each workplace or task. This should include a review of lens absorption and adsorption for the class of chemicals in use and an account of injury experience. Medical and first-aid personnel should be trained in their removal and suitable equipment should be readily available. In the event of chemical exposure, begin eye irrigation immediately and remove contact lens as soon as practicable. Lens should be removed at the first signs of eye redness or irritation - lens should be removed in a clean environment only after workers have washed hands thoroughly. [CDC NIOSH Current Intelligence Bulletin 59]

OTHER

- Overalls.
- PVC Apron.
- PVC protective suit may be required if exposure severe.
- Eyewash unit.
- Ensure there is ready access to a safety shower.

GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the: "Forsberg Clothing Performance Index".

The effect(s) of the following substance(s) are taken into account in the computer-generated selection: acetone

Protective Material CPI *	Rating
BUTYL/NEOPRENE	A
PE/EVAL/PE	A
PVDC/PE/PVDC	A
BUTYL	A
SARANEX-23 2-PLY	B
TEFLON	B
SARANEX-23	C
CPE	C
HYPALON	C
NITRILE+PVC	C
PVA	C
VITON/NEOPRENE	C
NEOPRENE	C
PVC	C
NATURAL+NEOPRENE	C
NATURAL RUBBER	C
NITRILE	C

* CPI - Chemwatch Performance Index
A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion

NOTE: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation.

* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

ENGINEERING CONTROLS

For flammable liquids and flammable gases, local exhaust ventilation or a process enclosure ventilation system may be required. Ventilation equipment should be explosion-resistant. Air contaminants generated in the workplace possess varying "escape" velocities which, in turn, determine the "capture velocities" of fresh circulating air required to effectively remove the contaminant.

Type of Contaminant	Air Speed
solvent, vapors, degreasing etc., evaporating from tank (in still air).	0.25-0.5 m/s (50-100 f/min.)
aerosols, fumes from pouring operations, intermittent container filling, low speed conveyer transfers, welding, spray drift, plating acid fumes, pickling (released at low velocity into zone of active generation)	0.5-1 m/s (100-200 f/min.)
direct spray, spray painting in shallow booths, drum filling, conveyer loading, crusher dusts, gas discharge (active generation into zone of rapid air motion)	1-2.5 m/s (200-500 f/min.)
Within each range the appropriate value depends on:	Lower end of the range Upper end of the range
1: Room air currents minimal or favorable to capture	1: Disturbing room air currents capture
2: Contaminants of low toxicity or of nuisance value only.	2: Contaminants of high toxicity
3: Intermittent, low production.	3: High production, heavy use
4: Large hood or large air mass in motion	4: Small hood-local control only

Simple theory shows that air velocity falls rapidly with distance away from the opening of a simple extraction pipe. Velocity generally decreases with the square of distance from the extraction point (in simple cases). Therefore the air speed at the extraction point should be adjusted, accordingly, after reference to distance from the contaminating source. The air velocity at the extraction fan, for example, should be a minimum of 1-2 m/s (200-400 f/min.) for extraction of solvents generated in a tank 2 meters distant from the extraction point. Other mechanical considerations, producing performance deficits within the extraction apparatus, make it essential that theoretical air velocities are multiplied by factors of 10 or more when extraction systems are installed or used.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL PROPERTIES

• Liquid. Mixes with water • Molecular Weight: 58.08 • Melting Range (°F): -139.72	• Boiling Range (°F): 132.8 • Specific Gravity (water=1): 0.79 @ 20 C

• Solubility in water (g/L): Miscible • pH (1% solution): Not applicable • Volatile Component (%vol): 100 • Relative Vapor Density (air=1): 2.0 • Lower Explosive Limit (%): 2.6 • Autoignition Temp (°F): 869 • State: Liquid • VOC(regulatory):	• pH (as supplied): Not applicable • Vapor Pressure (mmHg): 180.015 @ 20 C • Evaporation Rate: 11 BuAc=1 VFast • Flash Point (°F): 1.4 • Upper Explosive Limit (%): 12.8 • Decomposition Temp (°F): Not Available • Viscosity: Not Available • VOC(actual):

APPEARANCE

Clear, colorless, highly volatile, highly flammable liquid with characteristic sweet odor; mixes with water. Mixes in alcohol, ether, most hydrocarbons and oils.

Section 10 - CHEMICAL STABILITY AND REACTIVITY INFORMATION

CONDITIONS CONTRIBUTING TO INSTABILITY

- Product is considered stable under normal handling conditions.
- Stable under normal storage conditions.
- Hazardous polymerization will not occur.

STORAGE INCOMPATIBILITY

- Avoid reaction with oxidising agents.
- Acetone reacts violently with bromoform and chloroform in the presence of alkalies or in contact with alkaline surfaces.

Section 11 - TOXICOLOGICAL INFORMATION

TOXICITY AND IRRITATION

Oral (man) TDLo: 2857 mg/kg
Eye (human):500 ppm - irritant
Oral (rat) LD50: 5800 mg/kg
Eye (rabbit): 3.95 mg - SEVERE
Inhalation (human) TCLo: 500 ppm
Eye (rabbit): 20mg/24hr -moderate
Inhalation (man) TCLo: 12000 ppm/4 hr
Skin (rabbit):395mg (open) - mild
Inhalation (man) TCLo: 10 mg/m³/6 hr
Skin (rabbit): 500 mg/24hr - mild
Inhalation (rat) LC50: 50100 mg/m³/8 hr
Dermal (rabbit) LD50: 20000 mg/kg

CARCINOGEN ACGIH: acetone: A4

Section 12 - ECOLOGICAL INFORMATION

Fish LC50 (96hr.) (mg/l): 8300- 40000
Daphnia magna EC50 (48hr.) (mg/l): 10
log Kow (Prager 1995): - 0.24
log Kow (Sangster 1997): - 0.24
log Pow (Verschueren 1983): - 0.24
BOD5: 122%
ThOD: 72
Half- life Soil - High (hours): 168
Half- life Soil - Low (hours): 24
Half- life Air - High (hours): 2790
Half- life Air - Low (hours): 279
Half- life Surface water - High (hours): 168
Half- life Surface water - Low (hours): 24
Half- life Ground water - High (hours): 336
Half- life Ground water - Low (hours): 48
Aqueous biodegradation - Aerobic - High (hours): 168
Aqueous biodegradation - Aerobic - Low (hours): 24
Aqueous biodegradation - Anaerobic - High (hours): 672
Aqueous biodegradation - Anaerobic - Low (hours): 96
Aqueous biodegradation - Removal secondary treatment - High (hours): 75%
Aqueous biodegradation - Removal secondary treatment - Low (hours): 54%
Aqueous photolysis half- life - High (hours): 270
Photooxidation half- life water - High (hours): 3.97E+06
Photooxidation half- life water - Low (hours): 9.92E+04
Photooxidation half- life air - High (hours): 2790
Photooxidation half- life air - Low (hours): 279
DO NOT discharge into sewer or waterways.
log Kow: -0.24
Half-life (hr) air: 312-1896
Half-life (hr) H2O surface water: 20
Henry's atm m^3 /mol: 3.67E-05
BOD 5 if unstated: 0.31-1.76,46-55%
COD: 1.12-2.07
ThOD: 2.2
BCF: 0.69
Toxicity Fish: LC50(96) 5540-13000mg/L
Toxicity invertebrate: cell mult. inhib. 28-7500mg/L
Bioaccumulation: not sig
Nitrif. inhib.: 75% decr. at 840mg/L
Anaerobic effects: sig degrad
Degradation Biological: sig
processes Abiotic: Rxn OH*,photodissoc
In air, acetone is lost by photolysis and reaction with photochemically produced hydroxyl radicals; the estimated half-life of these combined processes is about 22 days. The relatively long half-life allows acetone

to be transported long distances from its emission source. Acetone is highly soluble and slightly persistent in water, with a half-life of about 20 hours; it is minimally toxic to aquatic life. Acetone released to soil volatilises although some may leach into the ground where it rapidly biodegrades. Acetone does not concentrate in the food chain. Drinking Water Standard: none available. Soil Guidelines: none available. Air Quality Standards: none available.

Section 13 - DISPOSAL CONSIDERATIONS

US EPA Waste Number & Descriptions
A. General Product Information

Ignitability characteristic: use EPA hazardous waste number D001 (waste code I)

B. Component Waste Numbers

When acetone is present as a solid waste as a discarded commercial chemical product, off-specification species, as a container residue, or a spill residue, use

EPA waste number U002 (waste code I).

Disposal Instructions

All waste must be handled in accordance with local, state and federal regulations.

- Recycle wherever possible.
- Consult manufacturer for recycling options or consult Waste Management Authority for disposal if no suitable treatment or disposal facility can be identified.
- Dispose of by: Burial in a licensed land-fill or Incineration in a licensed apparatus (after admixture with suitable combustible material)
- Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.

Section 14 – TRANSPORTATION INFORMATION

Dangerous Goods Class:	3	Subrisk:	None
UN Number:	1090	Packing Group:	II

Shipping Name: ACETONE

Air Transport IATA:

ICAO/IATA Class:	3	ICAO/IATA Subrisk:	None
UN/ID Number:	1090	Packing Group:	II
ERG Code:	3H		

Shipping name:ACETONE

Maritime Transport IMDG:

IMDG Class:	3	IMDG Subrisk:	None
UN Number:	1090	Packing Group:	II
EMS Number:	F-E,S-D		

Shipping name:ACETONE

Section 15 – REGULATORY INFORMATION

Risk

Risk Codes	Risk Phrases
R11	Highly flammable.
R36	Irritating to eyes.
R66	Repeated exposure may cause skin dryness and cracking.
R67	Vapors may cause drowsiness and dizziness.

REGULATIONS

US CERCLA List of Hazardous Substances and Reportable Quantities

Ingredient	CAS	RQ (Pounds)	RQ (KG)
acetone	67-64-1	5000	2270

acetone (CAS: 67- 64- 1) is found on the following regulatory lists;

- United Nations Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances - Table II
- United Nations List of Precursors and Chemicals Frequently used in the Illicit Manufacture of Narcotic Drugs and Psychotropic Substances Under International Control - Table II
- US ACGIH Biological Exposure Indices (BEI)

- US ACGIH Carcinogens Listing
- US ACGIH Threshold Limit Values (TLV)
- US CERCLA List of Hazardous Substances and Reportable Quantities
- US CERCLA Priority List of Hazardous Substances
- US Department of Transportation (DOT) List of Hazardous Substances and Reportable Quantities - Hazardous Substances Other Than Radionuclides US DOE Temporary Emergency Exposure Limits (TEELs)
- US DOT Coast Guard Bulk Hazardous Materials - List of Flammable and Combustible Bulk Liquid Cargoes
- US Drug Enforcement Administration (DEA) List II or Essential Chemicals US Drug Enforcement Administration (DEA) Thresholds for Regulated Transactions in List II Chemicals
- US EPA Acute Exposure Guideline Levels (AEGLs) - Interim US EPA Carcinogens Listing
- US EPA High Production Volume Program Chemical List
- US EPA Voluntary Children' s Chemical Evaluation Program (VCCEP)
- US Food Additive Database
- US NFPA 30B Manufacture and Storage of Aerosol Products - Chemical Heat of Combustion
- US NIOSH Recommended Exposure Limits (RELs)
- US OSHA Permissible Exposure Levels (PELs) - Table Z1
- US RCRA (Resource Conservation & Recovery Act) - Appendix IX to Part 264 Ground-Water Monitoring List 1
- US RCRA (Resource Conservation & Recovery Act) - List of Hazardous Inorganic and Organic Constituents 1
- US RCRA (Resource Conservation & Recovery Act) - List of Hazardous Wastes
- US RCRA (Resource Conservation & Recovery Act) - Phase 4 LDR Rule - Universal Treatment Standards
- US Toxic Substances Control Act (TSCA) - Inventory
- US TSCA Section 4 - Chemicals Subject to Testing Consent Orders
- US TSCA Section 4/12 (b) - Sunset Date/Status

Section 16 - OTHER INFORMATION

LIMITED EVIDENCE

Inhalation, skin contact and/or ingestion may produce health damage*.
Cumulative effects may result following exposure*.
May produce discomfort of the respiratory system and skin*.

* (limited evidence). Reasonable care has been taken in the preparation of this information, but the author makes no warranty of merchantability or any other warranty, expressed or implied, with respect to this information. The author makes no representations and assumes no liability for any direct, incidental or consequential damages resulting from its use. For additional technical information please call our toxicology department on +800 CHEMCALL.
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30.0 GLOSSARY

ACGIH The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLVs) for hundreds of chemicals, physical agents, and biological exposure indices.

ACUTE Severe, often dangerous conditions in which relatively rapid changes occur.

ACUTE EXPOSURE An intense exposure over a relatively short period of time.

ANSI The American National Standards Institute is a voluntary membership organization (run with private funding) that develops consensus standards nationally for a wide variety of devices and procedures.

ASPHYXIANT A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants such as nitrogen, either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

BOILING POINT The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. The boiling point is usually expressed in degrees Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.

"C" or CEILING A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value--Ceiling. (See also THRESHOLD LIMIT VALUE.)

CARCINOGEN A substance or physical agent that may cause cancer in animals or humans.

C.A.S. NUMBER Identifies a particular chemical by the Chemical Abstracts Service, a service of the American Chemical Society that indexes and compiles abstracts of worldwide chemical literature called "Chemical Abstracts."

CC Cubic centimeter, a volumetric measurement which is also equal to one milliliter (ml).

CERCLA Comprehensive Environmental Responsibility Compensation Liability Act

CHEMICAL As broadly applied to the chemical industry, an element or a compound produced by chemical reactions on a large scale or either direct industrial and consumer use or for reaction with other chemicals.

CHEMICAL REACTION A change in the arrangement of atoms or molecules to yield substances of different composition and properties. (See REACTIVITY.)

CHRONIC Persistent, prolonged or repeated conditions.

CHRONIC EXPOSURE A prolonged exposure occurring over a period of days, weeks, or years.

COMBUSTIBLE According to the DOT and NFPA, combustible liquids are those having a flash point at or above 100°F (37.8°C), or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances, and must be handled with caution. Substances such as wood, paper, etc., are termed "Ordinary Combustibles."

CONCENTRATION The relative amount of a material in combination with another material. For example, 5 parts (of acetone) per million (parts of air).

CORROSIVE A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

CUBIC METER (m3) A measure of volume in the metric system.

CUTANEOUS Pertaining to or affecting the skin.

DECOMPOSITION The breakdown of a chemical or substance into different parts or simpler compounds. Decomposition can occur due to heat, chemical reaction, decay, etc.

DERMAL Pertaining to or affecting the skin.

DERMATITIS An inflammation of the skin.

DILUTION VENTILATION See GENERAL VENTILATION.

DOT The United States Department of Transportation is the federal agency that regulates the labeling and transportation of hazardous materials.

DYSPNEA Shortness of breath; difficult or labored breathing.

EPA The Environmental Protection Agency is the governmental agency responsible for administration of laws to control and/or reduce pollution of air, water, and land systems.

EPA NUMBER The number assigned to chemicals regulated by the Environmental Protection Agency (EPA).

EPIDEMIOLOGY The study of disease in human populations.

ERYTHEMA A reddening of the skin.

EVAPORATION RATE The rate at which a material is converted to vapor (evaporates) at a given temperature and pressure when compared to the evaporation rate of a given substance. Health and fire hazard evaluations of materials involve consideration of evaporation rates as one aspect of the evaluation.

°F Degrees, Fahrenheit; a temperature scale.

FACESHIELD A protective device commonly intended to shield the wearer's face, or portions thereof, in addition to the eyes, from certain hazards. Faceshields are secondary protectors and shall be used only with primary protectors.

FLASH POINT The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture and burn when a source of ignition (sparks, open flames, cigarettes, etc.) is present. Two tests are used to determine the flash point: open cup and closed cup. The test method is indicated on the MSDS after the flash point.

FLAMMABLE LIQUID According to DOT and NFPA a flammable liquid is one that has a flash point below 100°. (See FLASH POINT.)

g See GRAM.

GENERAL VENTILATION Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition (see LOCAL EXHAUST VENTILATION).

g/Kg See GRAMS PER KILOGRAM.

GOGGLE A protective device intended to fit the face immediately surrounding the eyes in order to shield the eyes from a variety of hazards.

GRAM (g) A metric unit of weight. One ounce equals 28.4 grams.

GRAMS PER KILOGRAM (g/Kg) This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 grams (of substance) per kilogram of body weight (of the experimental animal).

HAZARDOUS MATERIAL Any substance or compound that has the capability of producing adverse effects on the health and safety of humans.

IGNITABLE A solid, liquid or compressed gas waste that has a flash point of less than 140°F. Ignitable material may be regulated by the EPA as a hazardous waste, as well.

INCOMPATIBLE The term applied to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

INGESTION Taking a substance into the body through the mouth as food, drink, medicine, or unknowingly as on contaminated hands or cigarettes, etc.

INHALATION The breathing in of an airborne substance that may be in the form of gases, fumes, mists, vapors, dusts, or aerosols.

INHIBITOR A substance that is added to another to prevent or slow down an unwanted reaction or change.

IRRITANT A substance that produces an irritating effect when it contacts skin, eyes, nose, or respiratory system.

Kg See KILOGRAM.

KILOGRAM (Kg) A unit of weight in the metric system equal to 2.2 pounds.

L See LITER.

LC50 See LETHAL CONCENTRATION50.

LD50 See LETHAL DOSE50.

LEL See LOWER EXPLOSIVE LIMIT.

LETHAL CONCENTRATION 50 The concentration of an air contaminant that will kill 50 percent of the test animals in a group during a single exposure (LC50).

LETHAL DOSE 50 The dose of a substance or chemical that will kill 50 percent of the test animals in a group within the first 30 days following exposure (LD50).

LEL See LOWER EXPLOSIVE LIMIT.

LITER (L) A measure of capacity. One quart equals .9 liter.

LOCAL EXHAUST VENTILATION (Also known as exhaust ventilation.) A ventilation system that captures and removes the contaminants at the point they are being produced before they escape into the workroom air. The system consists of hoods, ductwork, a fan and possibly an air cleaning device. Advantages of local exhaust ventilation over general ventilation include: removal of the contaminant at the point of origin (source) rather than dilution; requires less airflow and thus is more economical over the long term; and the system can be used to conserve or reclaim valuable materials. However, the system must be properly designed with the correctly shaped and placed hoods, and correctly sized fans and ductwork.

LOWER EXPLOSIVE LIMIT (LEL) (Also known as Lower Flammable Limit.) The lowest concentration of a substance that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn. (See also UEL.)

m3 See CUBIC METER.

MELTING POINT The temperature at which a solid changes to a liquid. A melting range may be given for mixtures.

mg See MILLIGRAM.

mg/kg See MILLIGRAMS PER KILOGRAM.

mg/m3 See MILLIGRAMS PER CUBIC METER.

MILLIGRAM (mg) A unit of weight in the metric system. One thousand milligrams equal one gram.

MILLIGRAMS PER CUBIC METER (mg/m3) Units used to measure air concentrations of dusts, gases, mists, and fumes.

MILLIGRAMS PER KILOGRAM (mg/kg) This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 milligrams (of substance) per kilogram of body weight (of the experimental animal).

MILLILITER (ml) A metric unit used to measure capacity. One milliliter equals one cubic centimeter. One thousand milliliters equal one liter.

ml See MILLILITER.

MSHA The Mine Safety and Health Administration; a federal agency that regulates the mining industry in the safety and health area.

MUTAGEN Anything that can cause a change (or mutation) in the genetic materials of a living cell.

NARCOSIS Stupor or unconsciousness caused by exposure to a chemical.

NFPA The National Fire Protection Association is a voluntary membership organization whose aim is to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 704, "Identification of the Fire Hazards of Materials." This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

NIOSH The National Institute for Occupational Safety and Health is a federal agency that among its various responsibilities trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

ODOR THRESHOLD The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

ORAL Having to do with the mouth.

OSHA The Occupational Safety and Health Administration--a federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.

OXIDATION The process of combining oxygen with some other substance or a chemical change in which an atom loses electrons.

OXIDIZER Is a substance that gives up oxygen easily to stimulate combustion of organic material.

OXYGEN DEFICIENCY An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% oxygen at sea level.

PEL See PERMISSIBLE EXPOSURE LIMIT.

PERMISSIBLE EXPOSURE LIMIT An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short term exposure (STEL), or a ceiling (C). The PELs are found in Tables Z-1, Z-2, or Z-3 of OSHA regulations 1910.1000. (See also TLV).

PERSONAL PROTECTIVE EQUIPMENT Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are respirators, gloves, and chemical splash goggles.

POLYMERIZATION A chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction with an uncontrolled release of energy.

PPM Parts (of vapor or gas) per million (parts of air) by volume.

REACTIVITY A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as exposure, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on MSDSs.

RESPIRATOR A device which is designed to protect the wearer from inhaling harmful contaminants.

RESPIRATORY HAZARD A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some bodily function impairment.

SARA Superfund Amendments and Reauthorization Act

SENSITIZER A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

SHORT TERM EXPOSURE LIMIT Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also the daily TLV-TWA must not be exceeded.

"SKIN" This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes. Thus, protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.

STEL Short Term Exposure Limit.

SUBSTANCE Any chemical entity.

SYNONYM Another name by which the same chemical may be known.

SYSTEMIC Spread throughout the body; affecting many or all body systems or organs; not localized in one spot or area.

TERATOGEN An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.

THRESHOLD LIMIT VALUE Airborne concentrations of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards, that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLV's: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL) and Ceiling (TLV-C). (See also PEL.)

TIME WEIGHTED AVERAGE The average time, over a given work period (e.g. 8-hour workday), of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the time period. Represented as TLV-TWA.

TLV See THRESHOLD LIMIT VALUE.

TOXICITY The potential of a substance to exert a harmful effect on humans or animals and a description of the effect and the conditions or concentration under which the effect takes place.

TRADE NAME The commercial name or trademark by which a chemical is known. One chemical may have a variety of trade names depending on the manufacturers or distributors involved.

TSCA Toxic Substances Control Act

TWA See TIME WEIGHTED AVERAGE.

UEL See UPPER EXPLOSIVE LIMIT.

UNSTABLE LIQUID A liquid that, in its pure state or as commercially produced, will react vigorously in some hazardous way under shock conditions (e.g., dropping), certain temperatures, or pressures.

UPPER EXPLOSIVE LIMIT Also known as Upper Flammable Limit (UFL). Is the highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is 1ppm and the UEL is 5ppm, then the explosive range of the chemical is 1ppm to 5ppm. (See also LEL).

VAPOR The gaseous form of substances which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with low boiling points will evaporate.

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UNIVERSITY OF DELAWARE RIGHT-TO-KNOW TRAINING PROGRAM
HAZARDOUS CHEMICAL SAFETY TRAINING CERTIFICATION

Use this form to document your Initial or Annual Right-To-Know Training and any other chemical safety training as appropriate.

This form is designed for Personnel, Students, Facilities Staff and Other Administrative Staff who do not perform research with chemicals. They may work around chemicals or use cleaning products and chemicals in a non-research function.

Please provide the following information as appropriate:

Department:	
Unit:	
Course Number:	
Date of Training:	

Please Check the Applicable Box:

☐ I USE OR WORK AROUND CHEMICALS
☐ I DO NOT USE OR WORK AROUND CHEMICALS

I certify I have received training pursuant to the Hazardous Chemical Information Act (Right-To-Know) and University of Delaware Policy. In addition to training on my rights under the law, I:

- ... know where Workplace Chemical List is posted and understand its purpose (if applicable).
- ... know how to interpret labels and MSDSs.
- ... have been instructed in the physical and health hazards, proper handling, storage and disposal practices for the chemicals I use.
- ... understand the protective measures, first aid procedures and emergency procedures necessary for the chemicals I use.
- ... have been instructed in any special hazard consideration (if applicable).
- ... have knowledge of where MSDSs are kept and that I have access to these.
- ... have received a copy of the Hazardous Materials Safety Manual.
- ... have received the Job Hazard Analysis and know what Personal Protective Equipment is required for my duties.
- ... am aware that there are special requirements for shipping and transporting chemicals. I am aware that I must contact the Department of Environmental Health and Safety to assist with shipping and transporting these materials.

☐ **SPECIAL TRAINING** (Document any chemical, task specific or other safety training below that is not covered by the Right-To-Know Training. This training is typically provided by supervisors as necessary. Attach additional pages as necessary)

The named individual has been thoroughly trained and demonstrates competency in safe work practices involving the chemical and/or special procedures listed below.

Date	Training Topic	Date	Training Topic

Printed Name of Employee/Student	**Printed Name of Supervisor/Instructor**
Signature of Employee/Student	**Signature of Supervisor/Instructor**

Please copy and distribute completed forms as follows:
1. Departmental/Unit Training File **2.** Safety Committee File **3.** Department of Environmental Health and Safety

UNIVERSITY OF DELAWARE CHEMICAL SAFETY TRAINING PROGRAM
HAZARDOUS CHEMICAL SAFETY TRAINING AND RIGHT-TO-KNOW CERTIFICATION

Use this form to document your Initial or Annual Right-To-Know Training, Chemical Hygiene Plan Training and any other chemical/laboratory safety training as appropriate.

This form is designed for Personnel, Researchers, Faculty, Staff and Students who work in research and teaching laboratories.

Please Check All That Apply: ☐ **I DO USE OR WORK AROUND CHEMICALS**
☐ **I DO NOT USE OR WORK AROUND CHEMICALS**

I certify I have received training pursuant to the Hazardous Chemical Information Act (Right To Know) and University of Delaware Policy. In addition to training on my rights under the law, I:

- know where the Workplace Chemical List/Chemical Inventory is located and understand its purpose.
- know how to interpret labels and MSDSs.
- know where the MSDSs are located and know that online resources exist through the EHS Web Page (http://www.udel.edu/ehs) .
- have been instructed in the physical and health hazards, proper handling, storage and disposal practices for the chemicals I use.
- have been instructed in any special hazard consideration (if applicable).
- understand the protective measures, first aid procedures and emergency procedures necessary for the chemicals I use.
- know that the Hazardous Materials Safety Manual is available online at http://www.udel.edu/ehs/hazmatman.pdf and have reviewed the manual. Print copies may be available upon request from Environmental Health and Safety
- have received a Job Hazard Analysis and know what Personal Protective Equipment is required for my duties. I understand that I must wear eye protection at all times in the laboratory when an eye hazard exists.
- understand that there are special procedures and requirements for managing chemical and hazardous waste and that these materials must not be poured down the drain or placed in the regular trash.
- am aware that there are special requirements for shipping and transporting chemicals, research samples, etc. I am aware that I must contact the Department of Environmental Health and Safety to assist with shipping and transporting these materials.
- understand that the Occupational Safety and Health Administration (OSHA) requires that laboratory workers be made aware of the Chemical Hygiene Plan (CHP) (29 CFR 1910.1450). It is located at http://www.udel.edu/ehs/chemhygieneplan.pdf. Contact your Departmental Chemical Hygiene Officer for more information or to access a printed copy.

☐ **CHEMICAL HYGIENE PLAN TRAINING**
The Environmental Health and Safety Administration (OSHA) requires that laboratory employees be made aware of the Chemical Hygiene Plan (CHP) at their place of employment (29 CFR 1910.1450). The CHP can be found online at http://www.udel.edu/ehs/chemhygieneplan.pdf. Contact your Departmental Chemical Hygiene Officer for more information or to access a printed copy.
After becoming familiar with the **"University of Delaware Chemical Hygiene Plan and Hazardous Material Safety Manual,"** please complete and return a copy of this form to your supervisor or the Department Chemical Hygiene Officer. By checking the box and signing below you acknowledge that you are aware of the Chemical Hygiene Plan and the policies and procedures applicable to the OSHA standard (29 CFR 1910.1450). Your supervisor will provide additional information and training as appropriate.

☐ **SPECIAL TRAINING** (Document any chemical, task specific or laboratory safety training below that is not covered by the Right-To-Know and Chemical Hygiene Plan Training. Attach additional pages as necessary)
The named individual has been thoroughly trained and demonstrates competency in safe work practices involving the chemical and/or special laboratory procedures listed below.

Date	Training Topic	Date	Training Topic

Date	**Printed Name of Supervisor/Instructor**
Printed Name of Employee/Student	**Signature of Supervisor/Instructor**
Signature of Employee/Student	**Department**

Please copy and distribute completed forms as follows:
1. Laboratory Safety Training File **2.** Safety Committee File **3.** Department of Environmental Health and Safety

For More Information:

- **Biological Safety Program**
  - **http://www.udel.edu/ehs/biosafety.html**
  - **Biosafety Manual**
    - **http://www.udel.edu/ehs/biosafetymanual/biosafetymanual.pdf**

- **Chemical Hygiene/Safety Program**
  - **http://www.udel.edu/ehs/chemindex.html**
  - **Chemical Hygiene Plan**
    - **http://www.udel.edu/ehs/chemhygieneplan.pdf**
  - **Departmental Chemical Hygiene Officers**
    - **http://www.udel.edu/ehs/dcho.html**

- **Radiation Safety Program**
  - **http://www.udel.edu/ehs/radiation/radsafety.html**
  - **Radiation Safety Manual**
    - **http://www.udel.edu/ehs/radiation/radsafetyman.html**

- **Chemical Waste Program**
  - **http://www.udel.edu/ehs/chemical.html**

- **Environmental Health and Safety Assistant Web Access**
  - **http://ehs.facil.udel.edu:1568**

- **Departmental Safety Committee Contacts**
  - **http://www.udel.edu/ehs/safetycomm.html**

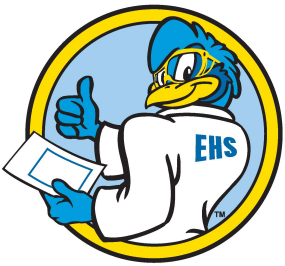
- **Safety Training Calendar**
  - **http://www.udel.edu/ehs/ehstrainsched99.html**

Department of Environmental Health & Safety
Programs, Services, and Education...

- Accident Investigation
- Asbestos Management
- Biosafety Cabinet Certifications
- Bloodborne Pathogens Program
- Chemical Hygiene Plan
- Chemical Waste Disposal/Training
- Code Reviews
- Computer Workstation Evaluations
- Confined Space Entry Program
- CPR/AED/First Aid
- Electrical Safety Information
- Emergency Response
- Ergonomics
- Fall Protection/Fall Arrest
- Fire Systems Inspection
- Fire Extinguisher Training
- Fire Investigation
- Fire And Safety Surveys
- First Aid Kits And Supplies
- Forklift Safety
- Fume Hood Certification Program
- General Safety Training
- Hearing Conservation
- High Risk Testing Program
- Hot Work Program
- Indoor Air Quality Evaluations
- Industrial Hygiene Evaluations and Monitoring
- Infectious Waste Management
- Laboratory Safety
- Laser Safety
- Lead-Based Paint Management
- Lock Out - Tag Out
- Microwave Safety
- Personal Protective Equipment
- Pesticide Management and Use
- Open Flame Permits
- Radiation Safety
- Radioactive Waste Disposal
- Respiratory Protection Program
- Right-To-Know Program
- Safety Committee Coordination
- Safety Training Video Library
- Safety Posters
- Storage Tank Management
- Safety Training Schedule
- Safety Training Video Library
- Trenching/Shoring Safety
- Web-Based Training Programs

YOU Have A …
Right To Know

The University of Delaware has an obligation under TITLE 16, CHAPTER 24 of the Delaware Code to provide information about the hazardous materials in your work area. We are also required to tell you how these materials affect your health and how to protect yourself against exposure.



Contact your Supervisor, Departmental Safety Committee, Departmental Chemical Hygiene Officer or Environmental Health and Safety to learn about the hazardous materials in your workplace.

University's Online Safety Data Sheet Program:
http://udel.chemwatchna.com/

DEHS Right-To-Know Program: http://www.udel.edu/ehs/rtk.html

Safety Committee Information
http://www.udel.edu/ehs/safetycomm.html

Departmental Chemical Hygiene Officer Information:
http://www.udel.edu/ehs/dcho.html

For general information contact DEHS at 302-831-8475 or go to our main website: http://www.udel.edu/ehs

Occupational Safety and Health Administration (OSHA), Wilmington Office: 302-573-6518