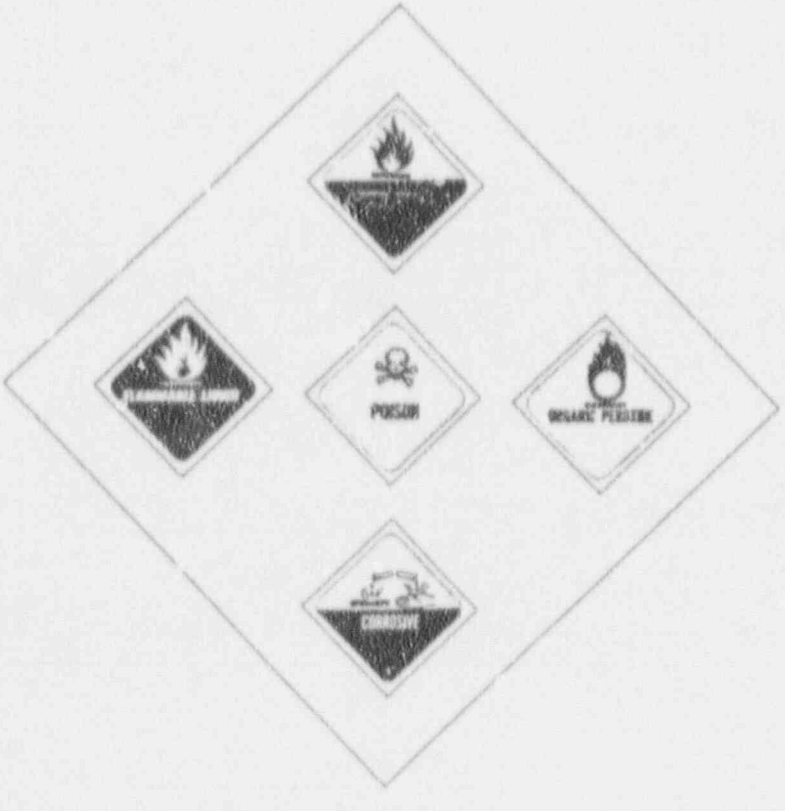
THE CATHOLIC UNIVERSITY OF AMERICA

CUA

CHEMICAL MATERIALS SAFETY MANUAL



The Content of this Procedure Manual Does Not Constitute a Contract

EMERGENCY TELEPHONE NUMBERS

FIRE/AMBULANCE*	9-911
CAMPUS POLICE	5111
ENVIRONMENTAL SAFETY OFFICE	6112
STUDENT HEALTH SERVICE	5744
POISON CONTROL CENTER	625-3333
RADIATION SAFETY	5206

* Campus Police must be notified immediately after any call for fire or emergency assistance.

EMERGENCY PROCEDURES FOR CHEMICAL SPILLS ARE FOUND IN SECTION 8.17, BEGINNING ON PAGE 23 OF THIS MANUAL.

ACKNOLWEDGEMENT

This manual is based on a similar manual which was developed by the University of Delaware's Department of Occupational Health and Safety. It has been edited to reflect the differences between the two universities and the procedures which have been adapted by each. We wish to give credit to the University of Delaware for the work that has gone into this manual. We wish to give our appreciation to the George Washington University, Office of Safety and Security, for providing an automated version of this manual, and to thank the administrations of both institutions for giving us permission to adapt it at The Catholic University of America.

SAFETY POLICY

The policy of the University 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 University Safety Manual contains general safety information for University employees, faculty and students. More specific safety information is contained in the following manuals: Laboratory Safety; Radiation Safety; Biohazard Safety; and in this Chemical Materials Safety Manual. Other safety manuals may be published to provide safety information. Each of these manuals should be issued to, used and referred to by employees, faculty and students whose work is related to any of these safety areas.

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

As a member of the University community, you have a Right-To-Know about the hazardous materials that you may work with on the job or in a laboratory. This right is a matter of federal law. Under regulations promulgated by the Federal Occupational Safety and Health Administration you are required to be trained in:

- The University's written Hazard Communication Plan.
- How to access information about the hazardous materials that you may be using at any time during the day or night.
- What to do in the case of a hazardous material spill or accidental release.
- How to protect yourself from personal injury while using hazardous materials.

The Office of Environmental Safety has responsibility for assuring compliance with this policy. The Office of Environmental Safety is staffed by the Director of Environmental Safety and a Hazardous Material Specialist. The Environmental Safety Office also functions in an advisory and consultative capacity providing a wide variety of occupational health and safety services. Supervisors should seek immediate assistance from the Environmental Safety Office if an occupational health or safety problem, or an environmental safety incident is experienced.

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8.1 HAZARD COMMUNICATION STANDARD

8.1.1 Background of the Hazard Communication Standard

The Federal Occupational Safety and Health Administration (OSHA) adopted a Hazard Communication Standard (HCS) in 1985 which was aimed at reducing hazardous materials injuries in the workplace. This Standard, commonly referred to as the Right-To-Know law, initially applied to industries in the manufacturing sector only. Subsequent to this rulemaking, several labor unions pressed OSHA to extend the HCS to the remaining workers in the United States. Making their case before a Federal Appeals Court in 1987, the court ordered OSHA to take immediate steps to extend the HCS throughout the remaining workplaces in the United States. All employers outside of the manufacturing sector that are subject to regulation by OSHA are responsible for meeting this strict performance standard. The Catholic University of America (CUA) was one of the institutions which came under the umbrella of this Standard. The HCS was implemented May 23, 1988.

In addition to the regulations promulgated by OSHA, the Superfund Amendments and Reauthorization Act of 1986 (SARA) became law in 1987. Title III of this Act describes each local community's Right-To-Know about the hazards involving materials located within that community's jurisdiction. SARA specifically mandates that employers who are required to maintain Material Safety Data Sheets (MSDSs) to comply with OSHA's rules must also provide copies of the MSDSs (or an inventory of materials requiring MSDSs) to the local community for use by emergency personnel.

8.1.2 Requirements of the Hazard Communication Standard

Each employee must be made aware that Federal Law mandates that he or she is entitled to know of the hazards which exist in the workplace;

Employers must inventory and evaluate materials used in the workplace to determine whether or not they fall within the scope of the HCS;

Materials are deemed to be hazardous if they are specifically named in the Federal Regulations, have a Threshold Limit Value assigned by the American Conference of Governmental Industrial Hygienists (ACGIH), have been named by the National Toxicology Program or the International Agency for Research on Cancer as a carcinogen, or if they meet the specific laboratory standards for flammables, corrosives, toxins, and irritants defined in the Federal Regulations (see OSHA Subpart Z, Appendix A of this manual);

Each material deemed hazardous must be labeled to identify it and the label must also indicate how the material is harmful to a person should he or she be exposed to it without proper protection;

Employers must obtain or produce an MSDS for each hazardous material used at the workplace. The MSDS must identify the product, explain its nature and the hazards involved in its use, the precautions to be taken for its safe use, and the procedures required in the case of inadvertent contact with the material or accidental release from its container;

The MSDS must be available at all times for use by employees who may be exposed to the hazardous material during the course of their employment. Employees must know how to interpret the technical language used to describe the material and fully understand what to do if they are accidentally exposed to it; and,

Each employer is required to develop and conduct a training program to achieve the objectives of the Standard. Implicit in this requirement is the need to fully document and maintain a record of such training activities.

8.1.3 Implementation of the Hazard Communication Standard at CUA

8.1.3.1 Each department head at the University:

is responsible to know if the materials in use in his or her department fall within the scope of the federal Hazard Communication Standard;

is responsible for insuring that emergency phone numbers are posted in each area where employees handle hazardous chemicals and in the office of each supervisor whose section employees handle hazardous chemicals;

shall cause a semi-annual inventory of hazardous materials used within the department to be taken prior to the start of the fall and spring semesters;

shall insure that all hazardous material storage containers are labeled to show their contents, the nature of the hazard represented, and the anticipated results of unprotected contact with the material;

shall maintain a current file of the copies of the Material Data Safety Sheets in each room or laboratory in which hazardous materials are used or stored and send the originals to the Hazardous Material Specialist;

shall forward a copy of the semi-annual inventory to the Hazardous Material Specialist;

shall insure that all employees under his or her supervision are trained in the requirements of the Hazard Communication Standard; and,

shall maintain a record of this training in the department's files and notation of each individual receiving the training will be maintained in the department's personnel records. Departmental training records shall, at a minimum, indicate:

- the date the training was conducted;
- the name of the person conducting the training;
- the name(s) of the person(s) trained with their signature(s); and,
- an outline of the training syllabus followed.

8.1.3.2 Each research scientist:

shall insure that all research employees who are associated with his/her research efforts are familiar with the Hazard Communication Standard and laboratory safety procedures as detailed above for department heads;

shall post appropriate safety instructions and phone numbers in the laboratory;

shall insure that proper safety equipment is on hand; and,

shall inform the Hazardous Material Specialist of the acquisition of any hazardous materials obtained by standing orders, donations, and other methods not specifically coordinated through the Purchasing Department.

8.1.3.3 The Purchasing Department:

shall advise the Hazardous Material Specialist whenever chemicals are purchased by departments and provide an inventory list of chemicals ordered; and,

shall forward to the Hazardous Material Specialist all MSDSs received by the Purchasing Department from manufacturers and suppliers for hazardous materials ordered by University departments.

8.1.3.4 The Hazardous Material Specialist:

shall assist department heads in meeting the requirements of the Hazard Communication Standard by:

- maintaining currency with the Standard and advising department heads of changes affecting them and the way in which they carry out their responsibilities;
- providing each department, where hazardous materials are used or stored, with a suitable means for prominently displaying Material Safety Data Sheets for hazardous materials used at the University;
- providing copies of Material Data Safety Sheets to department heads to allow the departments to update their MSDS files as changes in inventories of hazardous materials warrant;
- determining which of their materials fall within the scope of the Hazard Communication Standard when requested to do so;
- maintaining audio-visual and written training materials that can be made available to departments upon request;
- providing training to department heads in the requirements of the Standard and assisting department heads in meeting their training responsibilities when requested to do so;
- maintaining a supply of materials such as label forms which can be made available to department heads upon request; and,
- establishing and distributing the appropriate procedures for the disposal of hazardous waste.

8.2 EDUCATION PROGRAMS

The University must provide an education and training program for employees using or handling chemicals. 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.

Training programs shall include, as appropriate, the following:

- interpreting labels and MSDSs
- location of hazardous chemicals
- acute and chronic effects of chemicals
- where the University's Hazard Communication Plan is kept
- where MSDSs are kept
- safe chemical handling procedures
- personal protective equipment
- first-aid
- clean-up procedures
- waste disposal procedures

In the event a large variety of hazardous chemicals is stored or in use, the University may substitute generic training for chemical-specific training. The contents of this manual meet, in part, the generic training requirements. Supervisors shall provide additional training as necessary.

The University is required to keep a record of training sessions provided to employees. You may be required to sign a ledger verifying your attendance at a training session.

If you do not understand the material provided or discussed in this manual, contact your supervisor or the Environmental Safety Office.

8.3 HAZARDOUS CHEMICALS

The OSHA Hazard Communication Standard defines a hazardous chemical as any element, chemical compound or mixture of elements and/or compounds which is a physical hazard or a health hazard.

The Standard applies to all hazardous chemicals regardless of quantity.

A chemical is a physical hazard if there is statistically significant evidence that it is a combustible liquid, a compressed gas, an explosive, a flammable, an organic peroxide, an oxidizer, a pyrophoric compound, an unstable material (reactive) or water reactive substance.

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
- irritants
- reproductive toxins
- corrosives
- sensitizers
- radioactive material
- neurotoxins
- hepatotoxins
- nephrotoxins
- biohazards
- teratogens
- hematopoietic system agents

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)
- Carcinogens in the Work Site

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

- OSHA Regulations, 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances
- Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment, American Conference of Governmental Industrial Hygienists (ACGIH) (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.

If you are not sure a chemical you are using is hazardous, review the MSDS or contact your supervisor or the Environmental Safety Office.

8.4 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 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 who performs the transfer. 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.

In addition to the hazard information on the label, manufacturers of hazardous materials are required to generate a MSDS.

Read carefully all of the information on the label. If you do not understand something, contact your supervisor for an explanation or request the MSDS.

Labels must contain the following information:

- contents of the container
- name and address of the manufacturer
- physical and health hazards
- recommended personal protective equipment

8.5 MATERIAL SAFETY DATA SHEETS

A Material Safety Data Sheet (MSDS) is a document containing chemical hazard and safe handling information and is prepared in accordance with the OSHA Hazard Communication Standard.

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

If an MSDS 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 MSDSs on file are current.

Upon request, the University must make MSDSs available to employees or designated representatives.

Every laboratory and chemical storeroom on campus is being provided with the MSDSs for all chemicals known to be there by the Environmental Safety Office staff. The MSDSs are filed alphabetically in a clearly identified vinyl binder in each room.

The Environmental Safety Office, is the central repository for MSDSs on campus. If you find that a MSDS is missing from the vinyl binder in your laboratory or work area, contact your supervisor or call the Environmental Safety Office.

8.6 HANDLING CHEMICALS

Carefully read the label before using a chemical. The MSDS will provide any special handling information.

Do not work alone in the laboratory.

Use required personal protective equipment.

Label all containers with appropriate hazard information.

Keep your hands and face clean. Wash thoroughly with soap and water after handling any chemical.

Avoid direct contact with any chemical.

Keep chemicals off your hands, face and clothing, including shoes.

Never smell, inhale, or taste any 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 then is needed for immediate use.

Always use chemicals with adequate ventilation or in a chemical fume hood, biological safety cabinet, or in a glove box, as appropriate. Refer to the MSDS.

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 pipet. Use a pipet bulb or other filling device.

Electrically ground and bond containers using approved methods before transferring or dispensing a flammable liquid from a large container.

In the case of cleaning solvents, use them at the strength specified by the manufacturer.

For specific information regarding chemical handling, contact your supervisor or the Environmental Safety Office.

8.7 PERSONAL PROTECTION

Personal protective devices are to be used only where engineering and administrative controls cannot be used or made adequate, or while controls are being implemented.

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

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

The MSDS will list the personal protective equipment recommended for use with the chemical. The MSDS addresses "worst case" conditions. Therefore, all the equipment shown may not be necessary for a specific job.

Your supervisor or the Environmental Safety Office 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.

Check the MSDS 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 workplace and the specific process.

8.7.1 Protection Against Inhalation Hazards

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, you will receive special training from your supervisor or the Environmental Safety Office.

Do not use respiratory protective equipment until you have received proper training.

8.7.2 Protection of Skin and Body

Skin and body protection involves protective clothing and includes protection of various parts of the whole body either completely or partially as may be required.

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)

Lab coats, coveralls, aprons or protective suits shall be utilized where there is immediate danger to the skin from contact with a hazardous chemical, and where it is undesirable to have the employee attired in street clothes. General categories of contaminants include:

- dirt and grease
- toxic dust
- lab chemicals
- radioactive materials
- bacteriological agents

Protective garments are not to leave the workplace.

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

Exposure to strong acids, acid gases, organic chemicals, oxidizing agents, radioactive material, etiological agents, carcinogens, and mutagens requires the use of protective equipment that

prevents skin contamination. Impervious protective equipment must be used. Examples include:

- rubber gloves
- rubberized suits
- rubber boots
- special protective equipment

Protective garments are not equally effective for every hazardous chemical. Some chemicals will "break through" the garment in a very short time. Therefore, garment selection is based on the specific chemical utilized. General selection criteria are as follows:

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	G	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, then contact your supervisor or the Environmental Safety Office for information regarding chemical protective clothing.

8.8 CHEMICAL STORAGE

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

Label the chemical with the date when received.

Chemicals should not always be stored in alphabetical order.

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

Separate hazardous chemicals in storage as follows:

Solids:

- oxidizers
- flammable solids
- water reactive
- others

Liquids:

- acids
- caustics
- oxidizers
- perchloric acid
- flammables/combustibles

Gases:

- toxic
- flammable
- oxidizers and inert

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 strong reagents.

Dispose of old chemicals promptly. See waste disposal section of this pamphlet.

Do not store liquids above eye level.

Assure that all containers are properly labeled.

For more information on chemical storage, contact your supervisor or the Environmental Safety Office.

8.9 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.

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

Open containers of ethers should be discarded within six (6) months of opening.

The label and MSDS will indicate if a chemical is unstable.

The following are examples of materials which may form explosive peroxides:

- acetal
- cyclohexene
- decahydronaphthalene
- butadiyne
- dicyclopentadiene
- diethyl ether
- diethylene glycol
- dimethyl ether
- dioxane
- divinyl acetylene
- glycodimethyl ether
- tetrahydronaphthalene
- isopropyl ether
- methyl acetylene
- sodium amide
- tetrahydrofuran
- vinylidene chloride
- vinyl ethers

For additional information on chemical stability, contact your supervisor or the Environmental Safety Office.

8.10 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 reactive product can result.

The label and MSDS will contain information on incompatibilities.

The following is a table containing examples of incompatible chemicals:

Chemical	Keep Out of Contact With:
acetic acid	chromic acid, nitric acid, hydroxide compounds, perchloric acid, peroxides, permanganates
acetylene	chlorine, bromine, copper, fluorine, silver, mercury
alkali metals	water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, the 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

Chemical	Keep Out of Contact With:
hydrocyanic acid	nitric acid, alkali
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.).

(Based on the Manufacturing Chemist's Association, Guide for Safety in the Chemical Laboratory, pp. 215-217.)

8.11 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. Always write the date received and date opened on all containers of shock-sensitive chemicals.

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

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

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

Wear appropriate personal protective equipment when handling shock-sensitive chemicals.

The following are examples of materials which can be shock-sensitive.

acetylides of heavy metals
aluminum ophorite explosive
amatol
ammonal
ammonium nitrate
ammonium perchlorate
ammonium picrate
ammonium salt lattice
butyl tetryl
calcium nitrate
copper acetylide
cyanuric triazide
cyclonite (hexogen)
cyclotetramethylenetrinitramine
dinitroethyleneurea
dinitroglycerine
dinitrophenol
dinitrophenolates
dinitrophenyl hydrazine
dinitrotoluene
dipicryl sulfone
dipicrylamine
erythritol tetranitrate
fulminate of gold
fulminate of mercury
fulminate of platinum
fulminate of silver
gelatinized nitrocellulose
germane
guanyl nitrosaminoguanylidene hydrazine
hydrazine nitrate
heavy metal azides
hexanitrin
hexanitrodiphenylamine
hexanitrostilbene
hyrazoic acid
lead azide
lead mannite
lead mononitroresorcinate
Lead picrate
lead styphnate
magnesium ophorite
mannitol hexanitrate
mercury oxalate
mercury tartrate
mononitrotoluene
nitrated carbohydrate
nitrated glucoside
nitrated polyhydric alcohol
nitrogen trichloride
nitrogen tri-iodide
nitroglycerin
nitroglycide
nitroglycol
nitroguanidine
nitroparaffins
nitronium perchlorate
nitrourea
organic amine nitrates
organic nitramines
organic peroxides
picramic acid
picramide
picratol

(Examples of materials which can be shock-sensitive, continued from previous page.)

picric acid
picryl chloride
picryl fluoride
polynitro aliphatic compounds
potassium nitroaminotetrazole
silver acetylide
silver azide
silver styphnate
silver tetrazene
sodatol
sodium amatol
sodium dinitroorthocresolate
sodium nitrate-potassium explosive mixtures
sodium picramate
styphnic acid
tetrazene
tetranitrocarbazole
tetryl
trimonite
trinitroanisole
trinitrobenzene
trinitrobenzoic acid
trinitrocresol
trinitro-meta-cresol
trinitronaphthalene
trinitrophenetol
trinitrophloroglucinol
trinitroresorcinol
tritonal
urea nitrate

8.12 SOLVENTS

Many of the commonly used solvents are volatile and are harmful when relatively small amounts are inhaled. Most are readily absorbed through the skin. Most are flammable.

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
- nitrogenous bases such as amines
- carbon disulfide

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

For additional information, contact your supervisor or the Environmental Safety Office.

8.13 COMPRESSED GASES

Carefully read the label before using or storing compressed gas. The MSDS will provide any special hazard information.

Always use the minimum size cylinder required to perform the work.

Cylinders of compressed gases must be handled as high energy sources.

Do not expose cylinders to temperature extremes.

When storing or moving a cylinder, have the cap securely in place to protect the stem. (A pressurized cylinder can become a rocket when its stem is broken.)

Always use the correct regulator. Do not use a regulator adaptor.

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 with local ventilation.

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 when handling compressed gases.

For more information, contact your supervisor or the Environmental Safety Office.

8.14 RADIOACTIVE MATERIAL

Only persons, projects and facilities approved by the Radiation Safety Office are authorized to use radioactive material or other sources of ionizing radiation.

Individuals interested in using radioactive material or other sources of ionizing radiation should contact the Radiation Safety Office at ext. 5206.

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

Individuals authorized to use sources of ionizing radiation will receive specific training from their supervisor or the Radiation Safety Office. A Radiation Safety Manual is published by the Radiation Safety Office and distributed to authorized users of radioactive material.

8.15 RESTRICTED AREAS

Facilities placarded with following warning signs are restricted areas:

CAUTION-BIOHAZARDS
CAUTION-CANCER HAZARD
CAUTION-RADIOACTIVE MATERIAL
CAUTION-RADIATION AREA
CAUTION/DANGER-LASER
CAUTION-ASBESTOS

The names and phone numbers of responsible personnel shall be posted on the door(s) to all facilities where hazardous materials are stored or utilized.

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

Housekeeping personnel are permitted to enter restricted areas to perform routine tasks. However, these persons shall not touch labeled waste containers, other research equipment or materials.

Other support personnel, such as Campus Police and Physical Plant Department 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 Environmental Safety Office before performing work which may involve any of the above items.

Contact the Environmental Safety Office if emergency response or service is required in a restricted area.

Immediately report any unusual conditions to the Environmental Safety Office or the Campus Police, such as:

- spills
- leaks
- fires
- injuries
- contamination

For additional information regarding restricted areas, contact your supervisor or the Environmental Safety Office.

8.16 WASTE DISPOSAL

Hazardous chemical disposal must be in accordance with procedures established by the Environmental Safety Office.

Unless approved by the Environmental Safety Office, disposal of chemicals via the sanitary sewer system is not permitted.

The MSDS will contain special disposal information, if applicable.

Your department may also have procedures you are required to follow.

Disposal of radioactive material and etiological agents/cultures requires special procedures. Contact the Environmental Safety Office before proceeding.

Contact your supervisor or the Environmental Safety Office before disposing of any hazardous chemical.

8.17 CHEMICAL SPILLS

Anticipate spills by having the proper safety equipment on hand.

Alert personnel in the area that a spill has occurred.

Do what is necessary to protect life.

If the spill is too large for you to handle, is a threat to personnel or the public, involves an infectious agent or a corrosive, highly toxic or reactive chemical, call the Campus Police for assistance.

- Campus Police ext. 5111

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

Confine the spill with sorbents, if possible.

The Environmental Safety Office 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.

- Environmental Safety Office ext. 6112

If a spill involves radioactive materials, also contact the Radiation Safety Office.

- Radiation Safety Office ext. 5206

For specific spill clean-up information, contact your supervisor or the Environmental Safety Office.

8.17.1 Low Hazard Material Spills

No fire hazard; not particularly volatile, toxic or corrosive (e.g., salt solutions).

Use a sorbent material that will neutralize the spill if available.

- trisodium phosphate
- sand
- sodium bicarbonate for acids
- powdered citric acid for bases
- "Oil-Dri," "Zorb-All," "Speedi-Dri," Bentonite, etc.
- paper towels

A dustpan and brush should be used and rubber gloves and goggles should be worn.

Decontaminate area with soap and water after clean-up.

Place residue in a container for waste collection.

Contact your supervisor or the Environmental Safety Office for disposal information.

8.17.2 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
- bromine
- carbon disulfide
- hydrazine
- cyanides
- nitriles
- ethers
- organic halides

If you spill a highly toxic material, immediately contact the Environmental Safety Office (ext. 6112) or the Campus Police (ext. 5111).

8.17.3 Acid/Base Spills

Absorb spill with "Oil-Dri," "Zorb-All," "Speedi-Dri," Bentonite or other clay type sorbent.

Avoid contact with skin.

Place residue in container for waste collection.

For specific clean-up information, contact your supervisor or the Environmental Safety Office.

8.17.4 Mercury Spills

Call the Radiation Safety Office for prompt cleanup of spilled mercury (or disposal of surplus mercury). Only if assistance is unavailable from Radiation Safety, the following procedure should be used to minimize the extent of air contamination resulting from the spill.

Use a trapped vacuum line attached to a tapered glass or plastic tube, similar to a medicine dropper, to pick up mercury droplets. (In order to minimize waste disposal costs, as much of the mercury as possible should be recovered by vacuum.)

Do not use a domestic or commercial vacuum cleaner.

After vacuuming there will remain mercury droplets too small to be visible to the naked eye. Cover the area of the spill with one of the following:

- sodium polysulfide solution
- powdered sulfur
- silver metal compounds

Clean up the residue in a separate container for waste collection.

For specific clean-up information, contact your supervisor, the Environmental Safety Office, or the Radiation Safety Office.

8.17.5 Alkali Metal Spills

Smother with powdered graphite or "Met-L-X."

Call for assistance.

For specific clean-up information, contact your supervisor or the Environmental Safety Office.

8.17.6 White Phosphorus

Smother with wet sand or wet sorbents.

Call for assistance.

For specific clean-up information, contact your supervisor or the Environmental Safety Office.

8.18 INJURY AND ILLNESS

Employees must notify their immediate supervisor of all illnesses and injuries related to exposure to hazardous chemicals. Supervisors are responsible for reporting any injury or occupational illness to the Office of Personnel Services by completing the "First Report of Injury or Occupational Illness" form.

Employees injured on the job should request an ambulance by dialing 9-911 and report to the nearest emergency room for medical treatment. (Contact the Environmental Safety Office for further details.)

The Campus Police (ext. 5111) should be notified of the accident and that office will make arrangements for transportation of the victim, if required. Use emergency phone or dial direct.

Do not move a seriously injured person unless he or she is 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, call the Campus Police (ext. 5111).

Tell emergency and medical personnel:

- your name
- your location and nature of the emergency
- name and amount of chemical involved
- area of the body affected
- symptoms
- what first-aid steps you have already taken

If you have any questions regarding injury and illness procedures, contact your supervisor or the Environmental Safety Office.

8.19 PERSONAL CONTAMINATION

Do what is necessary to protect life. Remain calm.

The MSDS will contain special first-aid information.

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

A blanket should be used immediately to protect the victim from shock and exposure.

Get medical attention promptly by dialing:

- Campus Police 5111
- Ambulance 9-911 (then describe the emergency to Campus Police)
- Student Health Service 5744
- Environmental Safety Office 6112
- Poison Control Center 625-3333

For specific instruction regarding personal contamination, contact your supervisor or the Environmental Safety Office.

8.19.1 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 cool water for at least 15 minutes.

Wash off chemical with water but do not use neutralizing chemicals, unguents, creams, lotions or salves.

Get medical attention promptly.

8.19.2 Chemicals on the Skin in Small Areas

Immediately flush with cool water.

If there is no visible burn, remove jewelry to facilitate removal of any residual material and scrub area with warm water and soap. Soap area removing any additional jewelry as necessary.

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. DO NOT WAIT UNTIL THE NEXT DAY!

If there is any doubt, seek immediate medical attention.

8.19.3 Chemicals in the Eyes

Irrigate with plenty of water for at least 15 minutes. Use eyewash or other water source.

Simultaneously check for and remove contact lenses.

Wash thoroughly, but gently under eyelids.

Get medical attention promptly.

8.19.4 Smoke and Fumes

Anyone overcome with smoke or chemical fumes should be removed to uncontaminated air and treated for shock.

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 rescuer is certified, follow standard CPR procedures.

Get medical attention promptly.

8.19.5 Burning Chemicals on Clothing

Extinguish burning clothing by using the drop-and-roll technique, douse with cold water or use an emergency shower or emergency blanket.

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.

Get medical attention promptly.

8.19.6 Ingestion of Hazardous Chemicals

Identify the chemical ingested.

Call for an ambulance (ext. 9-911).

Call the Poison Information Center (625-3333)

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 or the label with the victim.

8.20 MINOR FIRST-AID

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

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

First-aid kits must be fully stocked at all times.

Do not dispense or administer any medications, including aspirin.

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

The MSDS contains special first-aid information.

After giving first-aid, notify the Campus Police (ext. 5111) for transportation of the victim to a medical facility for evaluation.

For specific first-aid information, contact your supervisor or the Environmental Safety Office.

8.21 FIRE AND FIRE-RELATED EMERGENCIES

8.21.1 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 the Campus Police (ext. 5111).
- Isolate the area and evacuate the building.
- Shut down equipment in the immediate area, if possible, but DO NOT turn off fume hood blowers.
- Close doors to isolate the area.
- Use the proper portable fire extinguisher to:
  - assist oneself to evacuate
  - assist another to evacuate
  - control a small fire, if possible
- Provide the fire/police teams with the details of the problem upon their arrival. Special hazard information you may know is essential.

8.21.2 If the fire alarms are ringing in your building:

- evacuate the building
- move at least 200 feet away from the building
- 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.

8.22 TOXICOLOGY OVERVIEW

8.22.1 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.

8.22.2 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 a 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.

8.22.3 Routes of Entry into the Body

There are three 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.

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 parts per million (ppm) or milligrams per cubic meter (mg/m^3) 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.

8.22.4 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 low level exposures of a duration measured in days, months or years. Symptoms may not be immediately apparent. Examples: lead or mercury poisoning, pesticide poisoning.

Local refers to the site of action of an agent and means the action takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples: strong acids or alkalis and war gases.

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. Other 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.

Substance 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.

8.22.5 Other Factors Affecting Toxicity

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

Age can effect 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. Preexisting disease can result in increased sensitivity.

Environmental factors such as temperature and pressure.

Host factors including genetic predisposition and the gender of the exposed individual.

8.23 CLASSIFICATION OF TOXIC MATERIALS

8.23.1 Physical Classifications

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.

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/m^3). For a proper assessment of the toxic hazard, the size of the aerosol's particles is important. Particles above one (1) micrometer diameter tend to deposit in the upper respiratory tract. Below one (1) micrometer, particles enter the lung. Very small particles (<0.2um), in general, are not deposited.

8.23.2 Physiological Classifications

Irritants are materials that cause inflammation of mucous membranes with which they come in contact. Inflammation of tissue results from concentrations far below those needed to cause corrosion. Examples include:

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

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

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

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. Examples include:

- hydrogen sulfide
- aromatic hydrocarbons

Exposure to a secondary irritant can result in pulmonary edema, hemorrhage and tissue necrosis.

Asphyxiants have the ability to deprive tissue of oxygen.

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

- nitrogen
- nitrous oxide
- carbon dioxide
- hydrogen
- helium

Chemical asphyxiants have as their specific toxic action rendering the body incapable of utilizing an adequate oxygen supply. They are active at very low concentrations (few ppm). Examples include:

- carbon monoxide
- cyanides

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

- alcohols
- halogenated hydrocarbons

Hepatotoxic agents cause damage to the liver. Examples include:

- carbon tetrachloride
- tetrachloroethane
- nitroamines

Nephrotoxic agents damage the kidneys. Examples include:

- uranium compounds
- halogenated hydrocarbons

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

- tetraethyl lead
- trialkyl tin compounds
- methyl mercury
- carbon disulfide
- manganese
- thallium
- organic phosphorus insecticides

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
- toluidine
- nitrobenzene
- benzene

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

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
- nickel compounds
- chromium compounds
- poison ivy
- chlorinated hydrocarbons

8.24 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, perchloroethylene, 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, nitrobenzene
hematopoietic agents	decreased blood functions
signs and symptoms	cyanosis; loss of consciousness
example chemicals	carbon monoxide, cyanides, nitrobenzene, 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, nickel, phenol, trichloroethylene

(Target organ categorization, contin .d from previous page.)

eye hazards	affect the eye or vision
signs and symptoms	conjunctivitis; corneal damage
example chemicals	organic solvents, acids, cresol, quinone, hydroquinone, benzol chloride, butyl alcohol, base:

8.25 HYGIENIC STANDARDS

TLV: the threshold limit value is a recommended occupational exposure standard published by the American Conference of Governmental Industrial Hygienists. TLVs are expressed as parts of vapor or gas per million parts of air by volume (ppm) or as approximate milligrams of particulate per cubic meter of air (mg/m^3). The TLV is the average concentration of a chemical that is thought most people can be exposed to for a working lifetime with no ill effects. The TLV is an advisory guideline. If applicable, a ceiling concentration (C) which should not be exceeded or a skin hazard (S) will be indicated with the TLV.

PEL: the permissible exposure limit is a legal standard issued by OSHA. Unless specified, the PEL is a time weighted average (TWA).

TWA: time weighted average is the basis for most exposure standards. The TWA is based on the average exposure weighted for an 8-hour work day. Ceiling (c) limits and acceptable maximum peaks above the average must be considered when exposures are evaluated.

The MSDS will list the hygienic standard for the hazardous chemical or each component of a mixture.

The Environmental Safety Office has a complete listing of published TLVs and PELs and other works concerning the subject of industrial toxicology. If you would like to conduct a more thorough review of a particular compound, contact the Environmental Safety Office.

The Mullen 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.

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

8.26 THE MSDS - SECTION BY SECTION

The following is a description of the MSDS which has been adopted by the Environmental Safety Office to comply with the federal Hazard Communication Standard. There is no prescribed form to be used, therefore, you may see some MSDSs in a different format than that which is described here. Whatever their form, MSDSs are to have the same information contained in them.

Section I of the MSDS lists information identifying the product and its manufacturer.

- 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 or the Environmental Safety Office.

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 number of components

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

Carcinogens will be listed if the concentrations are 0.1% or greater.

Section III describes the physical properties of the material.

- boiling point
- specific gravity
- vapor pressure
- melting point
- vapor density
- evaporation rate
- solubility in water
- appearance and odor

Section IV 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 materials 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 V 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 VI describes the known health hazard data for the material and exposure limits. 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 for: ingestion, inhalation, skin contact, eye contact

Section VII gives instructions for the steps to be taken in case of an accidental release or spill. The steps normally include information on containment, evacuation procedures and waste disposal as appropriate. The statements on the MSDS are general; more specific information is available from your supervisor.

- steps to be taken in case material is released or spilled
- waste disposal methods
- handling and storage procedures to be taken with the material
- special precautions or miscellaneous information regarding the material

Section VIII describes the protective equipment 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 for instructions.

- respiratory equipment: dust mask, chemical cartridge respirator, self-contained breathing apparatus
- ventilation: local, general, special
- protective gloves: type
- eye protection: glasses, goggles, shield
- other protective equipment

In some cases, manufacturers may choose to withhold certain information if the information is considered to be a trade secret.

However, the MSDS must still contain all relevant hazard, protection and health information.

Some MSDSs are more complete than others. Do not assume everything that you need to know is contained on the MSDS.

8.27 SAMPLE MATERIAL SAFETY DATA SHEET (MSDS)

Shown below is an example of the Material Safety Data Sheet used by the U.S. Department of Labor. Explanation of the information contained in this form can be found in Section 8.26 of this manual.

Material Safety Data Sheet
May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY (As Used on Label and List) | Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name	Emergency Telephone Number
Address (Number, Street, City, State, and ZIP Code)	Telephone Number for Information
	Date Prepared
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)

Section III — Physical/Chemical Characteristics

Boiling Point		Specific Gravity (H_2O = 1)	
Vapor Pressure (mm Hg.)		Melting Point	
Vapor Density (AIR = 1)		Evaporation Rate (Butyl Acetate = 1)	

Solubility in Water

Appearance and Odor

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL

Extinguishing Media

Special Fire Fighting Procedures

Unusual Fire and Explosion Hazards

(Reproduce locally) OSHA 174, Sept. 1985

(Sample of the Material Safety Data Sheet, page 2.)

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable		

Incompatibility (Materials to Avoid)

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Skin? Ingestion?

Health Hazards (Acute and Chronic)

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions Generally Aggravated by Exposure

Emergency and First Aid Procedures

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions

Section VIII — Control Measures

Respiratory Protection (Specify Type)

Ventilation	Local Exhaust	Special
	Mechanical (General)	Other

Protective Gloves	Eye Protection

Other Protective Clothing or Equipment

Work/Hygienic Practices

8.28 EXCEPTIONS TO THE HAZARD COMMUNICATION STANDARD

The Hazard Communication Standard does not apply to chemicals in the following categories:

- any article formed to a specific shape that does not release hazardous chemicals under normal use
- any food, food additive, drug or cosmetic
- distilled spirits, wines or malt beverages
- products intended for personal use and consumption

  (Employees using products of this type are exempted from the provisions of the Standard so long as the products are used in the same way and to the same degree that they are used by the general consumer. As an example, housekeepers would not be exempted from the provisions when using a strong industrial cleanser that is available to the general consumer because of the greater time each day that they spend using it.)

If you are not sure a chemical in your work area is exempted, contact your supervisor or Environmental Safety Office.

8.29 NOTICES TO EMPLOYEES

The University is required to advise you of your rights regarding the Hazard Communication Standard. This manual meets the requirement in part.

8.30 EMPLOYEE RIGHTS

Employees who may be exposed to hazardous chemicals are guaranteed access to the following:

- Chemical exposure information
- Workplace Chemical Lists
- Material Safety Data Sheets

In addition, employees shall receive training on the hazards of chemicals and on the measures that they can take to protect themselves.

The University must provide employees with appropriate personal protective equipment.

You have the right to file a complaint against the University regarding alleged violations of the Hazard Communication Standard. If you file a complaint, you are protected from:

- discharge
- cause for discharge
- discipline
- discrimination
- loss of pay, position, seniority or benefits

Alleged violations of the Standard should be referred to your supervisor or the Environmental Safety Office. However, you always have the right to file a compiaint with the Occupational Safety and Health Administration.

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

8.31 WORKPLACE CHEMICAL LISTS

The University is required to compile and maintain a Workplace Chemical List for all chemicals that require a Material Safety Data Sheet.

The Workplace Chemical List contains the following information:

- the chemical name of the common name
- the work area where the chemical is normally used or stored
- the typical amount of the chemical that is generally on hand

The Workplace Chemical List provides you with information regarding large quantities of hazardous chemicals in your work area.

New or newly assigned employees 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 semi-annually.

8.32 CHEMICAL HYGIENE PROGRAM

8.32.1 Background of the OSHA Regulation on Occupational Exposure to Hazardous Chemicals in Laboratories

The Federal Occupational Safety and Health Administration (OSHA) enacted the Occupational Exposure to Chemicals in Laboratories Standard in 1990. This standard applies to all employees engaged in the laboratory use of hazardous chemicals at CUA.

8.32.2 Requirements of the OSHA Regulation on Occupational Exposure to Hazardous Chemicals in Laboratories

A primary requirement of the standard is the formulation and implementation of a Chemical Hygiene Plan (CHP). The CHP includes work practices, procedures and policies to ensure that employees are protected from all potentially hazardous chemicals in their work area. Many of the specific required elements of the CHP are already contained in this manual. Additional elements not necessarily addressed by earlier sections of this manual are listed below in Sections 8.33 through 8.39.

The Laboratory Safety Manual for the University includes the Chemical Materials Safety Manual, the Radiation Safety Manual and the Biological Safety Manual.

Responsibility for the implementation of the policy contained in the Laboratory Safety Manual falls primarily upon the laboratory supervisor/research scientist.

Compliance of individual laboratories with this policy is monitored by the Environmental Safety Office, the Internal Auditor and, externally, by OSHA, EPA and NRC.

8.33 EXPOSURE REDUCTION

8.33.1 Environmental Monitoring

Regular instrumental monitoring of airborne concentrations of chemicals is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices or when a highly toxic substance is stored or used regularly (e.g., 3 times/week). If a laboratory meets these testing criteria or the laboratory supervisor has reason to believe that a laboratory area is chemically contaminated, contact the Environmental Safety Office to coordinate the provision of environmental monitoring.

8.33.2 Inspections, Maintenance, and Housekeeping

Formal chemical hygiene and housekeeping inspections should be performed by the Laboratory Safety Committee semi-annually.

Informal inspections should be continual and should be performed by the laboratory supervisor.

Eye wash fountains should be tested at intervals of not less than 3 months. A written record of these inspections shall be maintained on inspection tags attached to the eye wash fountain.

Safety showers should be tested at intervals of not less than 3 months. A written record of these inspections shall be maintained on inspection tags attached to the safety showers.

Other safety equipment, such as reusable gloves, face shields, liquid waste cans, etc., should be inspected regularly (e.g., every 3-6 months) by the laboratory supervisor.

Stairways and hallways shall not be used as storage areas. Access to exits, emergency equipment (fire extinguishers, eyewash fountains, etc.) and utility controls shall never be blocked.

Floors and laboratory benches should be cleaned regularly.

8.33.3 Protective Apparel and Equipment

- Protective apparel compatible with the required degree of protection for substances being handled should be purchased by the department and used in each laboratory.
- There should be at least one easily accessible drench-type safety shower within 10 seconds and not more than 100 feet away from laboratories using chemicals in concentrations that pose skin hazards. The delivered water flow should be a minimum of 30 gallons per minute at a temperature range of 15° to 35°C.
- An eyewash fountain should be available within each laboratory using chemicals in concentrations that pose eye hazards. The eyewash should deliver a continuous flow for 15 minutes at a temperature range of 15° to 35°C.
- A fire extinguisher compatible with the fire hazards in the laboratory should be available within each laboratory. Multipurpose dry chemical extinguishers, featuring an ammonium phosphate base, can be used on Class A:B:C fires and are generally preferred for installation in laboratories.

- A fire alarm and telephone for emergency use should be available nearby each laboratory.
- Other items designated by the laboratory supervisor or by the Environmental Safety Office should be provided.

8.33.4 Signs and Labels

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

- On the laboratory entrance post names and emergency telephone numbers of laboratory supervisors and names and telephone numbers of emergency personnel/facilities. Names of supervisors are kept on file in the Environmental Safety Office and the Department of Public Safety. This list is maintained by the Environmental Safety Office annually.
- Identity labels, showing contents of chemical containers (including waste receptacles) and associated hazards should be on all chemical containers. Labels on incoming containers of hazardous chemicals shall not be removed or defaced.
- Post location signs for safety showers, eyewash stations, fire extinguishers, other safety and first aid equipment, exits and areas where food and beverage consumption and storage are permitted or prohibited.
- Post warnings at areas or equipment where special or unusual hazards exist (e.g., biohazards, lasers, radio-isotopes, high voltage equipment, etc.).
- A "NO SMOKING" sign should be posted in each laboratory.

8.33.5 Accidents and Spills

- A University-wide emergency plan has been established and is regularly reviewed. A copy is maintained in the files of the Environmental Safety Office and is available to all individuals wishing to use it to develop their own laboratory plan to be reviewed by the Environmental Safety Office.
- A written emergency plan shall be established and communicated to all personnel by the supervisor of each laboratory; it should include procedures for ventilation failure, evacuation, medical care, reporting, and drills. Appropriate portions of this plan shall be posted in each laboratory.
- There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms.
- A University-wide spill control policy has been developed. See section 8.17.1 to 8.17.6 of this manual.
- All accidents or significant near accidents should be communicated to the Environmental Safety Office by the Laboratory Supervisor to be carefully analyzed as appropriate with the results distributed to all who might benefit. Copies of the respective report forms to be used by injured students and employees are found in the appendix.

8.34 VENTILATION

8.34.1 General Laboratory Ventilation

The central HVAC system should provide a source of fresh air for breathing and for input to local ventilation devices. It should not be relied on for protection from toxic substances released into the laboratory. Its purpose is to ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day. It should direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building.

8.34.2 Chemical Fume Hoods

In a laboratory where workers run the risk of significant exposure to potentially hazardous chemicals there should be at least one chemical fume hood for every 2 workers, and the hoods should be large enough to provide each person with 2.5 linear feet of working space at the face. If this is not possible, work with substances of unknown toxicity should be avoided or other types of local ventilation devices, approved by the Environmental Safety Office, should be provided.

Each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use. This device can be as sophisticated as a static pressure manometer or as simple as a length of tissue paper taped to the sash bottom.

Chemical fume hoods which recirculate exhaust air back to the laboratory environment should not be used. The absorbents and filters used may not adequately remove contaminants from the exhaust air.

8.34.3 Other Local Ventilation Devices

Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed. Canopy hoods, snorkels and other large local exhaust devices should not be installed on pre-existing ventilation systems without the approval of the Environmental Safety Office.

8.34.4 Glove Boxes and Special Ventilation Areas

Glove boxes have multiple ports in which arm-length rubber gloves are mounted, and the operator works through these. They are generally operated under negative pressure, so that any air leakage is into the box. If the material being used is sufficiently toxic to require the use of a negative pressure glove box, it is obvious that exhaust air will require treatment. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or given other treatment before it is released into the environment.

Glove boxes, used for experiments where protection from atmospheric humidity or oxygen is desired, commonly operate under ambient or positive pressure. If positive pressure glove boxes must be used with highly toxic chemicals, they should be thoroughly tested for leaks before each use, and there should be a method of monitoring the integrity of the system such as a pressure gauge.

Cold rooms and warm rooms and similar isolated areas should have provisions for rapid and safe escape in the event of electrical failure.

8.34.5 Modifications

Any alteration of the ventilation system, including both general ventilation systems and local hood exhaust systems, should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate. Contact the Environmental Safety Office to authorize any proposed modifications.

8.34.6 New Installations

Prior to the purchase of any new local exhaust system, contact the Environmental Safety Office for authorization and confirmation that the proposed system meets federal and local safety, health, and pollution regulations.

8.34.7 Performance

A ventilation rate of 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control.

General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas.

Airflow into and within a hood should not be excessively turbulent. Hood face velocity should be adequate (typically 60-100 linear feet per minute). However, if radioactive materials are involved, the Radiation Safety Manual should be consulted as to face velocity.

8.34.8 Evaluation

Performance should be evaluated on installation, regularly monitored (at least every six months), and reevaluated whenever a change in local ventilation devices is made. Contact the Environmental Safety Office to arrange for ventilation testing.

8.35 EMPLOYEE INFORMATION AND TRAINING PROGRAM

An employee safety information and training program is in existence at the University and is reviewed regularly. The purpose of this training is to assure that employees covered under this program are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs.

The laboratory supervisor shall provide this training at the time of an employee's initial assignment to a work area where hazardous chemicals or equipment are present and prior to assignments involving new exposure situations.

The training and education program should be a regular, continuing activity.

Every laboratory worker should know the location and proper use of available protective apparel, emergency equipment and procedures.

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

Literature and consulting advice concerning chemical hygiene are readily available from the Environmental Safety Office. Laboratory personnel should be encouraged to use these information resources.

8.36 REVIEW OF LABORATORY ACTIVITIES

Certain laboratory operations, procedures, or activities require approval from the laboratory supervisor prior to implementation. This includes working with particularly hazardous substances including reproductive toxins, chemicals which have a high degree of acute toxicity and chemicals considered as select carcinogens. A select carcinogen is a chemical (1) regulated by OSHA as a carcinogen, or (2) listed as a known carcinogen in the latest edition of the Annual Report on Carcinogens published by the National Toxicology Program, or (3) listed in groups 2A or 2B of the International Agency for Research on Cancer Monograph.

The laboratory supervisor is invited to ask for assistance from the Chemical Hygiene Officer in instances where there are questions about the safety of conducting high risk operations and experiments. When necessary, the Chemical Hygiene Officer will seek assistance from the Laboratory Safety Committee, as this committee is charged with reviewing procedures for high risk operations and experiments brought to its attention.

In instances where the laboratory activity may pose extremely hazardous conditions, the supervisor shall alert the Chemical Hygiene Officer.

8.37 MEDICAL PROGRAM

8.37.1 Conditions Obliging Medical Attention

The University shall provide all employees who work with hazardous chemicals in laboratories as defined in Section 8.32.1 of this manual an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the circumstances listed in this Section 8.37.1. Such medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

- If an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

- Where exposure monitoring reveals an exposure level routinely above the action level (or in absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

- If an event takes place in the work area such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

- All employees seeking any medical consultation, treatment or examination under this section must file a Workers' Compensation First Report of Injury Form with the Office of Personnel Services within 5 days after seeking such medical attention.

8.37.2 Information Provided to the Physician

Any release of information to the physician must be approved by the Chemical Hygiene Officer. The University shall provide the following information to the physician:

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

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

- A description of any signs and symptoms of the exposure that the employee may be

8.37.3 Physician's Written Opinion

For examination or consultation required under this standard, the University shall obtain a written opinion from the examining physician which shall include the following:

- Any recommendation for further medical follow-up;

- The results of the medical examination and any associated tests;

- Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and

- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

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

8.37.4 First Aid

An emergency room with medical personnel is available at nearby hospital(s). To arrange for emergency transport to these hospitals, dial 9-911 and notify the dispatcher of the incident. Then, dial ext. 5111 to notify the CUA Department of Public Safety for assistance in directing the ambulance to the scene.

8.38 CHEMICAL HYGIENE RESPONSIBILITIES

Responsibility for chemical hygiene rests at all levels. Specific responsibilities are as follows.

8.38.1 Executive Vice President

The Executive Vice President has the ultimate legal responsibility and accountability for chemical hygiene within the institution. The Executive Vice President shall:

- Appoint a chemical hygiene officer.
- Designate a signatory person for the University in safety, health, and environmental matters relating to proposals for funds from an outside agency for sponsored work
- Provide University legal counsel to the Chemical Hygiene Officer and other University employees who have need to consult with counsel on matters related to chemical hygiene.
- Include provisions for appropriate storage and disposal of chemicals in the long range plans for facilities development.
- Inform the University community of the chemical hygiene plan.
- Provide adequate support for institutional chemical hygiene.
- Respond to reports and or requests regarding matters of chemical hygiene to the appropriate individual.

8.38.2 Department Head/Building Administrator

In University departments or buildings containing laboratories where potentially hazardous chemicals are used, the Department Head and Building Administrator shall:

- Provide list of supervisors to the Environmental Safety Office on request.
- Develop plans, in consultation with the Environmental Safety Office for the appropriate storage of chemicals within the Department/Building.
- Develop a departmental plan, in consultation with the Environmental Safety Office, for the appropriate collection and delivery of any chemical waste to the Environmental Safety Office.
- Ensure that all new faculty members, researchers, student employees and other departmental employees as appropriate are informed of the hygiene plan.
- Ensure that the supervisors of all undergraduate students be informed of and knowledgeable in basic rules of chemical safety and that these rules be followed in all undergraduate laboratory courses.
- Inform the Environmental Safety Office of all chemically-related facility deficiencies which are known to him/her.

- Investigate and forward any reports of unsafe chemical practices to the Environmental Safety Office.
- Ensure that all common areas of the building are free of chemical hazards.

8.38.3 Laboratory Supervisor/Research Scientist

The laboratory supervisor/research scientist has overall responsibility for chemical hygiene in the laboratory which includes the responsibility to:

- Ensure that laboratory workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided;
- Provide regular, chemical hygiene and housekeeping inspections including routine inspections of emergency equipment;
- Be aware of the current legal requirements concerning regulated substances used in her/his laboratories;
- Determine the required levels of protective apparel and equipment and ensure that workers utilize the equipment and wear the apparel, including eye protection.
- Ensure that facilities and training for use of any material being ordered are adequate.
- Ensure that appropriate signs and notices of hazards and restricted activities are posted in the laboratory.
- Report any chemically-related problems to the appropriate department head and the Environmental Safety Office.

8.38.4 Laboratory Worker

The laboratory worker is responsible for:

- Planning and conducting each operation in accordance with the institutional chemical hygiene procedures; and
- Developing good personal chemical hygiene habits.
- Informing his/her supervisor of any incident or irregularity regarding the use of any chemical.

8.38.5 Chemical Hygiene Officer

The Chemical Hygiene Officer shall:

- Work with the Laboratory Safety Committee, administrators and other employees to develop and implement appropriate chemical hygiene policies and practices;
- Monitor procurement, use, and disposal of chemicals used in the laboratories;

- See that appropriate audits are conducted and records maintained;
- Help project directors develop adequate facilities and precautionary techniques;
- Know the current legal requirements concerning regulated substances;
- Seek ways to improve the chemical hygiene program;
- Ensure that appropriate sections of the Laboratory Safety Manual are reviewed annually.

8.39 BASIC RULES AND PROCEDURES FOR WORKING WITH CHEMICALS

CUA requires that all employees working in laboratories and other departmental employees who work in chemical laboratory areas know and follow the rules and procedures of the Chemical Hygiene Plan. In addition to the procedures in Sections 8.32-8.38 of this Chemical Hygiene Plan, employees should follow the rules listed below.

8.39.1 General Rules

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

8.39.1.1 Accidents and spills

The topic of chemical spills is addressed in detail in Section 8.17 of this manual.

The topic of personal contamination with chemicals is addressed in detail in Section 8.19 of this manual.

8.39.1.2 Avoidance of "routine" exposure

Develop and encourage safe habits; avoid unnecessary exposure to chemicals by any route.

Do not smell or taste chemicals.

Apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) should be vented into local exhaust devices.

Inspect gloves and test glove boxes before use.

Do not allow release of toxic substances in cold rooms and warm rooms, since they contain recirculated air.

8.39.1.3 Choice of chemicals

Use only those chemicals for which the quality of the available ventilation system is appropriate. Wherever practical, use existing chemical stocks before purchasing new stock. Avoid bulk purchase of chemicals and order the smallest amount needed for the project.

8.39.1.4 Eating, smoking, etc.

Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present; wash hands before conducting these activities.

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

8.39.1.5 Equipment and glassware

Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware. Shield or wrap Dewar flasks and other evacuated glass apparatus to contain chemicals and fragments should implosion occur. Use equipment only for its designed purpose.

8.39.1.6 Exiting

Wash areas of exposed skin well before leaving the laboratory.

8.39.1.7 Horseplay

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

8.39.1.8 Mouth suction

Do not use mouth suction for pipetting or starting a siphon.

8.39.1.9 Personal apparel

Confine long hair and loose clothing. Wear appropriate shoes at all times in the laboratory.

8.39.1.10 Personal work station

Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day.

8.39.1.11 Personal protection

Assure that appropriate eye protection is worn by all persons, including visitors, where chemicals are stored or handled.

Wear appropriate gloves when the potential for contact with toxic materials exists; when using reusable gloves, inspect before each use, wash before removal, and replace periodically. (A table of resistance to chemicals of common glove materials is given in Section 8.7.2 of this manual.)

Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls, inspecting the respirator before use. Many types of respirators are available. The choice of an appropriate respirator depends on many factors including type of contaminant and its air concentration, legal exposure limits, and warning properties (i.e., eye irritation, odor detection threshold, etc.). Before using any respirator, obtain approval from the laboratory supervisor or the Environmental Safety Office.

Use other protective and emergency apparel and equipment as appropriate.

Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken. Since contact lenses by themselves afford no protection from chemical splashes or projectiles, appropriate eye protection shall also be worn.

Remove laboratory coats immediately on significant contamination.

8.39.1.12 Planning

Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation.

8.39.1.13 Unattended operations

Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation.

8.39.1.14 Use of hood

Use the hood for operations which might result in release of toxic chemical vapors or dust.

As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm.

Confirm adequate hood performance before use; keep hood sash under the 100 feet per minute indicator at all times except when adjustments within the hood are being made; keep materials retained in hoods to a minimum and do not allow them to block vents or air flow.

Leave the hood "ON" in the following circumstances: if toxic substances are retained in it; or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "OFF."

8.39.1.15 Vigilance

Be alert to unsafe conditions and see that they are corrected when detected.

8.39.1.16 Waste disposal

Assure that the plan for each laboratory operation includes plans and training for waste disposal.

Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan.

Do not discharge to the sewer concentrated acids or bases; highly toxic, malodorous, or lachrymatory substances; or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow.

8.39.1.17 Working alone

Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous.

8.39.2 Working with Allergens and Embryotoxins

8.39.2.1 Allergens

Examples include the following: diazomethane, isocyanates, bichromates.)

Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity.

8.39.2.2 Embryotoxins

Examples include the following: organomercurials, lead compounds, formamide.)

If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.

Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.

Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.

Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

8.39.3 Working with Chemicals of Moderate Chronic or High Acute Toxicity

Examples include the following: diisopropyl fluorophosphate, hydrofluoric acid, hydrogen cyanide.)

The particular rules listed below supplement those mentioned above and are to be followed.

8.39.3.1 Aim

To minimize exposure to these toxic substances by any route using all reasonable precautions.

8.39.3.2 Applicability

These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities.

8.39.3.3 Location

Use and store these substances only in areas of restricted access with special warning signs.

Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance.

8.39.3.4 Personal protection

Always avoid skin contact by use of gloves and long sleeved laboratory coat (and other protective apparel as appropriate). Always wash hands and arms immediately after working with these materials.

8.39.3.5 Records

Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved.

8.39.3.6 Prevention of spills and accidents

Be prepared for accidents and spills.

Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity.

Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.

If a major spill occurs outside the hood, evacuate the area. Inform the Environmental Safety Office immediately. Assure that cleanup personnel wear suitable protective apparel and equipment.

8.39.3.7 Waste

Thoroughly decontaminate or incinerate contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion. These services can be arranged through the Environmental Safety Office.

Store waste and contaminated materials in closed, suitably labeled, impervious containers.

8.39.4 Working with Chemicals of High Chronic Toxicity

(Examples include the following: dimethylmercury and nickel carbonyl, benzo-a-pyrene, N-nitrosodiethylamine, other human carcinogens or substances with high carcinogenic potency in animals.)

Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance).

8.39.4.1 Access

Conduct all transfers and work with these substances in a "controlled area" which includes a restricted access hood, glove box, or portion of a laboratory, designated for use of

highly toxic substances. All people with access to controlled areas must be aware of the substances being used and must take necessary precautions.

8.39.4.2 Approvals

Prepare a written plan for use and disposal of these materials and obtain the approval of the laboratory supervisor and the Environmental Safety Office.

8.39.4.3 Non-contamination/decontamination

Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood. Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area.

Decontaminate the controlled area before normal work is resumed there.

8.39.4.4 Ex

On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.

8.39.4.5 Housekeeping

Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder.

8.39.4.6 Medical surveillance

If using toxicologically significant quantities of chemicals of high chronic toxicity on a regular basis (e.g., 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance.

8.39.4.7 Records

Keep accurate records of the amounts of these substances stored and used, the dates of use, and names of users.

8.39.4.8 Signs and labels

Assure that the controlled area is conspicuously marked with warning and restricted access signs and that all containers of these substances are appropriately labeled with identity and warning labels.

8.39.4.9 Spills

Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available.

8.39.4.10 Storage

Store containers of chemicals of high chronic toxicity only in a ventilated, limited access area in appropriately labeled, unbreakable, chemically resistant, secondary containers.

8.39.4.11 Glove boxes

For a negative pressure glove box, ventilation rate shall be at least 2 volume changes/hour and pressure at least 0.5 inches of water. For a positive pressure glove box, thoroughly check for leaks before each use. In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood.

8.39.4.12 Waste

Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel.

8.39.5 Animal Work with Chemicals of High Chronic Toxicity

8.39.5.1 Supervision of the animal care facilities is administered by the Institutional Animal Care and Use Committee appointed by the Executive Vice President. This committee should be consulted prior to use of any animal for research or teaching purposes.

Care and use of certain animals used for teaching or research and covered by the Animal Welfare Act (7USC2143) should strictly adhere to the guidelines described in that Act. Facilities housing animals covered by this act must be registered with the U.S. Department of Agriculture's Animal Inspection Service. Such facilities must file an annual report (US 18-23) with the USDA and should be inspected at least twice a year by the University's Consulting Veterinarian.

The University's Consulting Veterinarian must be licensed to practice in either the State of Maryland or Virginia or the District of Columbia. The Veterinarian receives an adjunct appointment in the Department of Biology. This appointment is re-evaluated on an annual basis, and can be renewed upon satisfactory reevaluation.

The rules of Section 8.39.4 also apply to animal work with chemicals of high chronic toxicity.

8.39.5.2 Access

For large scale studies, special facilities with restricted access are preferable.

8.39.5.3 Administration of the toxic substance

When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters.

8.39.5.4 Aerosol suppression

Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood).

8.39.5.5 Personal protection

When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator).

8.39.5.6 Waste disposal

Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products; otherwise, package the waste appropriately for burial in an EPA-approved site. These services can be coordinated through the Environmental Safety Office.

8.40 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 (privately funded) 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).

CHEMICAL As broadly applied to the chemical industry, an element or a compound produced by chemical reactions on a large scale for 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 also 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 (m^3) 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 U.S. 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 U.S. Environmental Protection Agency is the federal agency that is 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 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 Degree, Fahrenheit; a temperature scale.

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

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.

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 also LOCAL EXHAUST VENTILATION.)

g/Kg See GRAMS PER KILOGRAM.

GRAM (g) A metric unit of weight. One ounce equals 28.3 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 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 can not 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.

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

LC_{50} See LETHAL CONCENTRATION $_{50}$.

LD_{50} See LETHAL DOSE $_{50}$.

LEL See LOWER EXPLOSIVE LIMIT.

LFL 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.

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.

LITER (L) A measure of capacity. One quart equals approximately 0.9 liter and one liter equals approximately 34 fluid ounces.

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 hood, ductwork, a fan and possibly an air cleaning device. Advantages of local exhaust ventilation over general ventilation include: it removes the contaminant rather than dilutes it; it 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 the 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.)

m^3 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/m^3 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/m^3) Units used to measure air concentrations of dusts, gases, mists, and fumes.

MILLIGRAMS PER KILOGRAM (mg/kg) This indicates the dose of a substance (mg/kg) 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.

MSHA The Mine Safety and Health Administration; a federal agency that regulates the mining industry in the United States. Respirators are designed to meet standards set by this agency.

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

NARCOSIS Stupor or unconsciousness caused by exposure to a chemical.

NFPA The National Fire Prevention Association is a voluntary membership organization whose aims are 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 symbol using numerals zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates a 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 (or Act -- depending upon usage) is the federal agency under the Department of Labor that promulgates and enforces safety and health regulations for businesses having 10 or more employees 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 A substance that gives up oxygen easily to stimulate combustion of material, e.g., organic.

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

PERMISSIBLE EXPOSURE LIMIT (PEL) 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 limit (STEL), or a ceiling (C). The PELs are found in Tables Z-1, Z-2, or Z-3 of OSHA regulations (29 CFR 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 explosion, 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 a MSDS.

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

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.

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 (STEL) 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 represent 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 TLVs: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL) and Ceiling (TLV-C). (See also PEL.)

TIME WEIGHTED AVERAGE The average, 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 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.

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.

TWA See TIME WEIGHTED AVERAGE.

UEL See UPPER EXPLOSIVE LIMIT.

UFL 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 (i.e., dropping), certain temperatures, or pressures.

UPPER EXPLOSIVE LIMIT Also known as Upper Flammable Limit (UFL). Is the highest concentration (expressed 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 UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is 1 ppm and the UEL is 5 ppm, then the explosive range of the chemical is 1 ppm to 5 ppm. (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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APPENDIX A - OSHA SUBPART Z

Hazardous & Toxic Chemicals List of Regulated Substances

Each supervisor will be issued as a part of this Chemical Materials Safety Manual, a copy of the publication "Air Contaminants -- Permissible Exposure Limits (Title 29 Code of Federal Regulations Part 1910.1000)," published by the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), 1989.

The Environmental Safety Office will also have available to any employee or supervisor, for review, a copy of 29 CFR 1910, "Air Contaminants; Final Rule," published on January 19, 1989, in the Federal Register.

Any employee with specific questions about hazardous materials or who wishes to receive a copy of these air contaminant tables should ask his supervisor or the Environmental Safety Office for such inforr ation.