CHEMICAL HYGIENE PLAN

DES MOINES AREA COMMUNITY COLLEGE
ALL CAMPUSES

Last Revision: November 1, 2005

TABLE OF CONTENTS

A. INTRODUCTION

The Chemical Hygiene Plan is a written program developed and implemented by Des Moines Area Community College (DMACC) to ensure the safety of employees whose work involves the laboratory use of hazardous chemicals. It sets forth the policies, procedures, and practices, both for employees who work with hazardous chemicals and for those whose responsibilities include the support of such work.

Regulatory Basis

The development and implementation of the Chemical Hygiene Plan was mandated by the final rule on "Occupational Exposures to Hazardous Chemicals in Laboratories" (commonly known as the OSHA Lab Safety Standard). This rule has been incorporated into subpart Z of 29 CFR 1910 and is required to be implemented by January 31, 1991. Appendix I of this plan is a copy of the rule as published in the Federal Register on January 31, 1990. Of particular importance in understanding the applicability of the standard are the definitions it contains for "hazardous chemical", "laboratory", "laboratory scale", and "laboratory use of hazardous chemicals". A review of these definitions indicates that the standard does apply to the majority of science laboratories on the DMACC campus.

Administrative Responsibilities

DMACC is responsible for ensuring the safety of its employees and for complying with all related requirements of state and federal regulations. Because of the importance which the college places on safety, the administration encourages employees at all levels to promote positive attitudes regarding safety, to incorporate safety into their work practices, and to cooperate fully in the implementation of safety-related programs.

DMACC Chemical Hygiene Committee (DCHC)

The DMACC Chemical Hygiene Committee (DCHC) has prepared the Chemical Hygiene Plan and will oversee its adaptation and implementation by individual departments. The DCHC will also update the plan on an annual basis. The lead role in this effort is performed by the **DMACC Chemical Hygiene Officer (DCHO).**

Campus Chemical Officer (CCHO)

Each campus which is involved in the laboratory use of hazardous chemicals is responsible for the adaptation and implementation of the Chemical Hygiene Plan within the laboratories under its administrative control. Toward this end, each campus must designate a Campus Chemical Hygiene Officer **(CCHO)** who will be specifically responsible for this effort. (For specific campus representatives, see Appendix VII). This includes developing written standard operating procedures for chemical use, enforcing safety practices, providing or scheduling employee training, reporting hazardous conditions

to the DCHO, and maintaining adequate records to demonstrate compliance with all aspects of the Lab Safety Standard.

Employees

Employees are responsible for observing all appropriate practices and procedures contained in the Chemical Hygiene Plan as well as other general safety practices, for attending designated training sessions, and for reporting hazardous or unsafe conditions to the CCHO, DCHC, or DCHO.

Required Content of the Chemical Hygiene Plan

- Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals. A number of generic SOPs have been included in the plan. Each laboratory, however, is expected to develop any specific SOPs required and include them in the Plan. A standard blank SOP form has been included for this purpose. (See page B-17)

- Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals. These measures include engineering controls, use of personal protective equipment, and hygiene practices.

- A requirement that fume hoods and other protective equipment be functioning properly and control measures to ensure that they function properly.

- Provisions for employee training.

- Circumstances under which a laboratory procedure shall require prior approval before implementation.

- Provisions for medical consultations and examinations.

- Designation of personnel responsible for implementation of the Chemical Hygiene Plan and the assignment of a Chemical Hygiene Officer.

- Provisions for additional employee protection for work with carcinogens, reproductive toxins, and highly toxic substances. Protective provisions can include: designated areas, containment devices, waste removal procedures and decontamination procedures.

B. STANDARD OPERATING PROCEDURES

Procedures for Ordering Chemicals

The DMACC Safety Committee encourages all employees who are responsible for ordering chemicals to actively engage in waste minimization activities and to exercise prudence in ordering all hazardous materials.

Following are some guidelines that will aid in ordering hazardous chemicals:

- Estimate the amount of each chemical required by carefully pre-planning the experimental procedure.

- Select only those chemicals for which the quality of available ventilation is adequate.

- Obtain approval from the CCHO before ordering whenever:

  - a new laboratory procedure or significant change in a previous procedure is to be conducted.

  - it is likely that a Permissible Exposure Limit or other hazard limit could be exceeded during the course of the procedure.

- Contact the manufacturer before ordering new or unusual chemicals for which adequate hazard information is unavailable.

- Order chemicals in small container lots to avoid the hazards associated with repackaging.

- Request MSDSs from vendors when chemicals are ordered and appropriately file the copies when received.

- Notify appropriate receiving personnel that the material has been ordered.

- Transmit proper handling information to all those who will be involved with the chemical (for most chemicals, this information can be found on the MSDS).

- Prepare the laboratory for the arrival of the substance (e.g., establish storage location, post appropriate signs, obtain and check personal protective equipment).

Procedures for Receipt and Distribution of Chemicals

- Do not accept any chemical whose container is not properly labeled. Refuse to accept damaged containers.

- Review and observe information on the safe handling and storage of the chemical.

- Place all chemical containers which are to be delivered by hand within suitable carrying containers or buckets.

- When transporting chemicals by cart, ensure that the cart is stable under the load and has wheels large enough to negotiate uneven surfaces such as expansion joints and drainage depressions without tipping or stopping suddenly.

- When transporting gas cylinders, use an appropriate hand truck (never drag or roll cylinder), leave valve cover cap on until cylinder is in place, and handle only one cylinder at a time.

Procedures for the Safe Storage of Chemicals

The proper storage of chemicals is a highly complicated subject due to the diverse individual physical properties of the numerous chemicals which may be present in the laboratory. Some general procedures for chemical storage are listed below. These procedures, however, are not intended to be all-inclusive but should serve, instead, to supplement more specific procedures adopted for particular laboratory situations. Specific instructions on chemical storage may be obtained from the MSDS, container label, and by contacting your CCHO.

- Ensure that all containers are in good condition and properly labeled (including the purchase date).
- Store incompatible chemicals separately (do not store unsegregated chemicals alphabetically).
- Segregate chemicals by hazard class (e.g. flammable liquids, organic acids, oxidizers, etc.). Contact CCHO for assistance.
- Secure all storage shelves and cabinets to prevent tipping.
- Ensure that storage locations are dry and adequately ventilated.
- Store frequently used chemicals at or below eye level.
- Store flammable liquids in quantities exceeding 4 liters in safety cans.
- Store flammable liquids in quantities exceeding a total of 40 liters in approved safety cabinets.
- Use only explosion-proof refrigerators and freezers for storage of flammable liquids requiring refrigeration.
- Indicate the date of purchase and the date of opening on each container of peroxide forming chemicals.
- Dispose of all peroxide forming chemicals within one year of purchase or six months of opening.
- Store highly reactive or corrosive liquids in spill trays.
- Secure gas cylinders away from heat sources.

General Procedures for the Safe Use of Chemicals

- Know the hazards associated with the materials you are using (review labels and MSDSs).
- Review emergency procedures and ensure that necessary supplies and equipment for spill response are available.
- Know the locations of safety equipment such as emergency shower, eye wash, fire extinguisher, fire alarm, fire blanket and emergency phone numbers.
- Avoid working alone in the laboratory.
- Do not eat, drink, smoke, chew gum, or apply cosmetics in areas where laboratory chemicals are used or stored.
- Do not store food items or cosmetics in areas where laboratory chemicals are used or stored.
- Confine long hair and loose clothing when working with chemicals.
- Wear shoes at all times (avoid sandals and perforated shoes).
- Wear appropriate personal protection apparel including eye protection, lab coat, and gloves.
- Wear appropriate respiratory equipment when air containment concentrations cannot be sufficiently restricted by engineering controls. Comply with the **DMACC Personal Protective Equipment Program (DMACC PPE Program)**
- Remove laboratory coat immediately upon significant contamination.
- Do not smell or taste chemicals.
- Handle and store laboratory glassware with care to avoid damage and properly dispose of any damaged glassware.
- Do not use mouth suction for pipeting or starting a siphon.
- Keep work areas clean and uncluttered, with chemicals and equipment properly labeled and stored.
- Always wash hands and other exposed skin after chemical use.

- Do not leave potentially hazardous chemical processes unattended.
- Conduct all processes which may result in the release of toxic vapors, fumes, or dust within the fume hood or other adequate containment device.

Procedures for the Safe Use of Flammable/Combustibles

These are materials which, under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source. Materials which generate sufficient vapors to ignite at temperatures below 100 degrees F (38 degrees C) are "flammables", whereas materials which require temperatures above 100 degrees F to provide sufficient vapors for ignition are "combustibles". The invisible vapor trails from these materials can reach remote ignition sources, causing flashback fires. Fire can also result from reactions between flammables or combustibles and oxidizers. The following precautions should be observed when handling these materials:

- Eliminate ignition sources such as open flames, smoking materials, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity from areas in which flammable or combustible materials are used or stored. Post conspicuous "No Smoking" signs in these areas.

- Minimize the quantity of these materials within the work area.

- Store in approved flammable liquid containers (safety cans) and storage cabinets, or in a special storage room designed for that purpose. Store away from oxidizers.

- Flammable liquids stored in glass containers shall not exceed 1 liter unless chemical purity must be protected. In that case, 4 liter quantities are permissible.

- Refrigerators and freezers used for the storage of flammable or combustible liquids must be explosion-proof.

- Ensure that there is proper bonding and grounding when transferring or dispensing a flammable liquid from a large container or drum.

- Ensure that areas in which flammable/combustible materials are used or stored have appropriate sprinkler systems or fire extinguishers.

Procedures for the Safe Use of Corrosives

These are materials which chemically react at the point of contact to cause visible (often burn-like) damage to tissue. Examples of corrosives include acid and bases. When handling these materials, the following precautions should be observed:

- Wear eye protection and rubber gloves. A face-shield, rubber apron, and rubber boots may also be appropriate, depending on the work performed.

- Always add acid to water (never the reverse) to avoid violent reaction and splattering.

- Ensure that an eyewash and safety shower are readily accessible in areas where corrosives are used and stored. In the event of skin or eye contact with corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Get medical help immediately.

Procedures for the Safe Use of Reactives

These are materials that react rapidly with themselves or other materials to release relatively large amounts of energy. For some situations, the reaction may be violent enough to produce a detonation. A number of subcategories of this chemical class together with examples and precautions for handling are listed below:

Pyrophorics -ignite spontaneously upon contact with air.

Examples: metal alkyls, phosphorus, fine powders of metals such as magnesium, aluminum, and zinc

Precautions: use or store in inert environments

Oxidizers -react violently with organic materials or strong reducing agents

Examples: perchloric, chromic, and fuming nitric acids

Precautions: use minimum amounts for procedures: store away from organic materials, flammable materials, and reducers

Peroxidizables -react with oxygen to form peroxides which can explode with impact, heat or friction

Examples: ethyl ether, tetrahydrofuran, isopropyl ether, and liquid alkanes and alkenes

Precautions: date all peroxidizables upon receipt and upon opening; dispose of within 6 months of opening or 12 months of purchase; never open a container with obvious crystal formation around the lid

Water Reactives -react with water to produce a flammable or toxic gas, or other hazardous condition

Examples: alkali metals such as lithium, sodium, and potassium; acid anhydrides and acid chlorides

Precautions: avoid contact and handle away from water sources; use dry sand to smother fires; provide ventilation to disperse flammable gases

Special Procedures for Use of Select Carcinogens, Reproductive Toxins and Chemicals with High Acute Toxicity

Specific chemicals covered:

The chemicals covered by this procedure include the following:

- The OSHA listed carcinogens (see Appendix IV, List A).
- The National Toxicology Program (NTP) "Known to be Carcinogens" List (see Appendix IV, List A).
- The International Agency For Research on Cancer (IARC) list of "Carcinogenic to Humans" Group I (see Appendix IV, List A).
- The Reproductive Toxins List (see Appendix IV, List C).
- The Environmental Protection Agency (EPA) Acute Hazardous Waste List (Appendix V starting on Page M-1).

Appendix IV, List B, contains chemicals which are listed by NTP and IARC as "reasonably anticipated to be carcinogens". These chemicals require similar handling procedures as those described here, but considerable more judgment can be applied in their use and handling (i.e., amount of chemical being used; chemical formulations being used; duration of use; conditions of use, etc.)

Special Procedures

In accordance with recommendations of the American Chemical Society, quantities less than 10 milligrams are exempt from these special procedures. However, any quantity of hazardous chemical should be used with reasonable precautions which include: eliminate potential for ingestion, inhalation and skin contact; follow standard laboratory safety practices listed throughout this manual; and obtain training and information about chemicals before using them. The following special procedures apply to select carcinogens, reproductive toxins and highly acute toxicity chemicals:

- Establish a designated area for use (i.e., fume hood, glove box, lab bench, outside lab, etc.) and identify the area by signs or posting.
- Use containment devices and personal protective equipment as recommended by the MSDS.
- Establish procedures for the safe removal of contaminated waste. Develop written procedures if necessary.

- Develop appropriate decontamination procedures and use them on designated areas with required frequency, especially when work is complete.

- Only personnel trained to work with these chemicals should perform work, and always within the designated areas with the minimum quantities possible. Prior approval is required by supervisory personnel. (See page C-12 for prior approval of hazardous chemical operations.)

- Hazardous chemicals should be stored appropriately and securely.

Emergency Response Procedures

Despite strict adherence to laboratory safety practices, spills and accidents involving chemicals will occur in the laboratory. The amount of damage sustained by personnel and property from these accidents will be directly related to the quality of the laboratory's emergency plan and procedures. The following components of emergency planning and procedures are recommended:

Preplanning In preparing for spills and accidents in the laboratory, the DCHC suggests that the following factors be considered:

- The nature of the operation (e.g., experimental design, equipment used, and type of injury that might be inflicted).
- Potential location of a release or spill (e.g., outdoors versus indoors, in a laboratory, corridor, or storage area, on a table, in a hood, or on the floor).
- The quantities of material that might be released and the type of containment (i.e. compressed gasses, bottles, in pipes, etc.).
- The chemical and physical properties of the material (e.g., its physical state, vapor pressure, and air or water reactivity).
- The hazardous properties of the material (its toxicity, Corrosivity, and flammability).
- The availability and locations of emergency supplies and equipment.
- Building evacuation routes.

Equipment and Supplies Each laboratory should have appropriate equipment and supplies on hand for managing spills and accidents involving chemicals. Equipment should include a safety shower, fire blankets, eyewash, appropriate fire extinguisher(s), and first aid kit. The supplies available should include, but are not limited to various neutralizing agents (such as sodium carbonate and sodium bisulfate) and absorbents (such as vermiculite, calcium bentonite, and sand). These and other spill control items are often contained within various commercially available spill control kits.

Accidents Involving Personnel Injury

- For medical emergencies, call 911. (On campus call 9-911)
- Call the local Medical Personnel.

  Ankeny: DMACC Nurse 964-6352 or Pager 242-1289
  Boone: Boone County Hospital; 432-3140

Newton:
Carroll:
Urban:

- Assist persons involved and administer immediate first aid which may include:

  -Washing under a safety shower (in case of chemical exposures).

  -Using a fire blanket (in case of burning clothing).

  -Removing contaminated clothing.

  -Irrigating the eyes at an eyewash.

  -Administering artificial respiration.

- Notify building captain or alternate.

- Notify personnel in adjacent areas of any potential hazards (e.g., activate building or area alarms).

- Move injured personnel, only if necessary to prevent their exposure to further harm.

Fire and Fire-Related Emergencies

Small isolated fires within the laboratory may be extinguished using the appropriate portable fire extinguisher. For large or rapidly spreading fires, however, the following procedures should be observed:

- Call 9-911 to report the fire.

- Activate building and area alarms.

- Call Security

- Evacuate the building, shutting doors and providing assistance to others on the way out.
- Instruct people to go to a distance of 300 feet away from building.

- Provide fire or police officials with the details of the problem upon their arrival.

- Once outside, account for all personnel in laboratory.

Procedures for Handling Chemical Spills

The following general procedures should be observed by laboratory personnel for minor spills of chemicals:

- Attend to any persons who may have been contaminated.
- Notify people in the immediate area about the spill.
- Evacuate all nonessential personnel from the spill area.
- If the spilled material is flammable, turn off ignition and heat sources.
- Avoid breathing vapors of the spilled material and, if necessary, use a respirator **(see the DMACC PPE Program).**
- Maintain or establish the exhaust ventilation if it is safe to do so.
- Secure supplies to effect cleanup.
- During cleanup, wear appropriate personal protective equipment to prevent contamination.
- Notify the DCHC if you should require assistance or additional information.

Procedures for Handling Compressed Gas Cylinder Leaks

Occasionally, a cylinder or one of its component parts develops a leak. Most such leaks occur at the top of the cylinder in areas such as the valve threads, pressure safety device, valve stem, and valve outlet. Suspected leaks should be verified using a flammable gas detector or soapy water solution (a flame should not be used for detection). If the leak cannot be stopped by tightening a valve gland or packing nut, the supplier should be notified and emergency action procedures initiated:

Minor Leaks

- For flammable, inert, or oxidizing gases, move the cylinder to an isolated, well-ventilated area (e.g., within a fume hood) away from combustible materials. Post signs that describe the hazard.

- For corrosive and toxic gases, move the cylinder to an isolated, well-ventilated area (e.g., within a fume hood) and use suitable means to direct the gas into an appropriate chemical neutralizer. Post signs that describe the hazards.

- If it is necessary to move a leaking cylinder through populated portions of the building, place a plastic bag, rubber shroud, or similar device over the top and tape it (duct tape preferred) to the cylinder to confine the leaking gas.

Major Leaks

When the nature of the gas or the size of the leak constitutes a serious hazard, one or more of the following steps may be necessary:

- Call 9-911 to report the situation.

- Put on protective equipment (e.g., SCBA) and apparel.

- Evacuate personnel from the area.

- Observe procedures for personal injury accidents or fire as appropriate.

Procedures for Mercury Handling Spills

Because metallic mercury (Hg) is widely used in laboratory instruments and mercury compounds are used in many laboratory experiments, it is one of the most frequently spilled materials. Mercury must be used and handled with care since it is a subtle poison with cumulative effects which are not easily reversed. Metallic mercury and its compounds can be absorbed into the body by inhalation, ingestion or contact with the skin. If spills are frequent and mercury is added to the general air level, the combined concentration may reach or exceed toxic limits.

The CCHO is available for consultation regarding all spill clean up activities. However, spill clean up activities are the primary responsibility of the person(s) involved.

Mercury Handling Procedures

Proper handling of mercury in the laboratory or workplace is essential to preventing spills and maintaining a healthful working environment. Use the following guidelines when handling mercury:

- Keep mercury containers closed and stored in secondary containers in a well-ventilated area.
- Move instruments or apparatus containing mercury in an enameled or plastic tray or pan that can be cleaned easily and is large enough to contain the mercury.
- Transfer mercury from one container to another in a hood over a tray or pan to confine any spills.
- Provide mercury manometers and other mercury containing equipment with spill control and containment devices such as trays or pans.

Mercury Spill Procedures

Every effort should be made to prevent spills of metallic mercury since the substance is extremely difficult and time consuming to clean up. Globules can get into cracks and crevices, under table legs, under and into equipment. When a spill does occur, use the following procedures to assist in the clean up:

- Notify people in the immediate area that a mercury spill has occurred and isolate the area to avoid more extensive contamination by tracking.

- If the spill occurred on the floor, determine the extent of the area. Use chalk or a similar material to mark the boundary of the spill.

- Wear appropriate protective gear and plastic disposable shoes covers to prevent shoes from being contaminated when a floor clean up is involved.

- Push tools and globules of mercury together and collect by suction using an aspirator bulb or a vacuum device made from a filtering flask, a rubber stopper and several pieces of flexible glass tubing. Small globules can be amalgamated with zinc dust and resulting solid swept up. Droplets in floor crevices or in metal container crevices can be converted to mercuric sulfide by dusting with sulfur powder.

  NOTE: There are commercial mercury clean up kits that contain the necessary materials and small equipment for cleaning up minor spills of mercury or small droplets can be picked up on cellophane tape.

- Collect significant quantities of metallic mercury from spills, broken thermometers or other equipment, and contaminated mercury from laboratory activities in thick-walled, high-density polyethylene bottles for storage and disposal.

- Thoroughly wash hands, arms and face several times after completing clean up activities.

- After the clean up of a spill involving a tablespoonful or more of mercury, contact CCHO for monitoring the effectiveness of the clean up operation with a mercury-vapor analyzer.

STANDARD OPERATING PROCEDURE

Title: _____Dept: _____

Lab: _____ Supervisor: _____

Procedure Overview:

Safety Precautions:
(e.g., goggles, gloves, aprons, fume hoods, gloveboxes, biocabinets, etc.)

Procedure:
(Attach if necessary)

Special Procedures (required when using Select Carcinogens, Reproductive Toxins, or Substances with a high degree of acute toxicity). Check (√) completed items:

- ☐ Prior approval granted
- ☐ Designated area of use established
- ☐ Containment devices and personal protective equipment available
- ☐ Procedures for the safe removal of contaminated waste established
- ☐ Appropriate decontamination procedures developed
- ☐ Personnel are trained to work with these chemicals

Written By: _____ Date: _____

Approved By: _____ Date: _____
(Campus Chemical Hygiene Officer)

Distribution: Original—File in the Lab's Chemical Hygiene Plan,
Copies—DMACC CHO

C. CONTROL MEASURES

Administrative Controls

Administrative controls are procedural measures which can be taken to reduce or eliminate hazards associated with the use of chemicals. They include the following:

- Observing various standard laboratory practices and procedures for chemical safety, good hygiene, and good housekeeping (see Section B - Standard Operating Procedures).
- Ensuring that employees are provided with adequate training to safely work with hazardous materials (see Section D - Information and Training Section).
- Requiring prior review and approval of particularly hazardous operations, procedures, or activities (see page C-12).
- Restricting access to areas in which hazardous materials are used.
- Posting signs or placards to identify hazardous areas (designated areas).
- Labeling hazardous materials.

Laboratory Entrance Posting

The entrance to each laboratory in which chemicals are used or stored shall be posted with the following:

- Emergency information including the names and phone numbers of the lab supervisor or other responsible party to be contacted in the event of a fire, accident, or spill.
- Information on the presence within the laboratory of certain specific types of hazards (e.g., flammable, radiological, biological, and electrical). Standard signs and symbols (e.g., NFPA 704) have been established for warning of many of these hazards.

Posting of Safety Equipment Locations

Signs shall be posted within each chemical laboratory to identify the location of various types of safety equipment including safety showers, fire blankets, eye washes, fire extinguishers, eye protection, and safety and first-aid kits.

Container Labeling

Each chemical container should be labeled in accordance with the requirements of ANSI A129.1 which includes:

- Identification of the contents of the container.
- Signal word and summary description of any hazard(s).
- Precautionary information (what to do to minimize hazard or prevent an accident from happening).
- First-aid in case of exposure.
- Spill and cleanup procedures.
- If appropriate, special instruction to physicians.

Engineering Controls

The hazard associated with the use of chemicals should be reduced or eliminated to the extent possible through the use of engineering controls. In general, such controls include the following:

- Substitution of a less hazardous chemical, process, or piece of equipment.
- Physical isolation of the operator or process.
- Use of local and general exhaust ventilation (i.e. fume hoods).

Lab Fume Hoods (See Appendix II)

The laboratory hood is designed to prevent the escape of chemical fumes or vapors into the general laboratory atmosphere. It thus serves as the primary means of respiratory protection for laboratory personnel. In addition, the fume hood provides physical isolation and containment of chemicals and their reactions.

Criteria for Use

A fume hood should be employed for any chemical procedure which has the potential of creating:

- Airborne concentrations of one or more chemicals approaching the corresponding Permissible Exposure Limit (PEL).
- Flammable vapors approaching one tenth of the lower explosion limit.
- Materials of unknown toxicity.
- Odors which are potentially annoying to other personnel.

Procedures Not Requiring Fume Hood

Procedures which can generally be conducted safely outside the fume hood include those involving:

- Water-based solutions of salts, dilute acids, bases, other reagents.
- Very low volatility liquids or solids.
- Closed systems which do not allow significant escape to the laboratory environment.
- Extremely small quantities of chemicals that might otherwise be hazardous.

Protective Apparel and Equipment

Personal protective equipment (PPE) is personal apparel which includes, but is not limited to the following: hard hats; plain and prescription safety glasses; goggles; welders helmets or similar head protection; safety shields; safety shoes; protective clothing such as aprons, gloves, lab coats, etc.,; respirators; hearing protection; etc. These protective apparel items should be compatible with the required degree of protection for the chemicals being handled.

DMACC has a formal PPE policy which requires the department to provide necessary PPE items. The CCHO is responsible for coordinating and overseeing the use of any PPE items.

Respirators In certain situations where engineering controls (i.e. fume hoods) cannot effectively control the amount of chemical air contaminants within the work environment, personnel may be required to wear respiratory protective equipment. Personnel designated to use respiratory equipment must first have appropriate medical exams and approvals, fit tests and training. For more information, refer to the DMACC PPE Program.

Eye and Face Protection Eye and face protection is required where there is reasonable probability that injury could result without it. Any PPE designated for eye and face protection should meet the requirements listed in ANSI Z87.1 and appropriate OSHA regulations. General eye and face protective requirements include the following:

- Safety goggles are required in chemical operations where there is potential for chemical fumes, splashes, mists, sprays or dust exposure to the eyes.
- Safety glasses with permanent side shields are required in any operation where there is potential for eye exposure to projectiles.
- Face shields are required where there is potential face exposure to projectiles, chemicals, or radiant energy. Face shields should not be used as a substitute for eye protection and it may be necessary to provide both means of protection.

PPE items are provided by the employer; however, eye exams and associated costs are subject to health insurance provisions.

Hand and Body Protection

Skin contact is a potential source of exposure to chemicals. Therefore, necessary precautions must be taken to protect the skin when working with chemicals that can cause a significant exposure through skin contact. Appropriate gloves, lab coats, etc. should be selected to meet the needs of the specific chemical work environment. General requirements include the following:

- Lab coats are recommended to be worn by personnel in any area where chemicals are routinely used or stored. Lab coats should be laundered frequently and removed immediately if contaminated with hazardous chemicals.

- Gloves should be worn whenever there is potential for contact with corrosive or toxic materials. Glove materials must be chosen with the specific chemical use in mind (type of material, thickness, permeation rate, etc.). Gloves should be washed appropriately before removal and inspected periodically for wear and effectiveness.

- Other protective items (i.e., rubber aprons, rubber suits, coveralls, etc.) should be specified and used depending on the specific chemicals involved and the work environment. Laboratory employees and campus chemical hygiene officers should be involved in this decision-making process.

Foot Protection

The requirement and need for safety shoes and other foot protection in a chemistry lab is a judgmental process and can only be made after careful review of the chemicals and work operations involved. This should be conducted by the lab employee with assistance from the CCHO, if necessary.

However, it is mandatory that solid, non-perforated shoes be worn at all times by personnel who work in laboratories where chemical exposures are probable. Bare feet, sandals, and open-toed shoes are not permitted in chemical labs.

Safety Equipment

Safety Shields/ Containment Fume hoods with drawn sashes, glove boxes, face shields, or other devices should be employed whenever procedures with a high potential for sudden splattering (e.g. those involving concentrated acids, bases, oxidizers, or reducing agents) are involved. Chemicals which react explosively require special safety shields and/or containment.

Safety Showers An easily accessible, drench-type safety shower shall be available within 100 feet or 10 seconds travel time of each area where corrosives are frequently used or stored.

Fire Blankets Fire blankets should be available where flammable liquids are used or stored.

Eyewash Fountains An eyewash fountain shall be available in all areas where corrosives, hot liquids, or other eye irritating materials are used or stored.

Fire Extinguishers Each chemical laboratory shall be provided with a carbon dioxide or dry chemical fire extinguisher (or both). Other types of fire extinguishers should be available if required by the work being performed.

First Aid Kits Each chemical laboratory should have available a properly stocked first aid kit. Complete kits and first aid training is available through the Ankeny DMACC campus nurse (515-964-6352).

Laboratory Refrigerators Flammables which require refrigeration must not be stored in domestic refrigerators. The light switch or thermostat in such refrigerators could ignite flammable vapors causing an explosion. Flammables which require refrigeration must be stored only in explosion-proof refrigerators.

Laboratory Maintenance and Inspection

In order to ensure that overall laboratory safety is maintained, a program of inspection should be developed and conducted by the CCHO. Inspections should consist of formal reviews of chemical and general safety practices, housekeeping, and maintenance checks of safety-related equipment. The following types and frequencies of inspections are suggested:

- Chemical and general safety practices, housekeeping (semi-annually).
- Eyewash fountain functioning (monthly).
- Respirator maintenance and use (monthly).

The following equipment checks will be conducted annually.

- Safety shower functioning (Laboratory Employee).
- Fume hood function. (Ankeny DMACC Physical Plant or Designee)

Documentation of inspections must be maintained by the CCHO. Example forms for recording various inspections are included in this section.

LABORATORY SAFETY INSPECTION

DEPARTMENT: _____

BUILDING: _____ ROOM: _____

INSPECTED BY: _____ DATE: _____

		YES	NO	NA
A.	**GENERAL**			
A.1	Housekeeping adequate	___	___	___
A.2	Aisles/Exits not blocked	___	___	___
A.3	Hazard warning signs posted	___	___	___
A.4	Storage areas/rooms identified	___	___	___
A.5	Storage areas secured when not in use	___	___	___
A.6	Storage areas properly ventilated	___	___	___
A.7	Mixing/transferring chemicals not done in storage areas	___	___	___
A.8	Chemicals stored below eye-level	___	___	___
A.9	Chemicals not overcrowded on benches/in storage areas	___	___	___
A.10	Shelves clean, level, and securely anchored to wall	___	___	___
A.11	First aid supplies available	___	___	___
A.12	Emergency phone numbers posted	___	___	___
A.13	Eyewash and shower facilities within 100 feet or 10 seconds	___	___	___
A.14	Spill equipment available	___	___	___
A.15	MSDSs available	___	___	___
A.16	"Sharps" disposed of properly	___	___	___
A.17	Fume generating procedures done at least 20 cm from face of hood	___	___	___
A.18	Machine guards in place	___	___	___
B.	**FIRE SAFETY**			
B.1	Flammables stored in flammables cabinets	___	___	___
B.2	Flammable materials stock maintained at minimum levels	___	___	___
B.3	Refrigerators are spark-proof for storing flammable materials	___	___	___
B.4	Flammables not stored in exits	___	___	___
B.5	Flammables stored/used away from flames, heat, or sparks	___	___	___
B.6	Electrical equipment is spark-proof/explosion-proof	___	___	___
B.7	Fire extinguishers available	___	___	___

			YES	NO	NA
C.	**CHEMICAL SAFETY**				
	C.1	Oxidizing acids stored separate from organic acids, flammable and combustible materials	___	___	___
	C.2	Acids stored separately from caustics and active metals	___	___	___
	C.3	Oxidizers stored away from combustible, flammable, and reducing agents	___	___	___
	C.4	Toxic compounds stored appropriately and securely	___	___	___
	C.5	Chemicals stored by reactive class	___	___	___
	C.6	Peroxide-forms identified by date of receipt and date for disposal	___	___	___
	C.7	Perchloric acid quantities maintained a minimal level and used in perchloric acid fume hood	___	___	___
	C.8	All containers labeled	___	___	___
	C.9	Quantities of chemicals not excessive	___	___	___
	C.10	All work generating hazardous fumes done in fume hood	___	___	___
	C.11	Work capable of causing explosion done behind protective barriers	___	___	___
	C.12	Waste chemicals stored properly	___	___	___
D.	**GAS CYLINDERS**				
	D.1	Gas cylinders secured	___	___	___
	D.2	Cylinders stored away from heat, open flames, or sparks	___	___	___
	D.3	Empty cylinders labeled "empty"	___	___	___
	D.4	Cylinders or incompatible gases are segregated	___	___	___
	D.5	Valve cap securely in place when cylinder not in use	___	___	___
E.	**ELECTRICAL**				
	E.1	Circuits not overloaded with extension cords or multiple connection	___	___	___
	E.2	Circuit breakers labeled	___	___	___
	E.3	Motors are non-sparking	___	___	___
	E.4	Adequate lighting	___	___	___
	E.5	Grounding wires connected	___	___	___
	E.6	Heating devices equipped with automatic shut-off devices	___	___	___

F. OTHER

F.1 _____
F.2 _____
F.3 _____
F.4 _____
F.5 _____

G. COMMENTS

_____
_____
_____
_____
_____

REF: Furr, A.K. (ed.) "CRC Handbook of Laboratory Safety", 3rd Editions, CRC Press, 1990.
Pipetone, D.A. (ed.) "Safe Storage of Laboratory Chemicals", John Wiley & Sons, 1984.

Prior Approval for Hazardous Chemical Operations

The OSHA Lab Safety Standard requires that laboratory operations which involve particularly hazardous chemicals must receive advanced written approval. Outlined below are some examples of typical circumstances that require such approval:

- Any operation involving select carcinogens or reproductive toxins (see Appendix IV).
- Any operation involving highly reactive, potentially explosive, or particularly shock sensitive chemicals (review MSDS).
- Any use of acute toxins or poisons (review appropriate literature and MSDS).
- Any use of acutely corrosive or oxidizing chemicals (i.e., Hydrofluoric Acid, Perchloric Acid, etc.).
- Any chemical process or procedure that produces results which are unknown but potentially hazardous.
- Any change in protocol that has new hazard potential (i.e., different chemicals or new equipment).

Any operation which meets the above classification, or for other reasons is deemed to be particularly hazardous, must be reviewed and approved in advance by the CCHO. The form on the next page can be used to accomplish the prior approval process. This form or similar documentation should be kept in campus files and also filed with the DCHO.

PRIOR APPROVAL FOR HAZARDOUS LAB OPERATIONS

(CHEMICAL HYGIENE PLAN)
DES MOINES AREA COMMUNITY COLLEGE

CAMPUS: _____

BUILDING:_____

ROOM NUMBER: _____

Description of Chemical Procedure:

Description of Safety Precautions/Equipment:

Personnel Approved For This Procedure:

AUTHORIZED BY: _____ DATE:_____
(Campus CHO)

Distribution: Original—File in the Lab's Chemical Hygiene Plan,
Copies—DMACC CHO

D. INFORMATION AND TRAINING

Employee Information and Training

The Lab Standard requires that employees who work in laboratories with chemicals be informed of the types and levels of hazards to which they are exposed. In addition, they must be trained in practices for the safe use of chemicals and for handling emergency situations. This training and information must be provided when employees are initially assigned to a laboratory where chemicals are present and prior to assignments involving new hazardous chemicals and/or new work procedures. DMACC and ultimately Provosts or Academic Deans are responsible for ensuring that appropriate information and training has been provided to their employees.

Required Training Topics

- Content of the Lab Standard.
- Location and availability of the Chemical Hygiene Plan.
- Permissible exposure limits for OSHA regulated substances or recommended limits for other materials that have no OSHA limits.
- Signs and symptoms associated with laboratory chemical exposure.
- The location and availability of known reference material (including MSDSs) on the hazards and safety practices associated with laboratory chemicals (see Appendix III).
- Methods to detect the presence or release of chemicals.
- The physical and health hazards of chemicals in the work area.
- The measures the employees can take to protect themselves from these hazards including SOPs, control measures, personal protective equipment, and emergency procedures.

Training Resources

The training sessions that are available to DMACC employees are listed in Appendix VIII. Some of the topics that are recommended are as follows:

◊ -CPR
◊ -First Aid
◊ -Fire Extinguisher Use
◊ -Respiratory Protection
◊ -Right to Know Orientation
◊ -Hazardous Waste Management
◊ -Spill Control
◊ -Emergency Response (SOP)
◊ -Laboratory Safety
◊ -Chemical Handling and Storage
◊ -Back Injury
◊ -Hearing Conservation
◊ -Blood Borne Pathogens

Documentation of Training

Provosts or Academic Deans are responsible for documenting that their employees have been provided the training required under the Lab Safety Standard. This documentation must be retained for inspection by the DCHO and the Iowa Occupational Safety and Health Administration. The accompanying form may be used for this purpose.

CHEMICAL HYGIENE TRAINING
Des Moines Area Community College

Name _____ Department _____

Campus Location _____ Campus Phone _____

Employee Classification _____ Supervisor _____

OSHA's Laboratory Standard (29 CFR 1910.1450) requires that each laboratory employee be made aware of the location and content of the laboratory's Chemical Hygiene Plan (CHP). By your signature below, you acknowledge that you have read and understood the contents of this plan and know its location within the laboratory.

_____ _____
Employee Signature Date

The Laboratory Standard further requires that the employee's supervisor provide training which covers the specific topics described in the "Information and Training" section of the Chemical Hygiene Plan. This training must be provided at the time of the employee's initial assignment and on a refresher basis thereafter. Specific employee training should be documented below:

Description of Training	**Date**	**Provided by**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Distribution: Original—DMACC Chemical Hygiene Officer
Copies— Provost, Academic Dean, Physical Plant, HR, Campus CHO, and the Lab's CHP

CAMPUS CHEMICAL HYGIENE OFFICER

Des Moines Area Community College

Department _____ DCHO _____

Campus _____ Phone _____

OSHA's Laboratory Standard (29 CFR 1910.1450) requires that the responsibility for implementing the Chemical Hygiene Plan be formally delegated to an individual, referred to as the Chemical Hygiene Officer (CHO). At DMACC, the lead CHO will be responsible districtwide and will be designated as the DCHO. Each campus involved in the laboratory use of hazardous chemicals must designate a Campus CHO to oversee the adaptation and implementation of the Chemical Hygiene Plan in those laboratories under its control and will be designated as the CCHO.

By my signature, I accept the responsibility for ensuring that the Chemical Hygiene Plan is adapted and implemented in the laboratories of the above referenced department.

_____ _____

CCHO Signature Date

Distribution: Original--File in your lab's CHEMICAL HYGIENE PLAN
Copies--Academic Dean or Provost, Human Resources, and Physical Plant

E. EXPOSURE ASSESSMENT MEDICAL EXAMS

Exposure Assessments

An employee's exposure to a chemical must be assessed through monitoring if there is reason to believe that an overexposure has occurred or might occur.

Initial Monitoring

The employee shall contact the CCHO to initiate environmental monitoring when:

- A laboratory employee exhibits signs or symptoms of overexposure to a chemical used in the lab; or
- There is reason to believe that the level of employee exposure to a hazardous chemical exceeds the OSHA "action level" or permissible exposure level (PEL).

Periodic Monitoring

If the initial monitoring indicates a problem, the DCHO will make recommendations for corrective actions or alternative procedures. Each campus and laboratory employee is responsible for ensuring that the recommended corrective actions are followed. Additional monitoring will be conducted in order to establish the effectiveness of the corrective actions and periodically thereafter as specified by the particular standard involved.

Employee Notification

The employee must be notified in writing (by DCHO) of the outcome of any laboratory environmental monitoring within 15 days of the receipt of those results.

Medical Examinations

Medical examinations are required for the following:

- Personnel using respiratory protection.
- Documented exposures above established action levels or airborne concentrations above one-half of the PEL, TLV, or other recognized exposure limit.
- Personnel exhibiting signs or symptoms consistent with exposure to the chemicals with which they are working.
- Medical exams may be requested by the Laboratory Instructor or the CCHO. Medical exams will also be provided, upon request, to personnel exposed to hazardous chemicals as a result of a spill, leak, or explosion.

Medical Exam Criteria and Frequency

Exam Criteria

- Medical exam criteria will be determined by the licensed physician performing the exam.

- Where medical exam guidance exists, such as for OSHA regulated substances, these will be included in the physician's exam.

Exam Frequency

- For examinations resulting from exposures to OSHA regulated substances, the examination frequency will be the period set within the OSHA standard.

- For examinations resulting from potential overexposure to hazardous substances, the examination frequency will be determined by the licensed physician.

- All other examinations required for chemical exposure or protective equipment usage (e.g., respiratory protection) will be annual unless otherwise specified by the examining physician.

Exam Information and Results

- The following information will be provided to the examining physician:

- The identity of the hazardous chemical(s) to which the employee has been or may be exposed.

- A description of the conditions under which the exposure occurred, including surveillance data and accident reports.

- A description of the signs and symptoms of exposure that the employee is experiencing.

Upon completion of the exam, the physician will provide the following reports:

- Fitness for duty determination to the employer and employee, including duty restrictions.

- Recommendations for further examination.

- Results of the examination to the employee.

Periodic Update Examinations

Individuals covered by the laboratory standard receive periodic medical examinations as appropriate for assessing effects from established workplace hazards. The frequency of update examinations may be determined by the regulations governing the particular hazard (e.g., by OSHA for certain hazards), or at the physician's recommendation (including employee concerns).

Non-Routine Consultations and Examinations

Under the Lab Standard, employees are to be provided with the opportunity for medical consultation and examination under the supervision of a licensed physician whenever a chemical overexposure is suspected.

Information to Physician

The Provost or Academic Dean must provide the physician with the following information regarding an overexposure:

- The identity of the chemicals to which the employee may have been exposed.

- A description of the conditions under which the exposure occurred.

- A description of the employee's symptoms.

Physician's Written Opinion

The Provost or Academic Dean must obtain from the physician a written opinion which includes the following:

- Follow-up recommendations.
- Exam and test results.
- Any medical condition found as a result of the exam that may place the employee at an increased risk as a result of hazardous chemical exposure.
- A statement that the employee has been informed by the physician of the results of the consultation.

Emergency Assistance

Medical services are available at all hours by calling 9-911.

Personnel trained in emergency first aid are available during working hours at the Ankeny Campus Nurse's Office @ 964-6352 and pager No. 9-242-1289.

F. HAZARDOUS WASTE MANAGEMENT

Introduction

Des Moines Area Community College recognizes its responsibility to ensure that all campus activities involving hazardous materials and hazardous wastes are conducted in a manner that provide for the safety and security of employees, students, the general public and the environment. Furthermore, the college understands its obligation to conduct these operations in compliance with all applicable local, state and federal regulations.

In order for the college to fulfill these responsibilities and obligations, the specific policies and guidelines in this manual have been developed and implemented to promote the safe management of hazardous materials and hazardous wastes throughout all DMACC operations.

DMACC publishes this manual in an effort to achieve the following objectives:

- Maintain the personal health and safety of college employees and students.
- Assure a safe and healthful work environment for employees and students.
- Protect the environment by applying sound principles of treatment, storage and disposal of hazardous chemicals.
- Minimize the cost to handle and dispose of hazardous chemicals.

The proper management of hazardous chemicals and wastes at DMACC requires a partnership between all the various entities involved, and the specific functions and responsibilities of each are identified later in this manual. Through the cooperative efforts of DMACC faculty and staff and the use of the guidelines presented in this manual, these objectives can be fully accomplished.

This manual was prepared specifically for use by all DMACC departments. Any use of this manual by entities outside DMACC control is not authorized (except by written permission) and no liability is extended to such use.

FUNCTIONS AND RESPONSIBILITIES

The management of hazardous chemical waste in a college setting is complex. The specific functions and responsibilities are as follows:

DMACC

The president of DMACC is ultimately responsible for all health and safety issues. This responsibility is exercised through the normal chain of authority within the college by delegating the charge for ensuring safe work practices and adherence to established policies and guidelines to the Provosts, Vice-Presidents, Academic Deans, Supervisors and ultimately each employee.

DMACC Safety Committee

The DMACC Safety Committee is responsible for the development and implementation of proper management practices for all hazardous chemical wastes and hazardous materials at DMACC. The DMACC Safety Committee will delegate responsibilities for hazardous waste management to Provosts, Academic Deans, Department Heads, faculty and adjunct faculty according to appropriate EPA guidelines. To fulfill this responsibility, the following functions are coordinated by the Safety Committee.

- Develop and implement policies for DMACC.
- Prepare applications for federal, state, and local permits to properly generate and dispose of hazardous chemical waste and other applicable wastes.
- Ensure that college policies and regulatory guidelines regarding the proper disposal of hazardous chemical waste are followed.
- Prepare, submit and maintain records, reports and manifests as required by regulation.
- Design, implement and audit management practices and disposal procedures for chemical waste materials.

Provosts or Academic Deans

The primary responsibility of the Provosts or Academic Deans is to assure that the policies and guidelines established in this manual are strictly followed by all personnel under their jurisdiction.

Individual Employees

It is essential to the success of the DMACC hazardous chemical management program that laboratory/workplace personnel and other individuals who work with hazardous chemicals be conscientious in their efforts to follow the guidelines presented in this manual. Individuals have a responsibility to:

- Collect all chemical wastes in accordance with established guidelines.
- Determine the identity of all unknown or surplus chemicals utilizing the technical knowledge within the department or by having the unknown chemicals tested.
- Package and label all chemicals slated for pickup and disposal in accordance with established guidelines.
- Consult with Physical Plant regarding the safe handling and proper disposal of hazardous chemicals. Contact CCHO with questions or other concerns.

HAZARDOUS WASTE DEFINITION

The complete definition of hazardous waste is contained in the 1976 Resource Conservation and Recovery Act (RCRA), Part 261, Subpart C. The identification of hazardous waste is based on two important premises -- listing and testing characteristics. Listing a substance as hazardous waste is an EPA activity while the testing for a hazardous characteristic is a generator requirement. Questions pertaining to the determination of hazardous characteristics which have not been addressed in this manual should be directed to the DMACC Safety Committee.

Hazard Listing

The EPA may list a waste as hazardous if the agency determines that it causes or contributes to the following:

- Increases mortality.
- Increases serious irreversible illness.
- Increases serious incapacitating reversible illness.

- Is a substantial present or potential hazard to human health or the environment if improperly managed.

A waste may also be listed if it is deemed acutely toxic or acutely hazardous or otherwise toxic by the EPA. The criteria for this listing are as follows:

- Small doses cause human mortality.
- Oral LD50= <50ppm by weight (mg/kg).
- Inhalation LC50 = <2mg/l.
- Dermal LD 50 = <200 mg/kg.
- Contents include a hazardous constituent already listed.

Characteristics

Several characteristics for determining whether or not a waste is hazardous are discussed in RCRA, Part 261, Subpart C. These characteristics include the following: ignitability, corrosivity, reactivity, and toxicity characteristic leaching procedure (TCLP). It should be noted that waste demonstrating any of these characteristics is a hazardous waste whether it is listed or not.

Ignitability:

A waste is ignitable if a representative sample demonstrates the following properties:

- Is a liquid that has a flash point below 60 degrees C (140 degrees F), other than aqueous solutions containing less that 24% alcohol by volume.
- Is a material other than liquid that is capable of spontaneous and sustained combustion under standard temperature and pressure.
- Is an ignitable compressed gas.
- Is an oxidizer.

Corrosivity:

A waste is corrosive if a representative sample under aqueous condition has a pH equal to or less than two or equal to or greater than 12.5.

Reactivity:

A waste is reactive if a representative sample demonstrates any of the following properties:

- Is normally unstable or reacts violently.
- Reacts violently with water.
- Forms explosive mixtures with water.
- Generates toxic gases, vapors or fumes when mixed with water.
- Contains cyanide or sulfide and generates toxic gases, vapors or fumes between pH 2 and 12.5.
- Could detonate if heated under confinement or subjected to strong initiating source.
- Could detonate at standard temperature and pressure.

TCLP (Toxicity Characteristic Leaching Procedure):

A waste demonstrates characteristics of TCLP if a representative sample taken according to prescribed EPA extraction procedure contains a maximum concentration of any of the 39 substances listed in Appendix V- Section C.

COLLECTION CONTAINERS

It is important to use the proper container when collecting hazardous chemicals in the laboratory. A chemical collected in the wrong container could pose a danger to laboratory personnel and college property. The DMACC Chemical Hygiene Committee has established the following guidelines for collecting waste chemicals:

- Use separate screw-top container for each hazardous chemical waste.
- Use an appropriate container size to match the amount of waste generated.
- Use original chemical containers if appropriately sized. Carboys (Nalgene wide-mouth variety), glass bottles and plastic bottles are also acceptable.
- All containers must be compatible with the specific hazardous chemical waste stored in them.
- All hazardous chemical containers must be non-leaking and tightly capped.
- All containers must be identified and appropriately labeled.

HAZARDOUS CHEMICAL WASTE SEGREGATION

Hazardous chemical waste segregation has several advantages: the prevention of unwanted or potentially dangerous reactions, the protection of laboratory and other personnel from potentially unsafe working environments, the ease in handling and disposing of wastes and the reduction of disposal costs. Following are guidelines that have been developed to assist in segregating waste.

- Collect inorganic substances separately and do not mix solids with liquids unless the generation of a process waste is involved.

- Put halogenated and non-halogenated organic solvents in different containers.

- Collect individual non-halogenated organic solvents separately; however, when they must be mixed, clearly indicate each constituent and state its percentage composition in the mixture.

- Recycle vacuum pump oil and do not mix with organic solvents or other chemicals. Indicate on the label and on the manifest, "pump oil known to be contaminated with other chemicals." Call physical plant to arrange for disposal of pump oil.

- Contact physical plant for disposal of labware and equipment contaminated with acutely hazardous or toxic chemicals. Labware includes disposable laboratory items such as gloves, bench-top coverings, pipets, glassware, aprons, etc. As a general rule, clean and triple rinse lab-ware and dispose in the normal trash. Contact physical plant with any questions about proper disposal. Acute hazardous waste and toxic waste are listed in Appendices V Section A & B.

- Do not put empty chemical containers into the normal trash. Properly contain and mark "glass bottles" on the outside of the box prior to disposal in the commercial dumpster. Similarly, box and mark broken laboratory glassware as "broken glass" before disposal in the dumpster.

- Empty compressed gas cylinders should be returned to the vendor that it was purchased from. Many of the large compressed gas cylinders can be refilled. For disposal of compressed gas cylinders, contact the physical plant. Empty containers should also be labeled with an EMPTY tag.

DISPOSAL

Before disposing of chemicals, check the other CCHO's to see if they can use these chemicals.

To initiate disposal, contact the physical plant to arrange for pickup by a waste disposal company. The physical plant should contact other DMACC CCHO's to coordinate other possible disposal pickups. (Do NOT transport hazardous waste chemicals via normal car/truck transportation. Arrange for possible multiple pickups by vendor.)

When waste disposal vendor is contacted, they will supply a manifest form that will require you to supply the following information: (Remember, DO NOT combine any dissimilar waste chemicals.)

LABELING

Appropriate labeling of laboratory material is essential for proper handling and disposal. In laboratory, labeling helps minimize the generation of unknown chemical substances and facilitates better record-keeping. When preparing chemicals for disposal use the following guidelines for labeling:

- Use only permanent labels on chemical containers. No temporary stickers are allowed.
- Use a permanent marker when marking the container directly.
- Use proper chemical or common names in identifying chemical compounds.
- List the active ingredients whenever a tradename or proprietary name must be used. Such information is usually provided on the MSDS or by the chemical manufacturer upon request.
- Do not use chemical formulas, symbols, or structural formulas to identify a chemical for the purpose of disposal.

GENERAL GUIDELINES FOR UNKNOWN CHEMICALS

The process of identifying an unknown chemical can be tedious, and paying for commercial analysis can be cost prohibitive. However, some activities can be done in the laboratory to help identify unknowns and also to prevent them from occurring in the first place. The following guidelines are provided to assist with the problem of unknown chemicals:

- Conduct simple chemical and physical tests to place the substance in some broad chemical category such as organic or inorganic. Consult with the chemistry faculty or your CCHO.

- Exercise caution in opening chemical containers without labels especially if the cap is corroded or disfigured in any way. If unsure, seek assistance.

- Determine from other lab personnel any information that may help to identify the chemical.

ORPHAN REACTION MIXTURES

Like unknown chemicals, laboratory glassware containing reaction mixtures of an unknown nature, and sometime of unknown origin, can present difficult handling and disposal problems. The disposal method for such compounds can be determined in basically the same way as for unknown chemicals.

PREVENTING CHEMICAL UNKNOWNS AND ORPHAN REACTION MIXTURES

Following are suggestions to assist in reducing problems associated with unknown chemicals and orphan reaction mixtures;

- Maintain labels on chemical containers. Replace defaced labels with new ones.

- Institute a periodic review of chemical stock and rotate stock as new chemicals are purchased.

- Maintain accurate records of chemicals in stock. This will help with the identification of any containers with missing labels.

- Require all reaction mixtures stored in laboratory glassware to be labeled with the chemical composition, the date they were formed, the name of the laboratory personnel responsible and a note book reference. This procedure can provide the information necessary to facilitate the disposal of the mixture if the responsible laboratory personnel is not available.

HAZARDOUS WASTE DISPOSAL

The following information is required on each manifest:

- State the chemical name of the substance exactly as it appears on the container. No formulas, symbols or structural formulas are acceptable.
- If the substance is a mixture, properly list all components on the manifest and indicate their percentages.
- Sequentially number containers and list each container individually on the manifest.
- Indicate the quantity of the chemical in each container.
- Provide a contact name, department, campus address and the date of chemical pick up.

SHARPS - PACKAGING AND DISPOSAL

To prevent injury to laboratory, custodial and other personnel, sharps must not be disposed of in the normal trash bin but must be handled in a special manner. Use the following guidelines for proper packaging and disposal of sharps:

- Contain all sharps slated for disposal in special containers designed for this purpose.
- The special containers can be purchased.
- Sterilize all sharps that may pose a potential biohazard to humans prior to packaging for disposal.
- þ Sharps containers ready for disposal should be listed separately on the Hazardous Chemical Manifest. Then notify physical plant for pick up.

G. CHEMICAL SPILL PROCEDURES

Accidental release of chemicals occasionally do occur as a result of spills, leaks, etc. When spills happen, there is a potential for the development of harmful effects depending on the type of chemical involved and the associated hazards. Contingency planning can minimize potential problems. In the event of a spill, use the following procedures; however, they should be customized to meet the needs of individual laboratories and buildings.

- In case of injury or potential exposure, attend to victims immediately. Remove contaminated clothing promptly to reduce contact time with the chemical.

- For acid and base spill contamination: remove contaminated clothing and flush the affected area of the body with water for at least 15 minutes. For solvents: remove contaminated clothing and flush the body with water.

- In all cases seek medical attention:
  For medical emergencies, call 911, (On campus call 9-911).

  Call the local Medical Personnel at the Ankeny Campus Nurse's Office 964-6352 or Pager 9-242-1289.

- Avoid breathing the vapors of spilled material.

- Obtain supplies needed for spill clean up. Each laboratory should purchase and stock a "Spill Clean Up Kit" for this purpose. This can be purchased commercially through a chemical supply vendor. A typical kit includes: 3 pounds of oil-dry, two pairs of neoprene gloves, a copy of spill control guidelines, and two hazardous waste labels. These items maybe packaged in a 5-gallon plastic bucket which serves as the spill debris container.

- Wear the appropriate apparel during clean up such as gloves, lab coats, goggles and/or aprons. Depending on the substance spilled, a respirator may be necessary. Individuals using respirators require special training and medical approval. Call your CCHO for more information.

- Notify your CCHO if a hazardous substance is involved or if additional assistance and information is required.

H. WASTE MINIMIZATION STRATEGIES

One of the primary goals of the Resource Conservation and Recovery Act (RCRA) enacted by congress in 1976 was to reduce the production of hazardous waste. In recent years, the EPA has placed greater emphasis on hazardous waste minimization, and there is reason to believe that activities in this area will intensify in the future. More importantly, however, it is sound practice to manage resources properly.

Waste minimization offers numerous advantages: it conserves the use of chemicals, provides cost savings (both in the purchase and the disposal), reduces the chemical burden in landfills, promotes a cleaner environment, and enhances the safety and health of people. All generators of hazardous waste are encouraged to actively engage in waste minimization activities and to exercise prudence in handling all hazardous materials.

CHEMICAL EXCHANGE AND RE-USE PROGRAM

The Iowa Waste Reduction Center located at Cedar Falls, has established an Iowa Waste Exchange Program with area representatives through-out the state of Iowa. These individuals serve to facilitate the exchange process and assist in locating someone interested in obtaining the specific material. The DMACC representative for this program is located at the Economic Development Group on the Ankeny Campus. Contact phone numbers are listed below:

- Iowa Waste Reduction Center/Iowa Waste Exchange (Cedar Falls)
  800-422-3109.

- Economic Development Group #18/Iowa Waste Exchange Representative.
  For Ankeny, Newton and Urban Areas/Campuses
  515-964-6346.

- Region XII Council of Governments/Iowa Waste Exchange Representative.
  For Boone and Carroll Areas/Campuses
  712-792-1751.

- Illinois Chemical Exchange.

- EDG (Economic Development Group) On DMACC campus - they are setting up a brokering service for waste.

SOURCE REDUCTION

Material Substitution Laboratories should consider material substitution as a means of source reduction. Non-hazardous materials should be substituted for those with hazards whenever possible. Methylene chloride (dichloromethane) is much less toxic than carbon tetrachloride and can be satisfactorily substituted in most cases. There are also several non-hazardous substitutes for the chromic acid solutions used to clean glassware. Other possible substitutions should be investigated or users can contact CCHO for assistance.

Laboratory Practice Modifications Some laboratory procedures can be modified to minimize the amount of waste generated. When possible, teaching laboratories should consider microscale experiments. Down-sizing analytical equipment can also reduce waste.

The use of instrumentation for chemical analysis is another example of practice modification. Instrumental analyses such as gas chromatography, spectroscopy and nuclear magnetic resonance require minute amounts for quantitative determinations as opposed to more traditional wet chemistry techniques. Newer generations of automated equipment can also result in waste reduction over older, less efficient models.

Material Management Practices Laboratory personnel should consider waste minimization and disposal when purchasing chemicals. Buying in large volumes at discount prices is bad practice because the cost of disposing the excess material is greater than any cost savings that might be incurred. Generally, chemicals should only be purchased in the quantities needed for an experiment. Laboratory personnel should be trained to rotate chemical stock and maintain an up-to-date inventory.

Reclamation The DMACC Safety Committee encourages laboratories to seek ways of reclaiming any useful part of their waste stream, from redistillation of some solvents to reclamation of precious metals.

TRAINING

All campuses operating laboratories or generating hazardous waste must train their laboratory personnel on the proper handling of hazardous waste and waste minimization strategies on these campuses. New faculty and staff should be trained in these areas as part of their orientation process.

The CCHO is available to offer assistance, but ultimately the Provosts or Academic Deans are responsible for training. Effective training programs that support the hazardous waste management guidelines will ensure the achievement of the goals set forth in this manual.

1910.1450 Occupational exposure to hazardous chemicals in laboratories.

(Section 1910.1450 was added by 55 FR 3327, Jan. 31, 1990)

(a) Scope and application.

(1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(2) Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

(i) For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

(ii) Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

(iii) Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

(3) This section shall not apply to:

(i) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart 2, even if such use occurs in a laboratory.

(ii) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

(A) Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

(B) Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

(b) Definitions.

"Action level" means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Carcinogen" (see "select carcinogen").

"Chemical Hygiene Officer" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position

description or job classification that the designated individual shall hold within the employer's organizational structure.

"Chemical Hygiene Plan" means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

"Combustible liquid" means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"Compressed gas" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

"Designated area" means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, such as a laboratory hood.

"Emergency" means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

"Employee" means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

"Explosive" means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

"Flammable" means a chemical that falls into one of the following categories:

(i) "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) "Gas, flammable" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) "Liquid, flammable" means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"Flashpoint" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to forma a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"Hazardous chemical" means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

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

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

"Laboratory-type hood" means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

"Laboratory use of hazardous chemicals" means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

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

"Medical consultation" means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

"Organic peroxide" means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

"Oxidizer" means a chemical other than a blasting agent or explosive as defined in 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

"Physical hazard" means a chemical for which there is scientifically valid evidence tat it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

"Protective laboratory practices and equipment" means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

"Reproductive toxins" means chemicals which affect the reproductive chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

"Select carcinogen" means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6 - 7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

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

(C) After oral dosages of less than 50 mg/kg of body weight per day.

"Unstable (reactive)" means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

"Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

(c) Permissible exposure limits.

For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

(d) Employee exposure determination

(1) Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

(2) Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

(3) Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

(4) Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

(e) Chemical hygiene plan.

General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan.)

(1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

(i) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

(ii) Capable of keeping exposures below the limits specified in paragraph (c) of this section.

(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

(i) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

(ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment

and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

(iii) A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

(iv) Provisions for employee information and training as prescribed in paragraph (f) of this section;

(v) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

(vi) Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

(vii) Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and

(viii) Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

(A) Establishment of a designated area;

(B) Use of containment devices such as fume hoods or glove boxes;

(C) Procedures for safe removal of contaminated waste; and

(D) Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

(f) Employee information and training.

(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

(3) Information. Employees shall be informed of:

(i) The contents of this standard and its appendices which shall be made available to employees;

(ii) the location and availability of the employer's Chemical Hygiene Plan;

(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

(iv) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

(v) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

(4) Training.

(i) Employee training shall include:

(A) Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(B) The physical and health hazards of chemicals in the work area; and

(C) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(ii) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

(g) Medical consultation and medical examinations.

(1) The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

(i) Whenever 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.

(ii) Where exposure monitoring reveals an exposure level routinely above the action level (or in the 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.

(iii) Whenever 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.

(2) All 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.

(3) Information provided to the physician. The employer shall provide the following information to the physician:

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

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

(iii) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) Physician's written opinion.

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

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

(C) 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 workplace; and

(D) 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.

(ii) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

(h) Hazard identification.

(1) With respect to labels and material safety data sheets:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

(2) The following provisions shall apply to chemical substances developed in the laboratory:

(i) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

(ii) If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

(iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.120) including the requirements for preparation of material safety data sheets and labeling.

(i) Use of respirators.

Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

j) Recordkeeping.

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

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

(k) Dates

(1) Effective date. This section shall become effective May 1, 1990.

(2) Start-up dates.

(i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

(ii) Paragraph(a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(l) Appendices.

The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.
[For amendment dates see end of appendices]

Appendix A to 1910.1450 - National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

Table of Contents

D. Components of the Chemical Hygiene Plan

1. Basic Rules and Procedures
2. Chemical Procurement, Distribution, and Storage
3. Environmental Monitoring
4. Housekeeping, Maintenance and Inspections
5. Medical Program
6. Personal Protective Apparel and Equipment
7. Records
8. Signs and Labels
9. Spills and Accidents
10. Training and Information
11. Waste Disposal

E. General Procedures for Working With Chemicals

1. General Rules for all Laboratory Work with Chemicals
2. Allergens and Embryotoxins
3. Chemicals of Moderate Chronic or High Acute Toxicity
4. Chemicals of High Chronic Toxicity
5. Animal Work with Chemicals of High Chronic Toxicity

F. Safety Recommendations

G. Material Safety Data Sheets

Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. They were extracted form "Prudent Practices" for Handling Hazardous Chemicals in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW,. Washington DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deal with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical hazards. Therefore, only those recommendations directed primarily toward control of toxic exposures are cited in this appendix, with the term "chemical Hygiene" being substituted for the word "safety". However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given in section F.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs.

Paragraph and topic in laboratory standard	**Relevant appendix section**
(e)(3)(i) Standard operating procedures for handling toxic chemicals.	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposures.	D
(e)(3)(iii) Fume hood performance.	C4b
(e)(3)(iv) Employee information and training (including emergency procedures).	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities.	E2b, E4b
(e)(3)(vi) Medical consultation and medical examinations.	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities.	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances.	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A - D. Those recommendations of primary concern to employees who are actually handling laboratory chemicals are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B-E, "Prudent Practices" expresses certain general principles, including the following:

1. It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2,10). Skin contact with chemicals should be avoided as a cardinal rule (198).

2. Avoid underestimation of risk. Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).

3. Provide adequate ventilation. The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).

4. Institute a chemical hygiene program. A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6,11). Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers (13).

5. Observe the PELs, TLVs. The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels (6, 11, 21) including the:

1. Chief executive officer, who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. Supervisor of the department or other administrative unit, who is responsible for chemical hygiene in that unit (7).

3. chemical hygiene officer(s), whose appointment is essential (7) and who must:

(a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);

(b) Monitor procurement, use, and disposal of chemicals used in the lab (8);

(c) See that appropriate audits are maintained (8);

(d) Help project directors develop precautions and adequate facilities (10);

(e) Know the current legal requirements concerning regulated substances (50); and

(f) Seek ways to improve the chemical hygiene program (8, 11).

4. Laboratory supervisor, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:

(a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);

(b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);

(c) Know the current legal requirements concerning regulated substances (50, 231);

(d) Determine the required levels of protective apparel and equipment (156, 160, 162); and

(e) Ensure that facilities and training for use of any material being ordered are adequate (215).

5. Project director or director of other specific operation, who has primary responsibility for chemical hygiene procedures for that operation (7).

6. Laboratory worker, who is responsible for:

(a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and

(b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. Design. The laboratory facility should have:

(a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);

(b) Adequate, well-ventilated stockrooms/storerooms (218, 219).

(c) Laboratory hoods and sinks (12, 162);

(d) Other safety equipment including eyewash fountains and drench showers (162, 169); and

(e) Arrangements for waste disposal (12, 240).

2. Maintenance. Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continual appraisal and be modified if inadequate (11, 12).

3. Usage. The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially, to the quality of ventilation (13).

4. Ventilation - (a) General laboratory ventilation. This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).

(b) Hoods. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201-206 for a discussion of hood design, construction, and evaluation.

(c) Other local ventilation devices. Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).

(d) Special ventilation areas. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).

(e) Modifications. Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).

(f) Performance. Rate: 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 (194).

(g) Quality. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194, 195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60-100 lfm) (200, 204).

(h) Evaluation. Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

D. Components of the Chemical Hygiene Plan

1. Basic Rules and Procedures (Recommendations for these are given in section E, below)

2. Chemical Procurement, Distribution, and Storage

(a) Procurement. Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved (215, 216). No container should be accepted without an adequate identifying label (216). Preferably, all substances should be received in a central location (216).

(b) Stockrooms/storerooms. Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218-19). Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

(c) Distribution. When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).

(d) Laboratory storage. Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225-6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices (12) or when a highly toxic substance is stored or used regularly (e.g., 3 times/week) (13).

4. Housekeeping, Maintenance, and Inspections

(a) Cleaning. Floors should be cleaned regularly (24).

(b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent personnel changes and semiannually for others; informal inspections should be continual (21).

(c) Maintenance. Eye wash fountains should be inspected at intervals of not less than 3 months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Other safety equipment should be inspected regularly. (e.g., every 3-6 months) (6, 24, 171). Procedures to prevent restarting of out-of-service equipment should be established (25).

(d) Passageways. Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) Compliance with regulations. Regular medical surveillance should be established to the extent required by regulations (12).

(b) Routine surveillance. Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).

(c) First aid. Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby (173). See pp. 176-178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory:

(a) Protective apparel compatible with the required degree of protection for substances being handled (158-161);

(b) An easily accessible drench-type safety shower (162, 169);

(c) An eyewash fountain (162)

(d) A fire extinguisher (162-164);

(e) Respiratory protection (164-9), fire alarm and telephone for emergency use (162) should be available nearby; and

(f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).

(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).

(c) Inventory and usage records for high-risk substances should be kept as specified in sections E3e below.

(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

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

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);

(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);

(c) Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27) and areas where food and beverage consumption and storage are permitted (24); and

(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents

(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).

(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).

(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).

(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program

(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).

(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169).

Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6).

Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).

(d) Frequency of Training: The training and education program should be a regular, continuing activity - not simply an annual presentation (15).

(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. Waste Disposal Program.

(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).

(b) Content (14, 232, 233, 240): The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).

(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27).

Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).

(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241).

Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or adding them to mixed refuse for landfill burial is unacceptable (14).

Hoods should not be used as a means of disposal for volatile chemicals (40, 200).

Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1. General Rules

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

(a) Accidents and spills - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172).

Ingestion: Encourage the victim to drink large amounts of water (178).

Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33).

Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24, 33). See pp. 233-237 for specific clean-up recommendations.

(b) Avoidance of "routine" exposure: Develop and encourage safe habits (23); avoid unnecessary exposure to chemicals by any route (23);

Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199).

Inspect gloves (157) and test glove boxes (208) before use.

Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

(c) Choice of chemicals: Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) Eating, smoking, etc.: Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities (23, 24).

Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

(e) Equipment and glassware: Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (25). Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) Exiting: Wash areas of exposed skin well before leaving the laboratory (23).

(g) Horseplay: Avoid practical jokes or other behavior which might confuse, startle or distract another worker (23).

(h) Mouth suction: Do not use mouth suction for pipeting or starting a siphon (23, 32).

(i) Personal apparel: Confine long hair and loose clothing (23, 158). Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) Personal housekeeping: 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 (24).

(k) Personal protection: Assure that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154).

Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159).

Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169).

Use any other protective and emergency apparel and equipment as appropriate (22, 157-162).

Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155).

Remove laboratory coats immediately on significant contamination (161).

(l) Planning: Seek information and advice about hazards (7), plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation (22, 23).

(m) 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 (27, 128).

(n) Use of hood: Use the hood for operations which might result in release of toxic chemical vapors or dust (198-9).

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 (13).

Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200).

Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).

(o) Vigilance: Be alert to unsafe conditions and see that they are corrected when detected (22).

(p) Waste disposal: Assure that the plan for each laboratory operation includes plans and training for waste disposal (230).

Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24).

Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); 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 (242).

(q) Working alone: Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Working with Allergens and Embryotoxins

(a) Allergens (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).

(b) Embryotoxins (34-5) (examples: 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.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisopropylfluorophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).

Supplemental rules to be followed in addition to those mentioned above (Procedure B of "Prudent Practices", pp. 39-41):

(a) Aim: To minimize exposure to these toxic substances by any route using all reasonable precautions (39).

(b) Applicability: These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).

(c) Location: Use and store these substances only in areas of restricted access with special warning signs (40, 229).

Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the

generation of aerosols or vapors containing the substance (39); trap released vapors to revent their discharge with the hood exhaust (40).

(d) Personal protection: Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate) (39). Always wash hands and arms immediately after working with these materials (40).

(e) Records: Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).

(f) Prevention of spills and accidents: Be prepared for accidents and spills (41).

Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39).

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 (40).

If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) Waste: Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40).

Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

(Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances with high carcinogenic potency in animals (38).)

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) (47). (Procedure A of "Prudent Practices" pp. 47-50).

(a) Access: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substances being used and necessary precautions (48).

(b) Approvals: Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).

(c) Non-contamination/Decontamination: Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50).

Decontaminate the controlled area before normal work is resumed there (50).

(d) Exiting: On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).

(e) 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 (50).

(f) Medical surveillance: If using toxicologically significant quantities of such a substance on a regular basis (e.g., 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).

(g) Records: Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).

(h) Signs and labels: Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled with identity and warning labels (48).

(i) Spills: Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233-4).

(j) Storage: Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).

(k) Glove boxes: For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood (49).

(l) 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 (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity

(a) Access: For large scale studies, special facilities with restricted access are preferable (56).

(b) 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 (56).

(c) 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) (55, 56).

(d) 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) (56).

(e) Waste disposal: Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products (238); otherwise, package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page

references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6) 2. Electrically powered laboratory apparatus: (179-92) 3. Fires, explosions: (26, 57-74, 162-64, 174-5, 219-20, 226-7) 4. Low temperature procedures: (26, 88) 5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)

G. Material Safety Data Sheets

Material safety data sheets are presented in "Prudent Practices" for the chemicals listed below. (Asterisks denote that comprehensive material safety data sheets are provided).

*Acetyl peroxide (105)
*Acrolein (106)
*Acrylonitrile
Ammonia (anhydrous)(91)
*Aniline (109)
*Benzene (110)
*Benzo[a]pyrene (112)
*Bis(chloromethyl) ether (113)
Boron trichloride (91)
Boron trifluoride (92)
Bromine (114)
*Tert-butyl hydroperoxide (148)
*Carbon disulfide (116)
Carbon monoxide (92)
*Carbon tetrachloride (118)
*Chlorine (119)

Chlorine trifluoride (94)
*Chloroform (121)
Chloromethane (93)
*Diethyl ether (122)
Diisopropyl fluorophosphate (41)
*Dimethylformamide (123)
*Dimethyl sulfate (125)
*Dioxane (126)
*Ethylene dibromide (128)
*Fluorine (95)
*Formaldehyde (130)
*Hydrazine and salts (132)
Hydrofluoric acid (43)
Hydrogen bromide (98)
Hydrogen chloride (98)
*Hydrogen cyanide (133)
*Hydrogen sulfide (135)
Mercury and compounds (52)
*Methanol (137)
*Morpholine (138)
*Nickel carbonyl (99)
*Nitrobenzene (139)
Nitrogen dioxide (100)
N-nitrosodiethylamine (54)
*Peracetic acid (141)
*Phenol (142)
*Phosgene (143)
*Pyridine (144)
*Sodium azide (145)
*Sodium cyanide (147)
Sulfur dioxide (101)
*Trichloroethylene (149)
*Vinyl chloride (150)

Appendix B to 1910.1450 - References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory. (a) Materials for the development of the Chemical Hygiene Plan:

1. American Chemical Society, Safety in Academic Chemistry Laboratories, 4th edition, 1985.
2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.
3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL, 1978.
4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing Co., NY, 1978.
5. Kaufman, James A., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.
6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.
7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.

8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, DC, 1981.
9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, J. Chem. Ed., American Chemical Society, Easlon, PA, 1981.
10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA, 18042, Vol.I, 1967, Vol. II, 1971, Vol. III, 1974.
11. Steere, Norman V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.
12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.
(b) Hazardous Substances Information:
1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438 (latest edition).
2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.
4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.

5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.
6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).
7. IARC Monographs on the Evaluation of the Carcinogenic Risk of chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).
8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).
9. Occupational Health Guidelines, NIOSH/OSHA. NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.
10. Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes).
11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of documents US. Govt. Printing Office, Washington, DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.
14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications. Park Ridge, NJ, 1981.
(c) Information on Ventilation:
1. American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.
2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y. 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.
4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.
Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.
Fire Protection Guide on Hazardous Materials, 7th edition, 1978.
National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF7-1980, 1101 16th Street, NW., Washington, DC 20036.
(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.
2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.
[55 FR 3327, Jan. 31, 1990; 61 FR 5507, Feb. 13, 1996]

F:\MSOFFICE\WOLFF\TRAINING\CHEM-HYG\lab-std-electronic.doc

LABORATORY HOOD MANUAL

Des Moines Area Community College
Ankeny, Ia.

TABLE OF CONTENTS

I. INTRODUCTION

Laboratory fume hoods are designed to protect laboratory personnel by preventing contaminants such as chemical vapors, dusts, mists and fumes from escaping into the laboratory environment. Laboratory fume hoods also provide lab personnel with a physical barrier to chemicals and their reactions. Fume hoods are evaluated each year to verify their proper operation.

The purpose of this manual is to provide information regarding:

- How to obtain fume hood service
- The safe use of fume hoods
- Fume hood performance criteria

A glossary of terms used in this manual is provided in Appendix A.

All fume hood installations should comply with the most recent edition of Industrial Ventilation published by the American Conference of Governmental Industrial Hygienists (ACGIH), the American National Standard for Laboratory Ventilation (ANSI Z9.5-1992), the Uniform Mechanical Code, as well as applicable American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standards, and the National Fire Protection Association (NFPA) codes, particularly NFPA 91 (Blower and Exhaust Systems), and NFPA 45 (Fire Protection for Laboratories Using Chemicals). Where necessary, fume hood testing should conform to ASHRAE 110, “Methods of Testing Performance of Laboratory Fume Hoods.”

II. FUME HOOD SERVICE

Fume hood service is provided by DMACC Physical Plant. If you suspect your hood is not performing adequately or requires service, call the Physical Plant @ 964-6257.

Fume Hood Service Provided by Physical Plant

DMACC staff are committed to promoting safe work environments. DMACC inspects fume hoods annually and upon request. Laboratory fume hood inspections include:

Visual Inspection - including airflow indicating alarms where present. DMACC will reset alarms when necessary.

Smoke Trace - smoke is generated to verify contaminant capture at sash periphery.

Face Velocity - average face velocity is determined using a calibrated thermoanemometer (with sash set at maximum level indicated by arrows on sash, typically 18").

Certification - a certification card located on the front panel of every fume hood is updated with results of the visual inspection, smoke test and velocity measurement. Fume hoods which do not pass inspection will be tagged with a warning that details unsatisfactory condition(s).

Service - If your fume hood requires service, or if you wish to install, move, or upgrade a fume hood (including installing an airflow alarm), call the Physical Plant.

III. LABORATORY FUME HOOD SAFE WORK PRACTICES

Safe work practices for conventional, perchloric and radioisotope fume hoods are described in this section. Conventional fume hood practices also apply to perchloric acid and radioisotope fume hoods.

Conventional Chemical Fume Hoods

Each DMACC employee is expected to promote safety in the workplace and practice safe work procedures. Fume hood users should be able to answer the following questions before using a fume hood:

1. **Has DMACC certified your hood within the last year?**
   Check the certification card on the front panel of each hood.

2. **Is the hood face velocity adequate?**
   Check the certification card posted on the face of the fume hood for the most recent evaluation data. If an airflow alarm is installed, check for alarm light. Check to see that the audible alarm has not been disabled. If an alarm is not installed, check for airflow with a paper strip hung from the bottom of the hood sash. Do not rely on noise from the fume hood to indicate proper operation (blower motor noise may persist even if a fan belt breaks). See also Sash Height and Face Velocity in Section IV - Fume Hood Performance and Condition Criteria.

3. **Is the work six inches back from the sash?**
   Setting work back six inches from the plane of the sash reduces influence of drafts from people, doors, air supply diffusers, etc.

4. **Is housekeeping good?**
   Materials (supplies, equipment, etc.) in the fume hood typically reduce hood efficiency. Therefore, it is prudent to remove all materials not required for the task at hand.

5. **Does the sash slide easily?**
   The fume hood safety-glass sash protects the user in case of fire or explosion as well as from fumes during routine operations. A sash that is difficult to move will not likely be set at optimal working heights.

6. **Is the sash at the proper height?**
   The fume hood sash should be kept at or below the "keep sash below this level" sticker on each hood (see Figure 4). If your hood does not have this sticker, please call the Physical Plant. Sash openings of less than 12 inches may cause undesirable drafts in the fume hood.

7. What do I do if a fire occurs in my hood?

Be certain you know where your fire extinguishing equipment is located and that it is appropriate for the materials being used. Dial 911 if you are not confident that you can safely extinguish a fire.

8. Is the fume hood baffle properly set?

Some fume hoods have multiple baffle settings. Under most conditions, your fume hood will be most effective set in the "average" or "heavier than air" positions. The "lighter than air" setting should be used only for hot operations or when fumes are known to be less dense than air. Figure 1 illustrates common baffle locations.

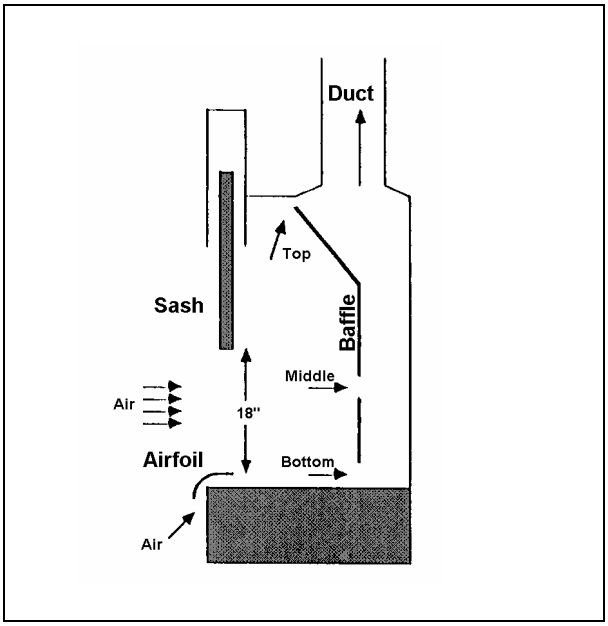

Figure 1. Common Baffle Locations

Other Prudent Fume Hood Practices

Other prudent practices relating to laboratory fume hood usage are listed below. These items should be reviewed by all DMACC personnel **prior to** using fume hoods.

- Do not put your head in the hood when contaminants are being generated.

- Hoods should not be routinely used as a waste disposal mechanism for volatile materials. If a flammable storage cabinet is not available, the hood may be used to store volatile waste waiting to be picked up by Physical Plant. The volatile waste must be in proper containers, closed and have proper labeling.

- Do not store chemicals or apparatus in the hood. Store hazardous chemicals in an approved safety cabinet.

- Place any heat generating equipment in the rear of the hood to minimize the effect of convection currents on the airflow in the hood.

- Keep the slots in the hood baffle free of obstruction by apparatus or containers.

- Place large apparatus to the rear of the hood and raise it off the surface with two to three inch blocks to allow airflow under the object and into the lower rear baffle.

- Minimize foot traffic past the face of the hood.

- Keep laboratory doors and windows closed.

- Do not position fans or air conditioners in a manner that will direct airflow across the face of the hood and interfere with containment.

- Do not block air supply vents or exhausts in the room.

- Do not remove the hood sash or panels except when necessary for apparatus setup. Replace sash or panels before operating.

- Do not place electrical receptacles or other spark sources inside the hood when flammable liquids or gases are present. No permanent electrical receptacles are permitted in the hood unless approved by the manufacturer.

Perchloric Acid Hoods

In addition to the prudent practices for standard fume hoods, the following additional procedures should be implemented when using perchloric acid:

1. **Use perchloric acid only in perchloric acid hoods.**
   Perchloric acid salts are unstable and may explode with impact. Primarily for this reason, perchloric acid may not be used in standard fume hoods, which lack automatic wash down systems. Any exceptions to this should be approved by DMACC Chemical Hygiene Officer.

2. **Use perchloric acid hoods exclusively for perchlorate work.**
   Never use organic materials in a hood designed specifically for perchloric acid. Perchlorates are considered to be fire and explosive hazards when associated with carbonaceous material or finely divided metals. They react violently with benzene, charcoal, olefins, ethanol, sulfuric acid and reducing materials. If perchlorates have accumulated in the perchloric acid fume hood, use of organics may create fire and explosion hazards.

3. **Use the perchloric acid hood water wash down regularly, preferably after each use.**
   Inspect hood for any salts that may accumulate (even where automatic wash down is employed). Remove deposits with water.

4. **Do not leave unnecessary organic materials in hood.**
   Fires and explosions may occur when perchloric acid contacts rags, sawdust, alcohol, cellulose, etc.

5. **Be particularly cautious when using perchloric acid with strong dehydrating agents, for example, acetic anhydride or sulfuric acid.**
   Under some conditions, particularly when using hot, concentrated materials, these agents may form dangerously explosive anhydrous perchloric acid.

6. **Apparatus used in perchloric hoods should be free of organic coatings and lubricants.**

7. **Spark producing apparatus (including electrical outlets) should not be used inside a perchloric acid hood.**

8. **Before maintenance on hood baffle, duct, fan, or other hood system components, have the CCHO check for presence of perchlorates.**

9. **Perchlorate hoods, ductwork and fans should be labeled with caution labels.**

10. **Use no more perchloric acid than necessary.**

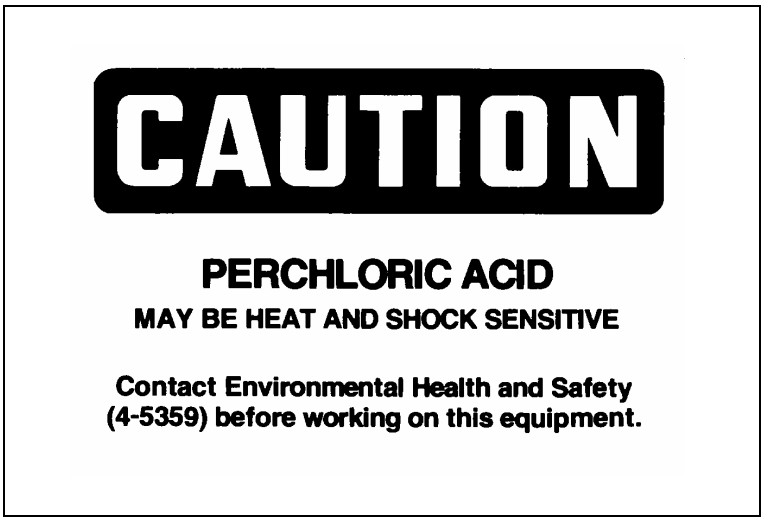

Figure 2. Perchloric Acid Caution Sticker

Radioisotope Hoods

Along with the work practices for standard fume hoods, the following additional procedures should be implemented when using radioisotope hoods:

Use radioisotopes only in hoods designed for that purpose.
DMACC recommends radioisotope hoods have stainless steel interior surfaces.

IV. FUME HOOD PERFORMANCE AND CONDITION CRITERIA

This section describes the operating performance criteria (primarily sash height and airflow face velocity) and physical condition criteria DMACC has established for laboratory fume hoods. In addition, several other factors may affect the operating performance of laboratory hoods such as the location of the hood in the lab, make-up air, weather conditions outside, etc.

Sash Height and Face Velocity

All laboratory hoods on campus have been labeled with a colored arrow sticker (Figure 4) indicating the maximum safe sash height for the hood. The sash should not be raised above this height because it may compromise the safety of lab personnel. The color of the arrow sticker corresponds to a hazard rating system for recommended face velocities (See Figure 4 - Sash Height Arrow Stickers and Figure 6 - Hazard Rating System).

DMACC fume hood policy dictates that:

- Where possible, face velocity will be set at 100 feet per minute (fpm) with sash at 18".
- Fume hoods with face velocities less than 100 fpm and greater than 60 fpm (measured using an 18” sash height) should be serviced but may be used with extreme caution (including maintaining the sash height at 12” or less) until servicing has been completed.
- Fume hoods with face velocities below 60 fpm at 18" sash height should not be used until repairs are made and the Physical Plant confirms acceptable face velocities.

It is important to remember that face velocity is not the only factor contributing to hood performance. Work practices and make-up air also affect performance.

Fume hoods will be inspected and certified by Physical Plant personnel at least annually. If it is suspected that a laboratory hood is not operating properly, the Physical Plant will perform an inspection on request. When the inspection is complete, the two-sided certification card (located on the face of every fume hood) is updated. The front of this card is reproduced as Figure 5. A hazard rating is determined by the average face velocity of the hood. Only materials that are within the limits of that rating should be used in the hood. The hazard rating scheme is printed on the back of the certification card and is reproduced as Figure 6.

Laboratory hood face velocity should be about 100 feet per minute (fpm) at the highest working sash height which is marked with a colored arrow sticker. Working sash height should be no higher than 18” and generally no lower than 12”. Face velocity may be as low as 60 fpm or as high as 150 fpm depending on the chemicals used in the hood. There should be less than +/-10% variation in point-to-point velocity with the sash in any given position.

Higher face velocities do not necessarily offer more protection. They can result in decreased protection due to turbulence around the worker's body causing the release of contaminants from the hood. Generally, face velocities in excess of 150 fpm should be reduced.

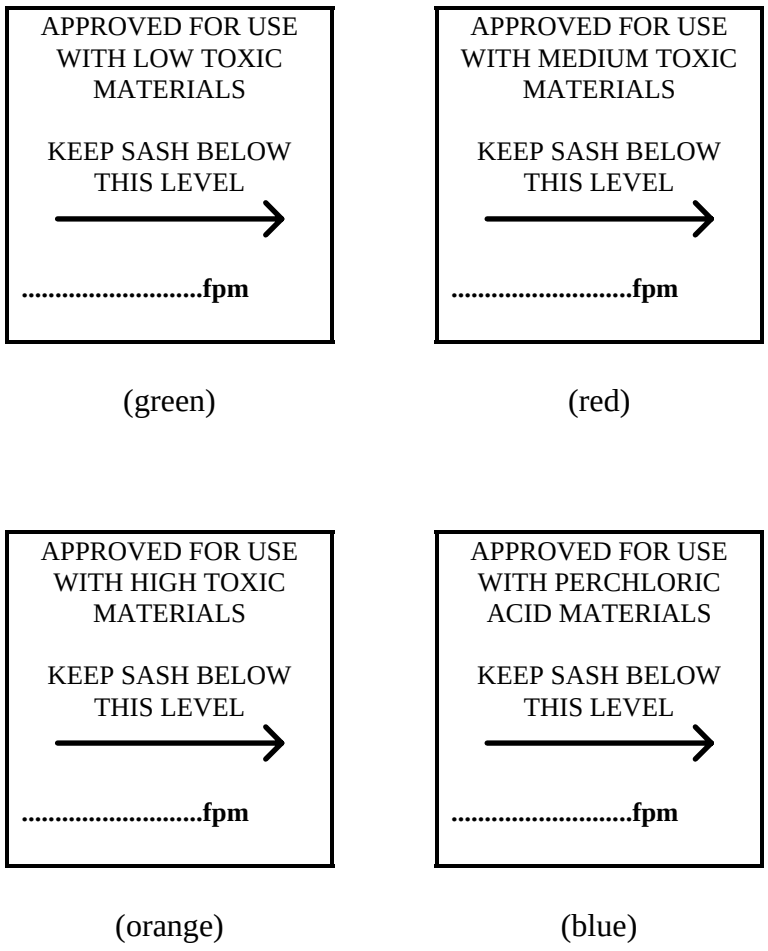

Figure 4. Sash Height Arrow Stickers

DMACC Environmental Health and Safety

LABORATORY HOOD CERTIFICATION

Building _____ Room _____ Fan Location _____ Exhaust No. _____

Date	Average Face Velocity	Rating	Sash* Height	Smoke Trace	Inspector's Initials	Remarks
7/7/96	90fpm	medium	18"	passed	S.T.	

(See back for rating)

***SET SASH TO MATCH ARROW ON HOOD FRAME**

Figure 5. Laboratory Fume Hood Certification Card (front)

Recommended Face Velocities (measured with sash at 18")		
Rating	**Appropriate Chemicals**	**Face Velocity**
LOW (green label)	**Combustibles; irritants**	**60-75 fpm**
MEDIUM (red label)	**Common lab chemicals; toxic vapors; flammables; radioisotopes**	**75-100 fpm**
HIGH (orange label)	**OSHA specific standards; special requirements**	**100-150 fpm**
PERCHLORIC ACID (blue label)	**Perchloric Acid**	**125-150fpm**

Figure 6. Laboratory Fume Hood Certification Card (back)

Location

The location of the laboratory hood with respect to the rest of the laboratory furniture and equipment has a direct influence on the performance of the hood. Laboratory hoods should be located away from the following:

- A single means of access to an exit or high pedestrian traffic areas (because of fire and explosion hazards).
- Operable windows and doors due to cross drafts (especially if the door swings away from the hood).
- Disruptive air supply to the room.
- The face of another hood positioned directly across an aisle.

Ideally, hoods should be located at the rear of a laboratory where they can be isolated from the rest of the lab. The best location for a laboratory hood is shown in Figure 7.

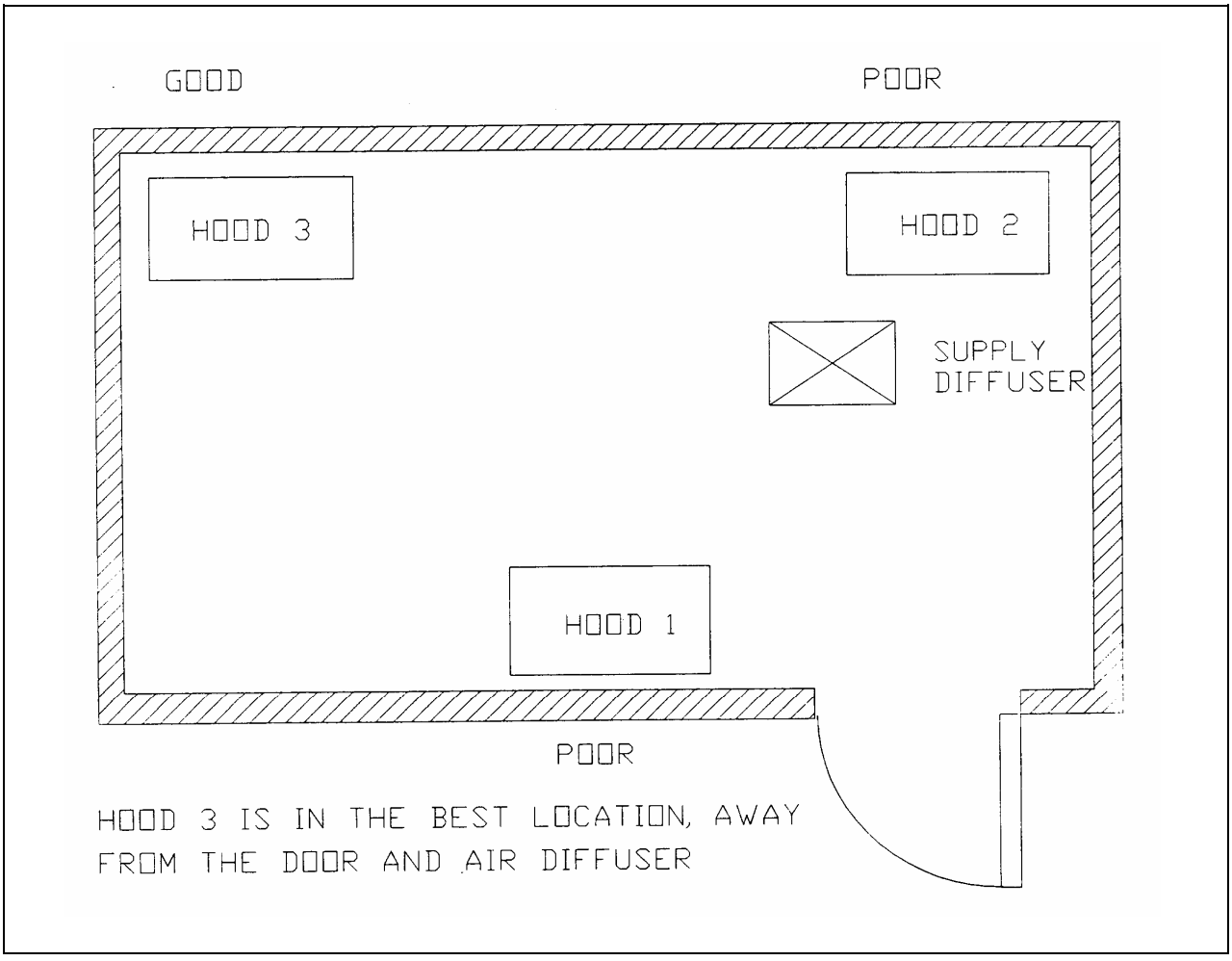

Figure 7. Proper Laboratory Hood Location

Laboratory Supply Air

Make-up or supply air has a significant effect on hood performance. Different types of supply systems have different requirements for supplying air to the lab without detracting from the performance of the laboratory hood. Some recommendations for supply air systems include the following:

- Perforated ceiling panels provide a better supply system than wall grilles or ceiling diffusers, and permit a greater concentration of hoods in a lab. Panel supply air velocity should be no more than 2/3's of the operating hood face velocity.

- Ceiling diffusers should not be located immediately in front of the hood face. Deflecting supply air from the quadrant of the diffuser blowing at the hood face should result in better hood performance. Terminal throw velocity at the exit vane of the diffuser should be 0.5 to 0.7 of the hood face velocity.

- Wall grilles or registers are not recommended by ACGIH (American Conference of Governmental Industrial Hygienists) for new facilities. However, in existing facilities, the wall grilles should have double deflection louvers set for maximum deflection.

Other Fume Hood Criteria

Other fume hood criteria and conditions such as a broken or difficult to operate sash, excessively turbulent hood airflow, and excessive equipment and supplies in the fume hood may also affect fume hood performance. These items will be noted during a hood evaluation and cited on DMACC's "WARNING" sheet for corrective action (See Figure 8).

Substandard Performance and Operating Criteria

When a fume hood does not meet regulatory or generally accepted performance or condition criteria, the hood will be tagged with a (yellow) "WARNING" sheet explaining the problem. This sheet will indicate whether or not the hood may be used prior to servicing (See Figure 8).

WARNING

This Hood Does Not Meet Minimum Performance Requirements.

_____ This hood may be used with extreme caution prior to servicing.
_____ This hood must not be used until service is complete.

To have a hood serviced contact Physical Plant 964-6257

Identified Problems:

_____ Improper airflow - refer to evaluation card
_____ Broken sash glass
_____ Sash difficult to operate or sash cable is broken
_____ Turbulence
_____ Equipment/items in hood blocking airflow
_____ Alarm inoperable (if applicable)
_____ Other _____

	Activity	**Signature**	**Date**
Lab Personnel	Contacted Physical Plant for Service	_____	_____
Mechanic	Fume Hood Serviced Certified	_____	_____

This sheet will be removed by Physical Plant after corrections have been made and the hood has been re-tested.

Figure 8. Minimum Performance Warning

APPENDIX A

GLOSSARY

Auxiliary Air - supply or supplemental air delivered near the outside face of a laboratory hood to reduce room air consumption.

Baffle - a panel or panels located at the rear of the hood interior that aid in distributing the flow pattern of air moving into and through the hood.

Bypass - an airflow-compensating opening that maintains a relatively constant volume exhaust through a laboratory hood regardless of the sash position and that functions to limit the maximum face velocity as the sash is lowered.

Canopy Hood - a suspended ventilating device used only to exhaust heat, water vapor, odors and other non-hazardous materials. This is not a laboratory hood and generally is not effective for exhausting toxic or flammable materials.

Capture Hood - a ventilating device that can be positioned to pull in contaminants that are produced outside of the hood. A sufficient velocity called the capture velocity is necessary to "grab" the contaminant and move it into the hood. They are generally used in welding and grinding operations.

Capture Velocity - the air velocity at the hood face necessary to overcome opposing air currents, and to contain contaminated air within the laboratory hood.

Damper - device installed in a duct to control airflow volume.

Deflector Vane - an airfoil-shaped vane along the bottom of the hood face which directs incoming air across the work surface to the lower baffle opening. The opening between the work surface and the deflector vane is open even with the sash fully open.

Ductless Hoods- hoods that pass air from the hood interior through an absorption filter and then discharge the air into the laboratory. They are only suitable for use with nuisance vapors and dusts that do not present a fire or toxicity hazard. This type of hood has very limited uses and needs specific approval by the Physical Plant.

Face Opening - the hood opening or the plane of the inside surface of the sash. This area is used to calculate the square footage of the hood opening, and face velocity is measured in this plane.

Face Velocity - the rate of flow or velocity of air moving into the laboratory hood entrance or face, usually expressed in feet per minute (fpm).

Glove Box - enclosure used to confine and contain hazardous materials with operator access by means of gloved portals or other limited openings; this enclosure is not a laboratory hood.

Hood Interior - the volume enclosed by the side, back, and top enclosure panels, the work surface, the access opening (called the face), the sash or sashes, and the exhaust plenum, including the baffle system for airflow distribution.

Laboratory Hood - a ventilated, enclosed work space intended to capture, contain, and exhaust fumes, vapors, and particulate matter generated inside the enclosure. It consists basically of side, back, and top enclosure panels, a work surface or counter top, an access opening called the face, a sash, and an exhaust plenum equipped with a baffle system for the regulation of air flow distribution. Laminar flow cabinets and biological safety cabinets are not laboratory hoods.

Make-Up-Air - air needed to replace the air taken from the room by laboratory hood(s) and other air exhausting devices.

Sash - a movable, transparent panel or panels set in the hood entrance used to form a protective shield and to control the face velocity.

Variable Air Volume (VAV) Hood- a hood that maintains constant face velocity regardless of sash position. Constant face velocity is maintained by means of a sensory device, either a hot-wire anemometer or a sash position sensor.

Walk-in Hood - enclosure hood that is designed with openings from floor to ceiling to accommodate large equipment.

APPENDIX B

OTHER HOOD TYPES

Hood Types

Exhaust hoods can be grouped into three main types: enclosure, capture and receiving. Enclosure hoods surround the point of emission either completely or partially. Laboratory fume hoods are a common type of enclosure hood and are the focus of the main part of this manual. Capture hoods "grab" air contaminants that are generated from a point outside the hood. Receiving hoods exhaust materials that are "directed" into the hood. These three types of hoods are illustrated in Figure B-1.

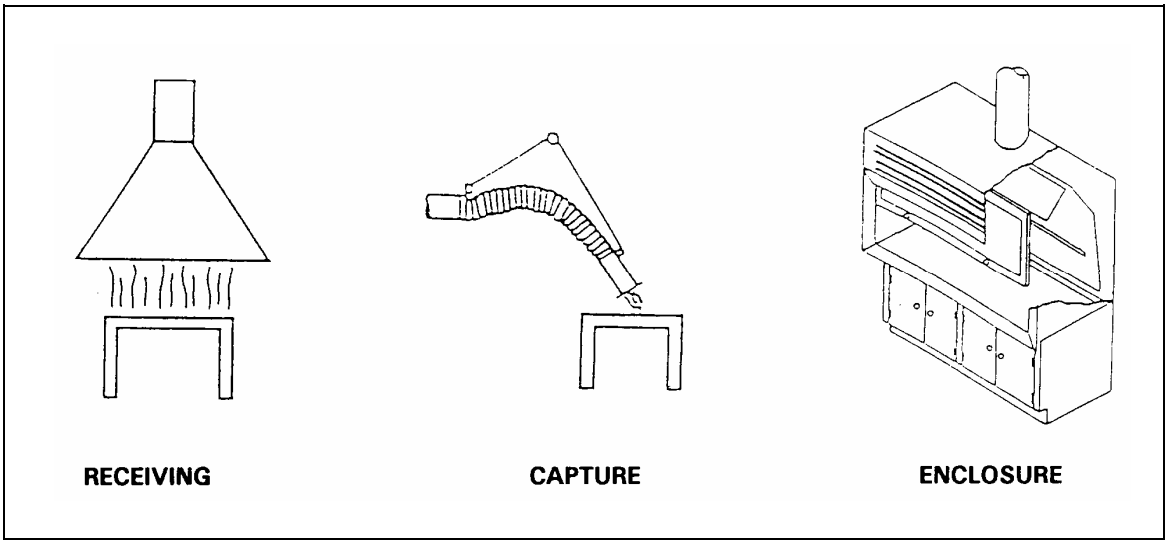

Figure B-1. Types of Hoods

Ductless Hoods -Ductless hoods are another type of enclosure hood. Ductless hoods pass air from the hood interior through an absorption filter and then discharge the air into the laboratory. These types of hoods are only suitable for use with nuisance vapors and dusts that do not present fire or toxicity hazards. These types of hood have very specific uses and need approval from the Physical Plant.

Capture Hood - Capture hoods are ventilating devices that can be positioned to pull in contaminants that are produced outside of a hood. A sufficient velocity called the capture velocity is necessary to "grab" the contaminant and move it into the hood. They are generally used in welding and grinding operations. An example of a capture hood would be a snorkel hood used to ventilate a welding bench. Appropriate capture velocities for different conditions of use are listed in Appendix C.

Plans for capture type hoods are reviewed by the Physical Plant. Contact the Physiacl Plant (964-6257) when selecting this type of hood.

Receiving Hood - Receiving hoods are devices generally used to exhaust heat, water vapor, odors and other non-hazardous materials. They are not a laboratory hood and generally are not effective for exhausting toxic or flammable materials.

Biological Safety Cabinet - Biological safety cabinets are special safety enclosures used to handle and contain pathogenic microorganisms or chemotherapeutic agents. Biological safety cabinets are **not** laboratory fume hoods. Biological safety cabinets provide protection for the product and also protect laboratory personnel by utilizing vertical airflow. Most biological safety cabinets in use at ISU are Class II Type A or Type B3. These cabinets recirculate approximately 70% of the exhaust air back into the cabinet's work area. Type B2 cabinets exhaust 100% of the air and are always hard ducted to the outside. Type B2 cabinets may provide protection for limited amounts of chemical usage, provided they are constructed of suitable materials, are properly maintained to ensure containment and will meet the requirements of this manual. Figure B-2 shows a typical biological safety cabinet. When purchasing a biological safety cabinet, contact the Physical Plant (964-6257) for assistance in choosing the appropriate type for your work.

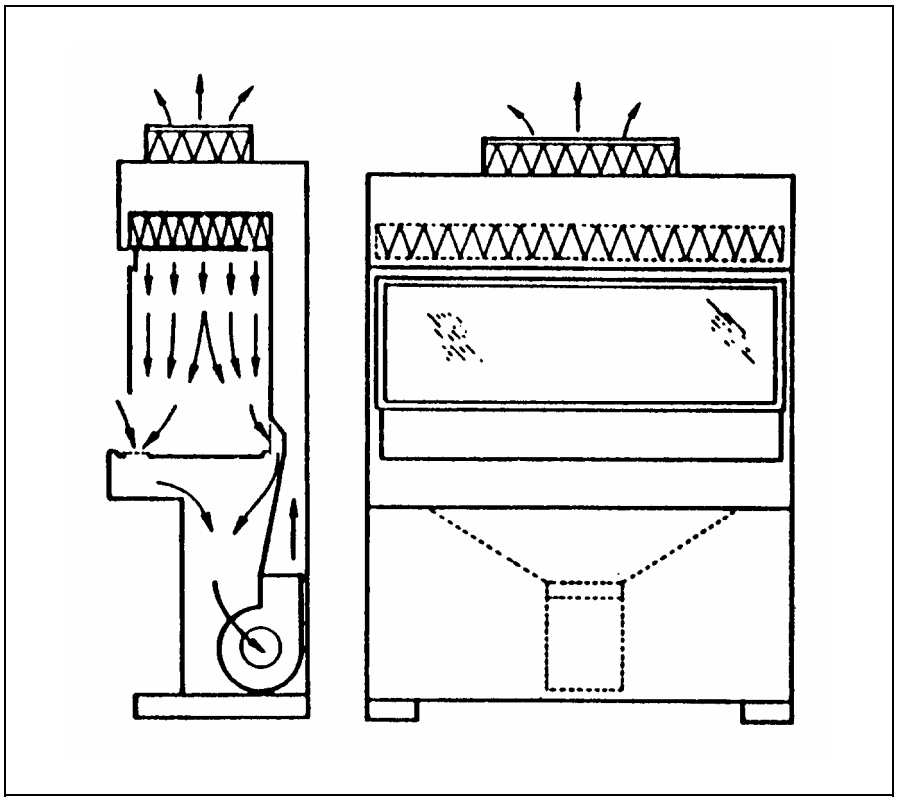

Figure B-2. Biological Safety Cabinet

Laminar Flow Cabinet - Laminar flow cabinets (or “clean benches”) are ventilated, partially enclosed cabinets primarily intended to provide "clean" airflow over the work surface by use of laminar airflow methods. This "clean" airflow provides protection for the product. Laminar flow cabinets do not provide protection for laboratory personnel and should not be used for storage or manipulation of infectious or toxic materials. Infectious or toxic materials should be handled in biological safety cabinets so that both product and employee safety needs are met. Laminar flow cabinets are **not** laboratory fume hoods and should not be subject to extensive chemical usage. A laminar flow cabinet is shown in Figure B-3.

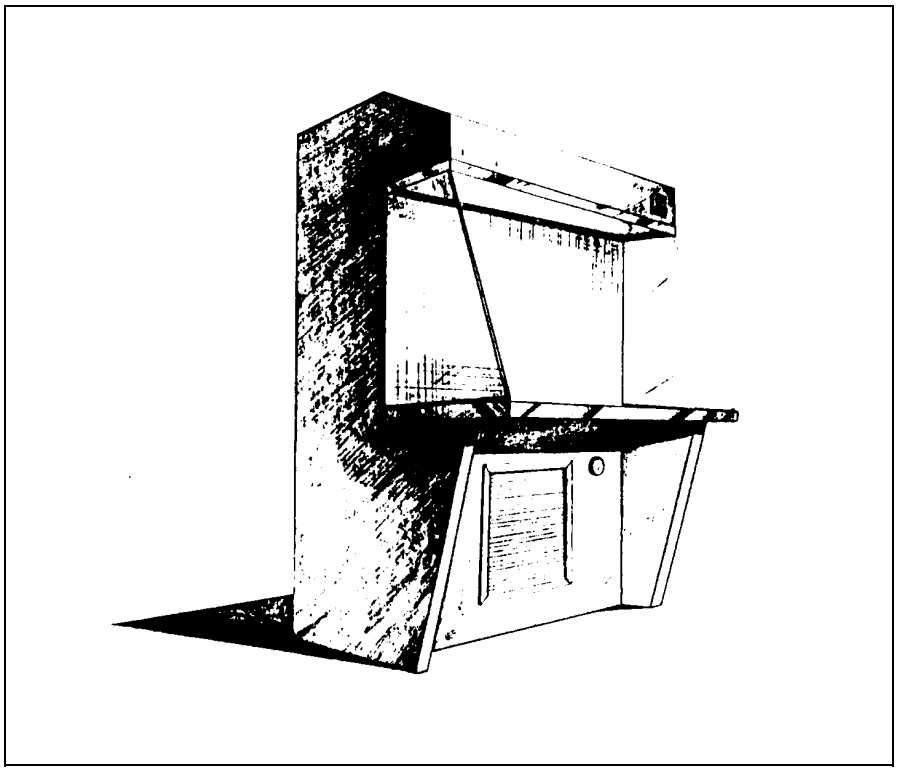

Figure B-3. Laminar Flow Cabinet

APPENDIX C

ACCEPTABLE RANGE OF HOOD CAPTURE VELOCITIES

RANGE OF HOOD CAPTURE VELOCITIES

Condition of Contaminant Dispersion	Example	Velocity (feet/minute)
Released with practically no velocity into quiet air	Evaporation from tanks; degreasing; etc.	50-100
Released at low velocity into moderately still air	Spray booths; intermittent container filling; low speed conveyor transfers; welding; plating; pickling	100-200
Active generation into zone of rapid air motion	Spray painting in shallow booths; barrel filling; conveyor loading; crushers	200-500
Released at high initial velocity into zone of very rapid air motion	Grinding; abrasive blasting; tumbling	500-2000

In each category above, a range of capture velocities is shown. The proper choice of values depends on several factors:

Lower End of Range	Upper End of Range
Room air currents minimal or favorable to capture	Disturbing room air currents
Contaminants of low toxicity or of nuisance value	Contaminants of high toxicity
Intermittent, low production	High production, heavy use
Large hood-large air mass in motion	Small hood-local control only

APPENDIX III

Material Safety Data Sheets

Material Safety Data Sheets (MSDS's) are information sheets required by OSHA for hazardous substances (chemicals). The Iowa Hazardous Chemical Risks Right to Know Standard (Iowa Administrative Code Section 347, Chapters 110-140) requires that employers (e.g., DMACC) make MSDS's "readily accessible" for any hazardous chemical in the workplace and states that employers must ensure that employees are made aware of MSDS content and locations. It is therefore a regulatory requirement that each DMACC workplace (including laboratories) maintain MSDS's for hazardous chemicals in their inventory. At this time, OSHA and the State of Iowa have determined that MSDS's available electronically (e.g., on the world wide web) may not meet the "readily accessible" criteria. DMACC suggests that each laboratory maintain paper copies of necessary MSDS's.

The Physical Plant maintains the DMACC central MSDS library (located in building #12) which may be accessed during normal work hours (8:00 a.m. to 5:00 p.m.) by all DMACC employees. Also, other locations of MSDS's are Building #3, Academic Dean's Office and Building #4, Room 6. DMACC also maintains an electronic index of MSDS's available on the Physical Plant PC's. Contact the Physical Plant (964-6253) or Security (6500) to obtain information regarding access to this index system.

When departments receive MSDS's for new chemicals, they must make copies and send them to the Physical Plant, then place the original MSDS's in the department's designated area. NOTE: Manufacturers and distributors must provide MSDS's to the department/consignee (only) at time of initial shipment.

Sample Explanation and Glossary of a Material Safety Data Sheet

OSHA specifies the information to be included on an MSDS, but does not prescribe the precise format for an MSDS. A non-mandatory MSDS form (OSHA Form 174) that meets the Hazard Communication Standard requirements has been issued and can be used as is or expanded as needed. A copy of Form 174 is provided in this appendix. Some MSDS's may look substantially different because the order and format of information is not mandatory. Nonetheless, the same information should be included. The MSDS must be in English and must include at least the following information:

Section I. Chemical Identity

The chemical and common name(s) must be provided for single chemical substances. An identity on the MSDS must be cross-referenced to the identity found on the label.

Section II. Hazardous Ingredients

For a hazardous chemical mixture that has been tested as a whole to determine its hazards, the chemical and common names of ingredients that are associated with the hazards, and the common name of the mixture must be listed. If the chemical is a mixture that has not been tested as a whole, the chemical and common names of all ingredients determined to be health hazards and comprising 1% or greater of the composition must be listed. All components of a mixture that have been determined to present a physical hazard must be listed.

Chemical and common names of carcinogens must be listed if they are present in the mixture at levels of 0.1% or greater.

Chemical and common names of all ingredients determined to be health hazards and comprising less than 1% (0.1% for carcinogens) of the mixture must also be listed if they can still exceed an established Permissible Exposure Limit (PEL) or Threshold Limit Value (TLV) or present a health risk to exposed employees at these concentrations.

Section III. Physical and Chemical Characteristics

The physical and chemical characteristics of the hazardous substance must be listed. These include items such as boiling and freezing points, density, vapor pressure, specific gravity, solubility, volatility, and the product's general appearance and odor. These characteristics provide important information for designing safe and healthful work practices.

Section IV. Fire and Explosion Hazard Data

A chemical’s potential for fire and explosion must be described. Also the fire hazards of the chemical and the conditions under which it could ignite or explode must be identified. Recommended extinguishing agents and fire-fighting methods must be described.

Section V. Reactivity Data

This section presents information about other chemicals and substances with which the chemical is incompatible or with which it reacts. Information on any hazardous decomposition products, such as carbon monoxide, must be included.

Section VI. Health Hazards

The health hazards of the chemical, together with signs and symptoms of exposure, must be listed. In addition, any medical conditions that are aggravated by exposure to the compound must be included. The specific types of chemical health hazards defined in the standard include carcinogens, corrosives, toxins, irritants, sensitizers, mutagens, teratogens and effects on target organs (i.e., liver, kidney, nervous system, blood, lungs, mucous membranes, reproductive system, skin, eyes, etc.)

The route of entry section describes the primary pathway by which the chemical enters the body. There are three principal routes of entry: inhalation, ingestion and skin absorption.

This section of the MSDS supplies the Occupational Safety and Health Administration (OSHA) PEL, the American Conference of Governmental Industrial Hygienists (ACGIH) TLV, and other exposure levels used or recommended by the chemical manufacturer.

If the compound is listed as a carcinogen (cancer-causing agent) by OSHA, the National Toxicology Program (NTP), or the International Agency for Research on Cancer (IARC), this information must be indicated on the MSDS.

Section VII. Precautions for Safe Handling and Use

The standard requires the preparer to describe the precautions for safe handling and use. These include recommended industrial hygiene practices, precautions to be taken during repair and maintenance of equipment and procedures for cleaning up spills and leaks. Some manufacturers also use this section to include useful information not specifically required by the standard, such as EPA waste disposal methods and state and local requirements.

Section VIII. Control Measures

The standard requires the preparer of the MSDS to list any generally applicable control measures. These include engineering controls, safe handling procedures and personal protective equipment. Information is often included on the use of goggles, gloves, body suits, respirators and face shields.

Material Safety Data Sheet

(OSHA Form 174)

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

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	% (Optional)

Section III - Physical / Chemical Characteristics

Boiling Point	Specific Gravity (Water = 1)
Vapor Pressure (mmHg)	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

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 Storage

Other Precautions

Section VIII - Control Measures

Respiratory Protection *(Specify Type)*

Ventilation	Local Exhaust	Special
	Mechanical *(General)*	Other

Protective Gloves	Other

Other Protective Clothing Or Equipment

Work / Hygienic Practices

MSDS Glossary

The following glossary presents brief explanations of acronyms and common terms frequently used by chemical manufacturers in their MSDS's.

ACGIH American Conference of Governmental Industrial Hygienists is an organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH establishes recommended occupational exposure limits for chemical substances and physical agents. See TLV.

Acid Any chemical that undergoes dissociation in water with the formation of hydrogen ions. Acids have a sour taste and may cause severe skin burns. Acids turn litmus paper red and have pH values of 0 to 6.

Acute Effect Adverse effect on a human or animal that has severe symptoms developing rapidly and coming quickly to a crisis.

Acute Toxicity Acute effects resulting from a single dose of, or exposure to, a substance. Ordinarily used to denote effects in experimental animals.

Adenocarcinoma A tumor with glandular (secreting) elements.

Adenosis Any disease of a gland.

Adhesion A union of two surfaces that are normally separate.

Aerosol A fine aerial suspension of particles sufficiently small in size to confer some degree of stability from sedimentation (e.g., smoke or fog).

Air-Line Respirator A respirator that is connected to a compressed breathable air source by a hose of small inside diameter. The air is delivered continuously or intermittently in a sufficient volume to meet the wearer's breathing requirements.

Air-Purifying Respirator A respirator that uses chemicals to remove specific gases and vapors from the air or that uses a mechanical filter to remove particulate matter. An air-purifying respirator must only be used when there is sufficient oxygen to sustain life and the air contaminant level is below the concentration limits of the device.

Alkali Any chemical substance that forms soluble soaps with fatty acids. Alkalis are also referred to as bases. They may cause severe burns to the skin. Alkalis turn litmus paper blue and have pH values from 8 to l4.

Allergic Reaction An abnormal physiological response to chemical or physical stimuli.

Amenorrhea Absence of menstruation.

Anesthetic A chemical that causes a total or partial loss of sensation. Overexposure to anesthetics can cause impaired judgment, dizziness, drowsiness, headache, unconsciousness and even death. Examples include alcohol, paint remover and degreasers.

ANSI American National Standards Institute is a privately funded, voluntary membership organization that identifies industrial and public needs for national consensus standards and coordinates development of such standards.

Antidote A remedy to relieve, prevent or counteract the effects of a poison.

API American Petroleum Institute is a organization of the petroleum industry.

Appearance A description of a substance at normal room temperature and normal atmospheric conditions. Appearance includes the color, size and consistency of a material.

Aquatic Toxicity The adverse effects to marine life that result from being exposed to a toxic substance.

Asphyxiant A vapor or gas that can cause unconsciousness or death by suffocation (lack of oxygen). Most simple asphyxiants are harmful to the body only when they become so concentrated that they reduce oxygen in the air (normally about 21 percent) to dangerous levels (18 percent or lower). Asphyxiation is one of the principal potential hazards of working in confined and enclosed spaces.

ASTM American Society for Testing and Materials is the world's largest source of voluntary consensus standards for materials, products, systems and services. ASTM is a resource for sampling and testing methods, health and safety aspects of materials, safe performance guidelines, effects of physical and biological agents and chemicals.

Asymptomatic Showing no symptoms.

Atm Atmosphere, a unit of pressure equal to 760 mmHg (mercury) at sea level.

Atmosphere-Supplying Respirator A respirator that provides breathable air from a source independent of the surrounding atmosphere. There are two types: air-line and self-contained breathing apparatus.

Auto-lgnition Temperature The temperature to which a closed, or nearly closed container must be heated in order that the flammable liquid, when introduced into the container, will ignite spontaneously or burn.

BAL British Anti-Lewisite - A name for the drug dimecaprol - a treatment for toxic inhalations.

Base A substance that (1) liberates hydroxide (OH) ions when dissolved in water, (2) receives hydrogen ions from a strong acid to form a weaker acid, and (3) neutralizes an acid. Bases react with acids to form salts and water. Bases have a pH greater than 7 and turn litmus paper blue. See Alkali.

BCM Blood-clotting mechanism effects.

Benign Not recurrent or not tending to progress. Not cancerous.

Biodegradable Capable of being broken down into innocuous products by the action of living things.

Biopsy Removal and examination of tissue from the living body.

BLD Blood effects.

Boiling Points-BP The temperature at which a liquid changes to a vapor state at a given pressure. The boiling point usually expressed in degrees Fahrenheit at sea level pressure (760 mmHg, or one atmosphere). For mixtures, the initial boiling point or the boiling range may be given.

Flammable materials with low boiling points generally present special fire hazards. Some approximate boiling points:

Propane	-44°F
Anhydrous Ammonia	-28°F
Butane	31°F
Gasoline	100°F
Allyl Chloride	113°F
Ethylene Glycol	387°F

BOM, or BuMines Bureau of Mines, U.S. Department of Interior.

Bonding The interconnecting of two objects by means of a clamp and bare wire. Its purpose is to equalize the electrical potential between the objects to prevent a static discharge when transferring a flammable liquid from one container to another. The conductive path is provided by clamps that make contact with the charged object and a low resistance flexible cable which allows the charge to equalize. See Grounding.

Bulk Density Mass of powdered or granulated solid material per unit of volume.

C Centigrade, a unit of temperature.

Ceiling Limit (PEL or TLV) The maximum allowable human exposure limit for an airborne substance which is not to be exceeded even momentarily. Also see PEL and TLV.

ca Approximately.

CAA Clean Air Act was enacted to regulate/reduce air pollution, CAA is administered by U.S. Environmental Protection Agency.

Carcinogen A substance or agent capable of causing or producing cancer in mammals, including humans. A chemical is considered to be a carcinogen if:

(a) It has been evaluated by the International Agency for Research on Cancer (IARC) and found to be a carcinogen or potential carcinogen; or

(b) It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

(c) It is regulated by OSHA as a carcinogen.

Carcinogenicity The ability to produce cancer.

Carcinoma A malignant tumor. A form of cancer.

CAS Chemical Abstracts Service is an organization under the American Chemical Society. CAS abstracts and indexes chemical literature from all over the world in “Chemical Abstracts.” “CAS Numbers” are used to identify specific chemicals or mixtures.

Caustic See Alkali.

cc Cubic centimeter is a volume measurement in the metric system that is equal in capacity to one milliliter (ml). One quart is about 946 cubic centimeters.

Central Nervous System The brain and spinal cord. These organs supervise and coordinate the activity of the entire nervous system. Sensory impulses are transmitted into the central nervous system, and motor impulses are transmitted out.

CERCLA Comprehensive Environmental Response, Compensation and Liability Act of 1980. The Act requires that the Coast Guard National Response Center be notified in the event of a hazardous substance release. The Act also provides for a fund

(the Superfund) to be used for the cleanup of abandoned hazardous waste disposal sites.

CFR Code of Federal Regulations. A collection of the regulations that have been promulgated under United States Law.

Chemical An element (e.g., chlorine) or a compound (e.g., sodium bicarbonate) produced by chemical reaction.

Chemical Cartridge Respirator A respirator that uses various chemical substances to purify inhaled air of certain gases and vapors. This type respirator is effective for concentrations no more than ten times the TLV of the contaminant, if the contaminant has warning properties (odor or irritation) below the TLV.

Chemical Family A group of single elements or compounds with a common general name. Example: acetone, methyl ethyl ketone (MEK) and methyl isobutyl ketone (MIBK) are of the "Ketone" family; acrolein, furfural and acetaldehyde are of the "aldehyde" family.

Chemical Name The name given to a chemical in the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS). The scientific designation of a chemical or a name that will clearly identify the chemical for hazard evaluation purposes.

Chemical Pneumonitis Inflammation of the lungs caused by accumulation of fluids due to chemical irritation.

CHEMTREC Chemical Transportation Emergency Center is a national center established by the Chemical Manufacturers Association (CMA) to relay pertinent emergency information concerning specific chemicals on requests from individuals. CHEMTREC has a 24-hour toll-free telephone number (800-424-9300) to help respond to chemical transportation emergencies.

Chronic Effect An adverse effect on a human or animal body, with symptoms that develop slowly over a period of time or that recur frequently. Also see Acute.

Chronic Exposure Long-term contact with a substance.

Chronic Toxicity Adverse (chronic) effects resulting from repeated doses of or exposures to a substance over a relatively prolonged period of time. Ordinarily used to denote effects in experimental animals.

Clean Air Act See CAA.

Clean Water Act Federal law enacted to regulate/reduce water pollution. CWA is administered by EPA.

CMA Chemical Manufactures Association. See CHEMTREC.

CO Carbon monoxide is a colorless, odorless, flammable and very toxic gas produced by the incomplete combustion of carbon. It is also a byproduct of many chemical processes. A chemical asphyxiant; it reduces the blood's ability to carry oxygen. Hemoglobin absorbs CO two hundred times more readily than it does oxygen.

$C0_2$ Carbon dioxide is a heavy, colorless gas that is produced by the combustion and decomposition of organic substances and as a byproduct of many chemical processes. C02 will not burn and is relatively nontoxic (although high concentrations, especially in confined spaces, can create hazardous oxygen-deficient environments).

COC Cleveland Open Cup is a flash point test method.

Combustible A term used by NFPA, DOT and others to classify certain liquids that will burn, on the basis of flash points. Both NFPA and DOT generally define "combustible liquids" as having a flash point of 100°F
(37.8°C) or higher but below 200°F (93.3°C). Also see "flammable." Non-liquid substances such as wood and paper are classified as "ordinary combustibles" by NFPA.

Combustible Liquid Any liquid having a flash-point at or above 100°F (37.8°C), but below 200°F (93.3°C), except any mixture having components with flashpoints of 200°F (93.3°C) or higher, the total volume of which makes up ninety-nine (99) percent or more of the total volume of the mixture.

Common Name Any means used to identify a chemical other than its chemical name (e.g., code name, code number, trade name, brand name or generic name). See Generic.

Compressed Gas:

(a) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 pounds per square inch (psi) at 70°F (21.1 °C); or

(b) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or

(c) A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72.

Conc See Concentration.

Concentration The relative amount of a substance when combined or mixed with other substances. Examples: 2 ppm hydrogen sulfide in air or a 50 percent caustic solution.

Conditions to Avoid Conditions encountered during handling or storage that could cause a substance to become unstable.

Confined Space Any area that has limited openings for entry and exit that would make escape difficult in an emergency, has a lack of ventilation, contains known and potential hazards and is not intended nor designated for continuous human occupancy.

Conjunctivitis Inflammation of the conjunctiva, the delicate membrane that lines the eyelids and covers the eyeballs.

Container Any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank or the like that contains a hazardous chemical. For purposes of the Right to Know program, pipes or piping systems are not considered to be containers.

Corrosive A chemical that causes visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the DOT in Appendix A to 49 CFR Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of 4 hours. This term shall not refer to action on inanimate surfaces.

CPSC Consumer Products Safety Commission has responsibility for regulating hazardous materials when they appear in consumer goods. For CPSC purposes, hazards are defined in the Hazardous Substances Act and the Poison Prevention Packaging Act of 1970.

Curettage Cleansing of a diseased surface.

Cutaneous Toxicity See "Dermal Toxicity."

CWA Clean Water Act was enacted to regulate/reduce water pollution. It is administered by EPA.

Cyst A sac containing a liquid. Most cysts are harmless.

Cytology The scientific study of cells.

Decomposition Breakdown of a material or substance (by heat, chemical reaction, electrolysis, decay or other processes) into parts or elements or simpler compounds.

Density The mass (weight) per unit volume of a substance. For example, lead is much more dense than aluminum.

Depressant A substance that reduces a bodily functional activity or an instinctive desire, such as appetite.

Dermal Relating to the skin.

Dermal Toxicity Adverse effects resulting from skin exposure to a substance. Ordinarily used to denote effects in experimental animals.

DHHS U.S. Department of Health and Human Services (replaced U.S. Department of Health, Education and Welfare). NIOSH and the Public Health Service (PHS) are part of DHHS.

Dike A barrier constructed to control or confine hazardous substances and prevent them from entering sewers, ditches, streams or other flowing waters.

Dilution Ventilation Air flow designed to dilute contaminants to acceptable levels. Also see general ventilation or exhaust.

DOL U.S. Department of Labor, OSHA and MSHA are part of DOL.

DOT U.S. Department of Transportation regulates transportation of chemicals and other substances.

Dry Chemical A powdered fire-extinguishing agent usually composed of sodium bicarbonate, potassium bicarbonate, etc.

Dysmenorrhea Painful menstruation.

Dsyplasia An abnormality of development.

Dyspnea A sense of difficulty in breathing; shortness of breath.

Ectopic pregnancy The fertilized ovum becomes implanted outside of the uterus.

Edema An abnormal accumulation of clear watery fluid in the tissues.

Endocrine glands Glands that regulate body activity by secreting hormones.

Endometrium The mucous membrane lining the uterus.

Environmental Toxicity Information obtained as a result of conducting environmental testing designed to study the effects on aquatic and plant life.

EPA U S. Environmental Protection Agency

Epidemiology Science concerned with the study of disease in a general population. Determination of the incidence (rate of occurrence) and distribution of a particular disease (as by age, sex or occupation) which may provide information about the cause of the disease.

Epithelium The covering of internal and external surfaces of the body.

Estrogen Principal female sex hormone.

Evaporation Rate The rate at which a material will vaporize (evaporate) when compared to the known rate of vaporization of a standard material. The evaporation rate can be useful in evaluating the health and fire hazards of a material. The designated standard material is usually normal butyl acetate (NBUAC or n-BuAc), with a vaporization rate designated as 1.0. Vaporization rates of other solvents or materials are then classified as:

- FAST evaporating if greater than 3.0. Examples: Methyl Ethyl Ketone = 3.8, Acetone = 5.6, Hexane = 8.3.

- MEDIUM evaporating if ≥ 0.8 to ≤ 3.0. Examples: 190 proof (95%) Ethyl Alcohol = 1.4, VM&P Naphtha = 1.4, MIBK = 1.6.

- SLOW evaporating if less than 0.8. Examples: Xylene = 0.6, Isobutyl Alcohol = 0.6, Normal Butyl Alcohol = 0.4, Water = 0.3, Mineral Spirits = 0.1.

Explosive A chemical that causes a sudden, almost instantaneous release of pressure, gas and heat when subjected to sudden shock, pressure or high temperature.

Exposure or Exposed State of being open and vulnerable to a hazardous chemical by inhalation, ingestion, skin contact, absorption or any other course; includes potential (accidental or possible) exposure.

Extinguishing Media The firefighting substance to be used to control a material in the event of a fire. It is usually identified by its generic name, such as fog, foam, water, etc.

Eye Protection Recommended safety glasses, chemical splash goggles, face shields, etc. to be utilized when handling a hazardous material.

F Fahrenheit is a scale for measuring temperature. On the Fahrenheit scale, water boils at 212°F and freezes at 32°F.

f/cc Fibers per cubic centimeter of air.

FDA U.S. Food and Drug Administration

Fetal Pertaining to the fetus.

Fetus The developing young in the uterus from the seventh week of gestation until birth.

Fibrosis An abnormal thickening of fibrous connective tissue, usually in the lungs.

FIFRA Federal Insecticide, Fungicide and Rodenticide Act requires that certain useful poisons, such as chemical pesticides, sold to the public contain labels that carry health hazard warnings to protect users. It is administered by EPA.

First Aid Emergency measures to be taken when a person is suffering from overexposure to a hazardous material before regular medical help can be obtained.

Flammable A chemical that includes one of the following categories:

(a) "Aerosol, flammable." An aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.

(b) "Gas, flammable." (1) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or (2) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(c) "Liquid, flammable." Any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99 percent or more of the total volume of mixture.

(d) "Solid, flammable." A solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A solid is a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashback Occurs when flame from a torch burns back into the tip, the torch or the hose. It is often accompanied by a hissing or squealing sound with a smoky or sharp-pointed flame.

Flashpoint The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested by the following methods:

(a) Tagliabue Closed Tester (see American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 1979 [ASTM D56-79]).

(b) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 [ASTM D93-79]). "

(c) Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester [ASTM D 3278-78]).

Foreseeable Emergency Any potential occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace.

Formula The scientific expression of the chemical composition of a material (e.g. , water is H_20, sulfuric acid is H_2SO_4, sulfur dioxide is $S0_2$).

Fume A solid condensation particle of extremely small diameter, commonly generated from molten metal as metal fume.

g Gram is a metric unit of weight. One ounce U.S. (avoirdupois) is about 28.4 grams.

General Exhaust A system for exhausting air containing contaminants from a general work area.. Also see Local Exhaust.

Generic Name A designation or identification used to identify a chemical by other than its chemical name (e.g., code name, code number, trade name, and brand name).

Genetic Pertaining to or carried by genes. Hereditary.

Gestation The development of the fetus in the uterus from conception to birth; pregnancy.

g/kg Grams per kilogram is an expression of dose used in oral and dermal toxicology testing to denote grams of a substance dosed per kilogram of animal body weight. Also see "kg" (kilogram).

Grounding The procedure used to carry an electrical charge to ground through a conductive path. A typical ground may be connected directly to a conductive water pipe or to a grounding bus and ground rod. See Bonding.

Gynecology The study of the reproductive organs in women.

Hand Protection Specific type of gloves or other hand protection required to prevent harmful exposure to hazardous materials.

Hazardous Chemical Any chemical whose presence or use is a physical hazard or a health hazard.

Hazardous Warning Words, pictures, symbols or combination thereof presented on a label or other appropriate form to inform of the presence of various materials.

HCS Hazard Communication Standard is an OSHA regulation issued under 29 CFR Part 1910.1200.

Health Hazard A chemical for which there is significant evidence, based on at least one study conducted in accordance with established scientific principles, that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic system and agents that damage the lungs, skin, eyes or mucous membranes.

Hemoglobin An iron-containing conjugated protein or respiratory pigment occurring in the red blood cells of vertebrates.

Hematoma A blood clot under the surface of the skin.

Hematopoietic System The blood-forming mechanism of the human body.

Hematuria The presence of blood in the urine.

Hepatotoxin A substance that causes injury to the liver.

Highly Toxic A chemical in any of the following categories:

(a) A chemical with a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical with a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs with-in 1 hour) to albino rats weighing between 200 and 300 grams each.

Hormones Act as chemical messengers to body organs.

Hyperplasia Increase in volume of a tissue or organ caused by the growth of new cells.

IARC International Agency for Research on Cancer.

Ignitable Capable of being set afire.

Impervious A material that does not allow another substance to pass through or penetrate it.

Incompatible Materials that could cause dangerous reactions by direct contact with one another.

Ingestion Taking in by the mouth.

Inhal See inhalation.

Inhalation Breathing in of a substance in the form of a gas, vapor, fume, mist or dust.

Inhibitor A chemical added to another substance to prevent an unwanted chemical change.

Insol See insoluble.

Insoluble Incapable of being dissolved in a liquid.

Intrauterine Within the uterus.

Irritant A chemical, which is not corrosive, that causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for 4 hours exposure or by other appropriate techniques, it results in an empirical score of 5 or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

Irritating As defined by DOT, a property of a liquid or solid substance which, upon contact with fire or where exposed to air, gives off dangerous or intensely irritating fumes (not including poisonous materials). See Poison, Class A and Poison, Class B.

kg Kilogram is a metric unit of weight, about 2.2 U.S. pounds. Also see "g/kg," "g," and "mg."

L Liter is a metric unit of capacity. A U.S. quart is about 9/10 of a liter.

Lacrimation Secretion and discharge of tears.

Label Notice attached to a container, bearing information concerning its contents.

Lactation The secretion of milk by the breasts.

LC Lethal concentration is the concentration of a substance being tested that will kill.

LCL Lethal concentration, low, lowest concentration of a gas or vapor capable of killing a specified species over a specified time.

LC_{50} The concentration of a material in air that will kill 50 percent of a group of test animals with a single exposure (usually 1 to 4 hours). The LC_{50} is expressed as parts of material per million parts of air, by volume (ppm) for gases and vapors, or as micrograms of material per liter of air (g/l) or milligrams of material per cubic meter of air (mg/m) for dusts and mists, as well as for gases and vapors.

LD Lethal dose is the quantity of a substance being tested that will kill.

LDL Lethal dose low, lowest administered dose of a material capable of killing a specified test species.

LD_{50} A single dose of a material expected to kill 50 percent of a group of test animals. The LD_{50} dose is usually expressed as milligrams or grams of material per kilogram of animal body weight (mg/kg or g/kg). The material may be administered by mouth or applied to the skin.

LEL, or LFL Lower explosive limit, or lower flammable limit, of a vapor or gas; the lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc or flame) is present. At concentrations lower than the LEL, the mixture is too "lean" to burn. Also see "UEL."

Lesion Any damage to a tissue.

Lfm Linear feet per minute, a unit of air velocity.

Local Exhaust A system for capturing and exhausting contaminants from the air at the point where the contaminants are produced (welding, grinding, sanding, other processes or operations). Also see General Exhaust.

M Meter is a unit of length in the metric system. One meter is about 39 inches.

m^3 Cubic meter is a metric measure of volume, approximately 35.3 cubic feet or 1.3 cubic yards.

Malaise A feeling of general discomfort, distress or uneasiness; an out-of-sorts feeling.

Malignant Tending to become progressively worse and to result in death.

Mammary Pertaining to the breast.

Mechanical Exhaust A powered device, such as a motor-driven fan or air steam venturi tube for exhausting contaminants from a workplace, vessel or enclosure.

Mechanical Filter Respirator A respirator used to protect against airborne particulate matter like dusts, mists, metal fume, and smoke. Mechanical filter respirators do not provide protection against gases, vapors, or oxygen deficient atmospheres.

Melting Point The temperature at which a solid substance changes to a liquid state.

Menorrhagia Excessive menstruation.

Menstruation Periodic discharge of blood from the vagina of a nonpregnant uterus.

Metabolism Physical and chemical processes taking place among the ions, atoms, and molecules of the body.

Metastasis The transfer of disease from one organ or part to another not directly connected with it.

Meter A unit of length; equivalent to 39.37 inches.

mg Milligram is a metric unit of weight that is one-thousandth of a gram.

mg/kg Milligrams of substance per kilogram of body weight is an expression of toxicological dose.

mg/m^3 Milligrams per cubic meter is a unit for expressing concentrations of dusts, gases or mists in air.

Micron (Micrometer) A unit of length equal to one-millionth of a meter; approximately 0.000039 of an inch.

Mist Suspended liquid droplets generated by condensation from the gaseous to the liquid state, or by breaking up a liquid into a dispersed state, such as splashing, foaming or atomizing. Mist is formed when a finely divided liquid is suspended in air.

Mixture Any combination of two or more chemicals if the combination is not, in whole or part, the result of a chemical reaction.

Mld Mild

ml Milliliter is a metric unit of capacity, equal in volume to 1 cubic centimeter (cc), or approximately one-sixteenth of a cubic inch. One-thousandth of a liter.

mmHg Millimeters (mm) of mercury (Hg) is a unit of measurement for low pressures or partial vacuums.

Molecular Weight Weight (mass) of a molecule based on the sum of the atomic weights of the atoms that make up the molecule.

mppcf Million particles per cubic foot is a unit for expressing concentration of particles of a substance suspended in air. Exposure limits for mineral dusts (silica, graphite, Portland cement, nuisance dusts and others), formerly expressed as mppcf, are now more commonly expressed in mg/m3.

MSDS Material Safety Data Sheet

MSHA Mine Safety and Health Administration, U.S. Department of Labor.

Mutagen A substance or agent capable of altering the genetic material in a living cell.

MW See molecular weight.

N_2 Nitrogen is a colorless, odorless and tasteless gas that will not burn and will not support combustion. The earth's atmosphere (air) is about 78 percent nitrogen. At higher concentrations, nitrogen can displace oxygen and become a lethal asphyxiant. See Asphyxiant.

Narcosis A state of stupor, unconsciousness or arrested activity produced by the influence of narcotics or other chemicals.

Nausea Tendency to vomit, feeling of sickness at the stomach.

NCI National Cancer Institute is that part of the National Institutes of Health that studies cancer causes and prevention as well as diagnosis, treatment and rehabilitation of cancer patients.

NFPA National Fire Protection Association is an international membership organization which promotes/improves fire protection and prevention and establishes safeguards against loss of life and property by fire. Best known on the industrial scene for the National Fire Codes-16 volumes of codes, standards, recommended practices and manuals developed (and periodically updated) by NFPA technical committees. Among these is NFPA 704M, the code for showing hazards of materials as they might be encountered under fire or related emergency conditions, using the familiar diamond-shaped label or placard with appropriate numbers or symbols.

Neo See neoplasia.

Neonatal The first 4 weeks after birth.

Neoplasia A condition characterized by the presence of new growths (tumors).

Nephrotoxin A substance that causes injury to the kidneys.

Neurotoxin A material that affects the nerve cells and may produce emotional or behavioral abnormalities.

Neutralize To eliminate potential hazards by inactivating strong acids, caustics and oxidizers. For example, acids can be neutralized by adding an appropriate amount of caustic substance to the spill.

ng nanogram, one-billionth of a gram.

NIOSH National Institute for Occupational Safety and Health, U.S. Public Health Service, U.S. Department of Health and Human Services (DHHS), among other activities, tests and certifies respiratory protective devices and air sampling detector tubes, recommends occupational exposure limits for various substances, and assists OSHA and MSHA in occupational safety and health investigations and research.

Nonflammable Not easily ignited, or if ignited, not burning rapidly.

Non-Sparking Tools Tools made from beryllium-copper or aluminum-bronze greatly reduce the possibility of igniting dusts, gases or flammable vapors. Although these tools may emit some sparks when striking metal, the sparks have a low heat content and are not likely to ignite most flammable liquids.

NO_x Oxides of nitrogen which are undesirable air pollutants. NO emissions are regulated by EPA under the Clean Air Act.

NPIRS National Pesticide Information Retrieval System is an automated data base operated by Purdue University containing information on EPA registered pesticides, including reference file MSDS's.

NRC National Response Center is a notification center that must be called when significant oil or chemical spills or other environment-related accidents occur. The toll-free telephone number is 1-800-424-8802.

NTP National Toxicology Program. The NTP publishes an Annual Report on Carcinogens.

Odor A description of the smell of the substance.

Odor Threshold The lowest concentration of a substance's vapor, in air, that can be smelled.

Olfactory Relating to the sense of smell.

Oral Used in or taken into the body through the mouth.

Oral Toxicity Adverse effects resulting from taking a substance into the body by mouth. Ordinarily used to denote effects in experimental animals.

Organic Peroxide An organic compound that contains the bivalent -O-O structure and may be considered a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Organogenesis The formation of organs during development.

OSHA Occupational Safety and Health Administration, U.S. Department of Labor.

Ovary The female sex gland in which ova are formed.

Overexposure Exposure to a hazardous material beyond the allowable exposure limits.

Oxidation In a literal sense, oxidation is a reaction in which a substance combines with oxygen provided by an oxidizer or oxidizing agent. See Oxidizing Agent.

Oxidizer A chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, causing fire either by itself or through the release of oxygen or other gases.

Oxidizing Agent A chemical or substance that brings about an oxidation reaction. The agent may (1) provide the oxygen to the substance being oxidized (in which case the agent has to be oxygen or contain oxygen), or (2) it may receive electrons being transferred from the substance undergoing oxidation

(chlorine is a good oxidizing agent for electron-transfer purposes, even though it contains no oxygen).

Pathologic Pertaining to or caused by disease.

Pathology Scientific study of alterations produced by disease.

PEL Permissible Exposure Limit is an occupational exposure limit established by OSHA's regulatory authority. It may be a time-weighted average (TWA) limit or a maximum concentration exposure limit.

Percent Volatile Percent volatile by volume is the percentage of a liquid or solid (by volume) that will evaporate at an ambient temperature of 70°F (unless some other temperature is specified). Examples: butane, gasoline and paint thinner (mineral spirits) are 100 percent volatile; their individual evaporation rates vary, but in time, each will evaporate completely.

pH The symbol relating the hydrogen ion (H+) concentration to that of a given standard solution. A pH of 7 is neutral. Numbers increasing from 7 to 14 indicate greater alkalinity. Numbers decreasing from 7 to 0 indicate greater acidity.

Physical Hazard Means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, an explosive, a flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

Placenta A structure that grows on the wall of the uterus during pregnancy through which the fetus is nourished.

PMCC Pensky-Martens Closed Cup. See Flashpoint.

Pneumoconiosis A condition of the lung in which there is permanent deposition of particulate matter and the tissue reaction to its presence. It may range from relatively harmless forms of iron oxide deposition to destructive forms of silicosis.

Poison, Class A A DOT term for extremely dangerous poisons--poisonous gases or liquids that, in very small amounts, either as gas or as vapor of the liquid, mixed with air, are dangerous to life. Examples: phosgene, cyanogen, hydrocyanic acid, nitrogen peroxide.

Poison, Class B A DOT term for liquid, solid, paste or semisolid substances--other than Class A poisons or irritating materials--that are known (or presumed on the basis of animal tests) to be so toxic to humans that they are a hazard to health during transportation.

Polymerization A chemical reaction in which one or more small molecules combine to form larger molecules. A hazardous polymerization is a reaction that takes place at a rate that releases large amounts of energy. If hazardous polymerization can occur with a given material, the MSDS usually will list conditions that could start the reaction and--since the material usually contains a polymerization inhibitor--the length of time during which the inhibitor will be effective.

ppb Parts per billion is the concentration of a gas or vapor in air-parts (by volume) of the gas or vapor in a billion parts of air. Usually used to express extremely low concentrations of unusually toxic gases or vapors; also the concentration of a particular substance in a liquid or solid.

ppm Parts per million is the concentration of a gas or vapor in air-parts (by volume) of the gas or vapor in a million parts of air; also the concentration of a particulate in a liquid or solid.

Prenatal Preceding birth.

psi Pounds per square inch (for MSDS purposes) is the pressure a material exerts on the walls of a confining vessel or enclosure. For technical accuracy, pressure must be expressed as psig (pounds per square inch gauge) or psia (pounds per square inch absolute; that is, gauge pressure plus sea level atmospheric pressure, or psig plus approximately 14.7 pounds per square inch). Also see mmHg.

Pul See pulmonary.

Pulmonary Relating to, or associated with, the lungs.

Pulmonary Edema Fluid in the lungs,

Pyrophoric A chemical that will ignite spontaneously in air at a temperature of 13°F (54.4°C) or below.

Reaction A chemical transformation or change. The interaction of two or more substances to form new substances.

Reactive See Unstable.

Reactivity Chemical reaction with the release of energy. Undesirable effects--such as pressure buildup, temperature increase, formation of noxious, toxic or corrosive byproducts--may occur because of the reactivity of a substance to heating, burning, direct contact with other materials or other conditions in use or in storage.

Reducing agent In a reduction reaction (which always occurs simultaneously with an oxidation reaction) the reducing agent is the chemical or substance which (1) combines with oxygen or (2) loses electrons to the reaction. See Oxidation.

REL The NIOSH REL (Recommended Exposure Limit) is the highest allowable airborne concentration which is not expected to injure the worker. It may be expressed as a ceiling limit or as a time-weighted average (TWA).

Reproductive Toxin Substances that affect either male or female reproductive systems and may impair the ability to have children.

Respiratory Protection Devices that will protect the wearer's respiratory system from overexposure by inhalation to airborne contaminants. Respiratory protection is used when a worker must work in an area where he/she might be exposed to concentration in excess of the allowable exposure limit.

Respiratory System The breathing system that includes the lungs and the air passages (trachea or "windpipe," larynx, mouth and nose) to the air outside the body, plus the associated nervous and circulatory supply.

Routes of Entry The means by which material may gain access to the body, for example, inhalation, ingestion and skin contact.

RCRA Resource Conservation and Recovery Act is environmental legislation aimed at controlling the generation, treating, storage, transportation and disposal of hazardous wastes. It is administered by EPA.

Sarcoma A tumor that is often malignant.

Self-Contained Breathing Apparatus A respiratory protection device that consists of a supply or a means of respirable air, oxygen or oxygen-generating material carried by the wearer.

Sensitizer A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

SETA Setaflash Closed Tester. See Flashpoint.

Silicosis A disease of the lungs (fibrosis) caused by the inhalation of silica dust.

Skn Skin

"Skin" A notation (sometimes used with PEL or TLV exposure data) that indicates that the stated substance may be absorbed by the skin, mucous membranes and eyes--either airborne or by direct contact--and that this additional exposure must be considered part of the total exposure to avoid exceeding the PEL or TLV for that substance.

Skin Absorption Ability of some hazardous chemicals to pass directly through the skin and enter the bloodstream.

Skin Sensitizer See Sensitizer.

Skin Toxicity See Dermal Toxicity.

Solubility in Water A term expressing the percentage of a material (by weight) that will dissolve in water at ambient temperature. Solubility information can be useful in determining spill cleanup methods and reextinguishing agents and methods for a material.

Solvent A substance, usually a liquid, in which other substances are dissolved. The most common solvent is water.

So_x Oxides of sulfur.

Species On the MSDS's, species refers to the test animals--usually rats, mice or rabbits--used to obtain the toxicity test data reported.

Specific Chemical Identity The chemical name, Chemical Abstracts Service (CAS) Registry Number, or any precise chemical designation of a substance.

Specific Gravity The weight of a material compared to the weight of an equal volume of water is an expression of the density (or heaviness) of a material. Insoluble materials with specific gravity of less than 1.0 will float in (or on) water. Insoluble materials with specific gravity greater than 1.0 will sink in water. Most (but not all) flammable liquids have specific gravity less than 1.0 and, if not soluble, will float on water--an important consideration for fire suppression.

Spill or Leak Procedures The methods, equipment and precautions that should be used to control or clean up a leak or spill.

Splash-Proof Goggles Eye protection made of a noncorrosive material that fits snugly against the face and has indirect ventilation ports.

Spontaneously Combustible A material that ignites as a result of retained heat from processing, or that will oxidize to generate heat and ignite, or that absorbs moisture to generate heat and ignite.

Squamous Scaly or platelike.

Stability The ability of a material to remain unchanged. For MSDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions that may cause instability (dangerous change) are stated; for example, temperatures above 150°F.; shock from dropping.

STEL Short-Term Exposure Limit (ACGIH terminology). See TLV.

Stenosis Narrowing of a body passage or opening.

Steroid A complex molecule among which are the male and female sex hormones.

Subcutaneous Beneath the layers of the skin.

Supplied-Air Respirators Air line respirators of self-contained breathing apparatus.

Sys System or systemic.

Systemic Poison A poison that spreads throughout the body affecting all body systems and organs. Its adverse effect is not localized in one spot or area.

Systemic Toxicity Adverse effects caused by a substance that affects the body in a general rather than local manner.

Synonym Another name or names by which a material is known. Methyl alcohol, for example, is known as methanol or wood alcohol.

Target Organ Effects The following is a target organ categorization of effects that may occur, including examples of signs, symptoms and examples of chemicals that have been found to cause such effects. These examples are presented to illustrate the range and diversity of effects and hazards found in the workplace, and the broad scope employers must consider in this area, but they are not intended to be all inclusive.

(a)	Hepatoxins	Chemicals that produce liver damage.
	Signs and Symptoms	Jaundice; liver enlargement.
	Chemicals	Carbon Tetrachloride; nitrosamines.
(b)	Nephrotoxins	Chemicals that produce kidney damage.
	Signs and Symptoms	Edema; proteinuria
	Chemicals	Halogenated hydrocarbons; uranium.
(c)	Neurotoxins	Chemicals that produce their primary toxic effects on the nervous system.
	Signs and Symptoms	Narcosis; behavioral changes; decrease in motor functions.
	Chemicals	Mercury, carbon disulfide.
(d)	Agents that act on blood hematopoietic system	Decrease hemoglobin function; deprive the body tissues of oxygen.
	Signs and Symptoms	Cyanosis; loss of consciousness.
	Chemicals	Carbon monoxide; cyanides.
(e)	Agents that damage the lung	Chemicals that irritate or damage the pulmonary tissue.
	Signs and Symptoms	Cough, tightness in chest, shortness of breath.
	Chemicals	Silica; asbestos.
(f)	Reproductive toxins	Chemicals that adversely affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).
	Signs and Symptoms	Birth defects; sterility.
	Chemicals	Lead; DBCP
(g)	Cutaneous hazards	Chemicals that affect the dermal layer of the body.
	Signs and Symptoms	Defatting of the skin; rashes; irritation.
	Chemicals	Ketones; chlorinated compounds.
(h)	Eye hazards	Chemicals that affect the eye or visual capacity.
	Signs and Symptoms	Conjunctivitis; corneal damage.
	Chemicals	Organic solvents; acids.

Target Organ Toxin A toxic substance that attacks a specific organ of the body. For example, overexposure to carbon tetrachloride can cause liver damage.

TCC Tag (Tagliabue) Closed Cup. See Flashpoint.

TCL Toxic concentration low, the lowest concentration of a gas or vapor capable of producing a defined toxic effect in a specified test species over a specified time.

TDL Toxic dose low, lowest administered dose of a material capable of producing a defined toxic effect in a specified test species.

Temp Temperature.

Ter See Teratogen.

Teratogen A substance or agent, exposure to which by a pregnant female can result in malformations in the fetus.

Tfx Toxic effect(s)

TLV Threshold Limit Value is a term used by ACGIH to express the airborne concentration of material to which nearly all persons can be exposed day after day without adverse effects. ACGIH expresses TLVs in three ways:

TLV-TWA: The allowable time-weighted average concentration for a normal 8-hour workday or 40-hour workweek.

TLV-STEL: The Short-Term Exposure Limit, or maximum concentration for a continuous 15-minute exposure period (maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided the daily TLV-TWA is not exceeded).

TLV-C: The ceiling exposure limit--the concentration that should not be exceeded even instantaneously.

TOC Tag Open Cup. See Flashpoint.

Torr A unit of pressure, equal to 1/760 atmosphere.

Toxic A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Toxic Substance Any substance that can cause acute or chronic injury to the human body, or which is suspected of being able to cause diseases or injury under some conditions.

Toxicity The sum of adverse effects resulting from exposure to a material, generally, by the mouth, skin or respiratory tract.

Trade Name The trademark name or commercial trade name for a material or product.

Transplacental An agent that causes physical defects in the developing embryo.

TSCA Toxic Substances Control Act (Federal Environmental Legislation administered by EPA) regulates the manufacture, handling and use of materials classified as "toxic substances."

TWA Time-Weighted Average exposure is the airborne concentration of a material to which a person is exposed, averaged over the total exposure time--generally the total workday (8 to 12 hours). Also see TLV.

UEL, or UFL Upper explosive limit or upper flammable limit of a vapor or gas; the highest concentration (highest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc or flame) is present. At higher concentrations, the mixture is too "rich" to burn. Also see LEL.

ug Microgram, one-millionth of a gram.

Unstable Tending toward decomposition or other unwanted chemical change during normal handling or storage.

Unstable Reactive A chemical that, in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense or become self-reactive under conditions of shocks, pressure or temperature.

USDA U.S. Department of Agriculture.

Vapor The gaseous form of a solid or liquid substance as it evaporates.

Vapor density The weight of a vapor or gas compared to the weight of an equal volume of air is an expression of the density of the vapor or gas. Materials lighter than air have vapor densities less than 1.0 (examples: acetylene, methane, hydrogen). Materials heavier than air (examples: propane, hydrogen sulfide, ethane, butane, chlorine, sulfur dioxide) have vapor densities greater than 1.0. All vapors and gases will mix with air, but the lighter materials will tend to rise and dissipate (unless confined). Heavier vapors and gases are likely to concentrate in low places--along or under floors, in sumps, sewers, manholes, trenches and ditches--where they may create fire or health hazards.

Vapor pressure The pressure exerted by a saturated vapor above its own liquid in a closed container. When quality control tests are performed on products, the test temperature is usually 100°F and the vapor pressure is expressed as pounds per square inch (psig or psia), but vapor pressures reported as MSDS's are in millimeters of mercury (mmHg) at 68°F (20°C), unless stated otherwise. Three facts are important to remember:

1. Vapor pressure of a substance at 100°F will always be higher than the vapor pressure of the substance at 68°F (20°C).
2. Vapor pressures reported on MSDS's in mmHg are usually very low pressures; 760 mmHg is equivalent to 14.7 pounds per square inch.
3. The lower the boiling point of a substance, the higher its vapor pressure.

Ventilation See General Exhaust, Local Exhaust and Mechanical Exhaust.

Vermiculite An expanded mica (hydrated magnesium-aluminum-iron silicate) used as sorbent for spill control and cleanup.

Viscosity The tendency of a fluid to resist internal flow without regard to its density.

Volatility A measure of how quickly a substance forms a vapor at ordinary temperatures.

Water Disposal Methods Proper disposal methods for contaminated material, recovered liquids or solids, and their containers.

Water-Reactive A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Work Area A room or defined space in a work-place where hazardous chemicals are produced or used and where employees are present.

Workplace An establishment at one geographical location containing one or more work areas.

Zinc Fume Fever A condition brought on by inhalation of zinc oxide fume characterized by flulike symptoms with a metallic taste in the mouth, coughing, weakness, fatigue, muscular pain, and nausea, followed by fever and chills. The onset of symptoms occurs four to twelve hours after exposure.

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST A

List A includes substances regulated by OSHA as carcinogens[1], group 1 substances listed as being carcinogenic to humans by the International Agency for Research on Cancer (IARC)[2], and substances listed by the National Toxicology Program (NTP) as being known to be carcinogenic to humans.[3]

Substances involving industrial processes or manufacturing conditions which are not generally present at DMACC may have been omitted from this list. To ensure the current status of the chemical, check with the coordinating agency at the locations footnoted or call your CCHO.

SUBSTANCE	OSHA	IARC	NTP
Aflatoxins		X	X
2-Acetylaminofluorene	X		
Acrylonitrile	X		
4-Aminodiphenyl	X	X	X
Arsenic (Inorganic) & Arsenic compounds	X	X	X
Asbestos	X	X	X
Azathioprine		X	X
Benzene	X	X	X
Benzidine	X	X	X
Beryllium and Beryllium compounds		X	
Bis (2-Chloroethyl) 2- Naphylamine (Chlornaphazine)		X	
Bis (Chloromethyl) Ether	X	X	X
1,4-Butanediol dimethylsulfonate (Myleran)		X	X
Cadmium and Cadmium compounds	X	X	
Chemotherapeutic Agents (MOPP,etc)		X	
Chlorambucil		X	X
1-(2-Chloroethyl)-3-(4-methylcyclohexyl) -1-nitrosourera (MeCCNU)		X	X
Chloromethyl Methyl Ether Technical Grade		X	X
Chromium And Compounds		X	X
Coal Tar Pitch Volatiles		X	
Coke Oven Emissions	X	X	X
Cyclophosphamide		X	X
1,2-Dibromo-3-chloropropane		X	
3-3'-Dichlorobenzidine		X	
Diethylstilbestrol		X	X
4-Dimethylaminoazobenzene	X		
N,N-Dimethylnitrosoamine	X		
Erionite		X	X

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST A

SUBSTANCE	OSHA	IARC	NTP
Estrogens (Conjugated)		X	X
Ethylene Oxide	X	X	
Ethyleneimine	X		
Formaldehyde	X		
Melphalan		X	X
Methyl Chloromethyl Ether	X		
Mustard Gas		X	X
Naphthylamine (Alpha)	X		
Naphthylamine (Beta)	X	X	X
Nickel compounds		X	
4-Nitrobiphenyl	X		
N-Nitrosodimethylamine	X		
Phenacetin (Analgesic Mixtures)			X
Propiolactone (Beta-)	X		
Radon (and decay products)		X	X
Solar Radiation		X	
Soots, Tars and Mineral Oils		X	
Talc containing asbestiform fibers	X	X	X
Thorium Dioxide			X
Treosulphan		X	
Vinyl Chloride	X	X	X

1 *Iowa Occupational Safety and Health Standards for General Industry* - 29 CFR 1910 - Subpart Z, Iowa Division of Labor Services. [On-line].
Available: http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc_1910_subpart_Z.html (6/10/96).

2 *Monographs on the Evaluation of the Carcinogenic Risk to Humans,* International Agency for Research on Cancer (IARC), Volumes 1 to 29, Supplement 4. [On-line].
Available: http://www.iarc.fr/monoeval/grlist.htm (6/10/96).

3 *Fifth Annual Report on Carcinogens* - Summary, National Toxicology Program (NTP), Technical Resources, Inc., Rockville, MD. [On-line].
Available: http://ntp-server.niehs.nih.gov/Main_Pages/NTP_ARC_PG.html (6/10/96).

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST B

Substances listed in group 2A (higher degree) and 2B (lower degree) by the International Agency for Research on Cancer (IARC) as probable carcinogens[2], and substances listed by the National Toxicology Program (NTP) as reasonably anticipated to be carcinogenic.[3]

Substances involving industrial processes or manufacturing conditions which are not generally present at DMACC may have been omitted from this list. To ensure the current status of the chemical, check with the coordinating agency at the locations footnoted or call your CCHO.

SUBSTANCE	OSHA	NTP
A-Alpha-C (2-Amino-9*H*-pyrido[2,3-*b*]indole)	2B	
Aacetaldehyde	2B	X
Acetamide	2B	
2-Acetylaminofluorene		X
Acrylamide	2A	X
Acrylonitrile	2A	X
Adriamycin	2A	
AF-2 [2-(2-Furyl)-3- (5-nitro-2furyl)acrylamide]	2B	
Aflatoxins	2B	
2-Aminoanthraqinone		X
0-Aminoazatoluene		X
Aminoazobenzene	2B	
Aminoazotoluene	2B	
4-Aminodiphenyl		
1-Amino-2-methylanthraquinone		X
2-Amino-5-(5-nitro-2-furyl) -1,3,4-thiadiazole	2B	
Amitrole	2B	X
Androgenic (anabolic) Steroids	2A	
ortho-Anisidine	2B	
0-Anisidine Hydrochloride		X
Antimony trioxide	2B	
Aramite	2B	
Auramine	2B	
Azacitidine	2A	
Azaserine	2B	
Benz (a) Anthracene	2A	X
Benzidine-based dyes	2A	

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST B

Benzo (a) pyrene	2A	
Benxo [j] fluoranthene	2B	
Benzo (k) fluoranthene	2B	
Benzofuran	2B	
Benzotrichloride		X
Benzyl violet 4B	2B	
Beryllium And Beryllium Compounds	2A	X
Bischloroethyl nitrosourea	2A	X
Bleomycins	2B	
Bracken fern	2B	
Bromodichloromethane	2B	X
1,3-Butadiene		X
Butylated hydroxyanisole	2B	X
beta-Butyrolactone	2B	
C.E. Basic Red 9 Monohydrochloride		X
Cacarbazine		X
Caffeic acid	2B	
Captafol	2A	
Carbon black	2B	
Carbon Tetrachloride		X
Ceramic fibers	2B	X
Chloramphenicol	2A	
Chlordane	2B	
Chlordecone (Kepone)	2B	
Chlorendic Acid	2B	X
Chlorinated Parafins		X
alpha-Chlorinated tolunes (benzyl chloride, benzal chloride, benzotrichloride)	2B	
3-Chloro-2-methylpropene		X
para-Chloro-*ortho*-toluidine	2A	
4-Chloro-O-phenylenediamine	2B	X
para-Chloroaniline	2B	
1,2-Chloroethyl -3-cyclohexyl -1-Nitrosourea (CCNU)	2A	X
Chloroform	2B	X
1-Chloro-2-methylpropene	2B	
Chlorophenols	2B	
Chlorophenoxy herbicides	2B	
Chlorozotocin	2A	
CI Acid Red	2B	
CI Basic Red	2B	
CI Direct Blue	2B	
Cisplatin	2A	X
Citrus Red No. 2	2B	
Cobalt	2B	

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST B

para-Cresidine	2B	
p-Cresididne		X
Cupferron		X
Cycasin	2B	
Dacarbazine	2B	
Dantron	2B	
Daunomycin	2B	
DDT	2B	X
Di(2-ethylhexyl)phthalate		X
N,N'-Diacetylbenzidine	2B	
2,4-Diaminoanisole Sulfate	2B	X
2,4-Diaminotoluene	2B	X
Dibenz (A,h) Acridine	2B	
Dibenz (A,j) Acridine	2B	
Dibenzo (7H-)(c,g)Carbazol		
7H-Dibenzo[*c,g*]carbazole	2B	
Dibenzo[*a,e*]pyrene	2B	
Dibenzo[*a,h*]pyrene	2B	
Dibenzo[*a,i*]pyrene	2B	
Dibenzo[*a,l*]pyrene	2B	
1,2-Dibromo-3-chloropropane	2B	X
1,2-Dibromoethane (EDB)		X
1,4-Dichlorobenzene		X
para-Dichlorobenzene	2B	
3,3'-Dichlorobenzidine	2B	X
3,3'-Dichlorobenzidine Dihydrochloride		X
3,3'-Dichloro-4,4'-diaminodiphenyl ether	2B	
1,2-Dichloroethane	2B	X
Dichloromethane (Methylene Chloride	2B	X
Dichloropropene (Technical Grade)	2B	X
Dichlorvos	2B	
Dienestrol	2B	
Diepoxybutane	2B	X
Di(2-ethylhexyl)phthalate	2B	
1,2 Diethylhydrazine	2B	
Diethyl Sulfate	2A	X
Diglycidyl Resorcinol Ether	2B	X
Dihydrosafrole	2B	
Diisopropyl sulfate	2B	
3,3'-Dimethoxybenzidine	2B	X
Dimethyl Sulfate	2A	X
4-Dimethylaminoazobenzene		X
para-Dimethylaminoazobenzene	2B	
trans-2-[(Dimethylamino)methylimino]-		

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST B

5-[2-(5-nitro-2-furyl)-vinyl]- 1,3,4-oxadiazole	2B	
2,6-Dimethylaniline	2B	
3,3'-Dimethylbenzidine	2B	X
Dimethylcarbamoyl Chloride	2A	X
Dimethylformamide	2B	
1,2-Dimethylhydrazine	2B	
Dimethylhydrazine	2B	X
Dimethylvinyl Chloride		X
3,7-Dinitrofluoranthene	2B	
1,6-Dinitropyrene	2B	
1,8-Dinitropyrene	2B	
2,4-Dinitrotoluene	2B	
2,6-Dinitrotoluene	2B	
1,4-Dioxane	2B	X
Direct Black 38		X
Direct Blue 6		X
Disperse Blue		
Epichlorohydrin	2A	X
Ethyl methanesulfonate	2B	
Estrogens (Not Conjugated): Estradiol-17B		X
Estrogens (Not Conjugated): Estrone		X
Estrogens (Not Conjugated): Ethinylestradiol		X
Estrogens (Not Conjugated): Mestranol		X
Ethyl Acrylate		X
Ethylene Dibromide	2A	
Ethyl Methanesulfonate		X
N-Ethyl-*N*-nitrosourea	2A	
Ethylene Oxide		X
Ethylene Thiourea	2B	X
Formaldehyde (Gas)	2A	X
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl) thiazole	2B	
Furan	2B	
Glasswool	2B	X
Glu-P-1 (2-Amino-6-methyldipyrido [1,2-*a*:3',3'-*d*]imidazole)	2B	
Glu-P-2 (2-Aminodipyrido[1,2-*a*:3'2'-*d*]imidazole)	2B	
Glycidaldehyde	2B	
Glycidol		X
Griseofulvin	2B	
HC Blue No. 1	2B	
Heptachlor	2B	
Hexachlorobenzene	2B	X
Hexachlorocyclohexames	2B	
Hexachloroethane		X
Hexamethylphosphoramide	2B	X

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST B

Hydrazine	2B	X
Hydrazine Sulfate		X
Hydrazobenzene		X
IQ (2-Amino-3-methylimidazo[4,5-*f*]quinoline)	2A	
Ideno(1,2,3-cd)pyrene	2B	
Iron Dextran Complex	2B	X
Isoprene	2B	
Kepone (Chlordecone)		X
Lasiocarpine		
Lead Acetate		X
Lead and lead compounds, inorganic	2B	
Lead Phosphate		X
Lindane and other Hexachlorocyclohexane Isomers		X
Magenta	2B	
MeA-*alpha*-C (2-Amino-3methyl-9H-pyrido[2,3-*b*]indole)	2B	
Medroxyprogesterone acetate	2B	
MeIQ 92-Amino-3,4-dimethylimidazo[4,5-*f*]quinoline	2B	
MeIQx 92-Amino-3,8-dimethylinidazo [4,5-*f*]quinoxaline	2B	
Merphalan	2B	
5-Methoxypsoralen	2A	
2-Methylaziridine (Propyleneimine)	2B	X
Methylazoxymethanol acetate	2B	
5-Methylchrysene	2B	
Methylenebis (4,4'-)(N,N-dimethyl) benzenamine		X
4,4'-Methylene bis (2-methylaniline)	2B	
4,4'-Methylenebis (2-Chloroaniline) (MBOCA)	2A	X
4,4'-Methylenedianiline	2B	
4,4'-Methylenedianiline Dihydrochloride		X
Methylmercury compounds	2B	
Methyl methanesulfonate	2B	X
2-Methyl-1-nitroanthraquinone	2B	
N-Methyl-*N*'-nitro-*N*-nitrosoguanidine	2A	X
N-Methyl-*N*-nitrosourea	2A	
N-Methyl-*N*-nitrosourethane	2B	
Methylthiouracil	2B	
Mitomycin C	2B	
Monocrotaline	2B	
5-(morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]- 2-oxazolidionone	2B	
Metronidazole	2B	X
Michler's Ketone		X
Mirex	2B	X
Nafenopin	2B	

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST B

Nickel And Nickel Compounds	2B	X
Nitrilotriacetic Acid	2B	X
Nitroacenaphthene	2B	
Nitroanisole	2B	
Nitrobenzene	2B	
6-Nitrochrysene	2B	
Nitrofen	2B	X
2-Nitrofluorene	2B	
1-[(5-Nitrofurfurylidene)amino]- 2-imidazolidinone	2B	
N-[4-(5-Nitro-2-Furyl)-2-thiazolyl]acetamide	2B	
Nitrogen Mustard *N*-oxide	2B	
Nitrogen Mustard	2A	
Nitrogen Mustard Hydrochloride		X
2-Nitropropane	2B	X
1-Nitropyrene	2B	
4-Nitropyrene	2B	
N-nitrosodiethanolamine	2A	X
N-nitrosodiethylamine		X
N-Nitrosodiethylamine	2A	
N-Nitrosodimethylamine	2A	
N-Nitrosodimethylamine		X
N-nitrosodi-n-butylamine		X
N-nitrosodi-n-propylamine	2B	X
3-(*N*-Nitrosomethylamino)propionitrile	2B	
4-(N-Nitrosomethyl-amino)-1-(3-pyridyl)-1-butanone(NNK)		X
N-nitrosomethylamino	2B	
N-Nitrosomethylethylamine	2B	
N-nitrosomethylvinylamine	2B	X
N-nitrosomorpholine	2B	X
N-nitrosonornicotine	2B	X
N-nitrosopiperidine	2B	X
N-nitrosopyrrolidine	2B	X
N-nitrososarcosine	2B	X
N-nitroso-n-ethylurea		X
N-nitroso-n-methylurea		X
Norethisterone	2B	X
Ochratoxin A	2B	X
Oil Orange SS	2B	
Oxazepam	2B	
4,4'-Oxydianiline		X
Oxymetholone		X
Panfuran S (containing dihydroxymethylfuratrizine)	2B	
Pentachlorophenol	2B	

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST B

Phenacetin	2A	X
Phenazopyridine Hydrochloride	2A	X
Phenazopyridine hydrochloride	2B	
Phenobarbital	2B	
Phenoxybenzamine Hydrochloride	2A	X
Phenyl glycidyl ether	2B	
Phenytoin And It's Sodium Salt	2B	X
PhIP (2-Amino-1-methyl-6- phenylimidazo[4,5-*b*]pyridine)	2B	
Polybrominated Biphenyls		X
Polychlorinated Biphenyls (PCB)		X
Polycyclic aromatic hydrocarbons		X
Ponceau MX	2B	
Ponceau 3R	2B	
Potassium bromate	2B	
Procarbazine Hydrochloride	2A	X
Progesterone		X
1,3-Propane Sultone	2B	X
Propiolactone (Beta-)	2B	X
Propylene Oxide	2B	X
Propylthiouracil	2B	X
Reserpine		X
Rockwool	2B	
Saccharin	2B	X
Safrole	2B	X
Selenium Sulfide		X
Silica crystalline	2A	X
Slagwool	2B	
Sodium *ortho*-phenylphenate	2B	
Sterigmatocystin	2B	
Streptozoticin	2B	X
Styrene	2B	
Styrene-7,8-oxide	2A	
Sulfallate	2B	X
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	2B	X
Tetrachloroethylene (Perchloroethylene)	2A	X
Tetranitromethane	2B	X
Thioacetamide	2B	X
Thiodianiline	2B	
Thiourea	2B	X
Toluene Diisocyanate	2B	X
o-Toluidine	2B	X
o-Toluidine Hydrochloride		X
Toxaphene		X
Trichlormethine (Trimustine hydrochloride)	2B	

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST B

Trichloroethylene	2A	
2,4,6-Trichlorophenol	2B	X
Trichloropropane	2A	
Tris (1-Aziridinyl) Phosphine Sulfide	2B	X
Tris (2,3-Dibromopropyl) phosphate	2A	X
Trp-P-1 (3-Amino-1,4-dimethyl-5*H*-pyrido[4,3-*b*]indole)	2B	
Trp-P-2 (3-Amino-1-methyl-5*H*-pyrido[4,3-*b*]indole	2B	
Trypan Blue	2B	
Ultraviolet radiation A	2A	
Ultraviolet radiation B	2A	
Ultraviolet radiation C	2A	
Uracil Mustard	2B	
Urethane	2B	X
Vinyl acetate	2B	
Vinyl bromide	2A	
4-Vinylcyclohexene	2B	
4-Vinylcyclohexene diepoxide	2B	
4-Vinyl-1-cyclohexene diepoxide		X
Vinyl fluoride	2A	

[2] *Monographs on the Evaluation of the Carcinogenic Risk to Humans,* International Agency for Research on Cancer (IARC), Volumes 1 to 29, Supplement 4. [On-line]. Available: http://www.iarc.fr/monoeval/grlist.htm (6/10/96).

[3] *Fifth Annual Report on Carcinogens* - Summary, National Toxicology Program (NTP), Technical Resources, Inc., Rockville, MD.
[On-line]. Available: http://ntp-server.niehs.nih.gov/Main_Pages/NTP_ARC_PG.html (6/10/96).

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST C

Reproductive toxins are chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). Some chemicals or conditions on this list are also carcinogenic. Other materials or conditions may have negative, non-carcinogenic effects on the the reproductive system.

Substances involving industrial processes or manufacturing conditions which are not generally present at DMACC may have been omitted from this list. To ensure the current status of the chemical, check with the coordinating agency at the locations noted at the end of this list, or call your CCHO. Also, consultant the material safety data sheet (MSDS) for specific information related to reproductive toxicity.

Acute hypoxia
Alcohol ingestion
Alkylating agents
Aminopterin
Anesthetic gases
Anticoagulants
Antidiabetics
Antihistamine antiemetics
Arsenic
Benzene
Boron
Boron Anhydride
Cadmium
Carbamates
Carbaryl
Carbon disulfide
Carbon monoxide
Chemotherapeutic cancer agents
Chloramphenicol
Chlordecone
Chloroprene
Chloroquine
Cigarette smoke
Copper
DDT
Di-n-butylphthalate
Dibromochloropropane
Dinitrotoluene
Erythromycin
Estrogens
Ethylene dibromide
Ethylene glycol ethers
Ethylene oxide
Excess vitamin K
Hallucinogens
High temperatures
Irradiation
Kepone
Lead
Manganese
Marijuana smoking
Mercury, inorganic
Methyl mercury
Microwaves
Mineral deficiency
Narcotics
Novobiocin
Organophosphates
Prednisolone
Quinline
Rubella virus
Selenium
Steroid hormones
Streptomycin
Styrene
Sulfouamides
Syphillis
Tellurium
Tetracyclines
Thalidomide
Thiazide diuretics
Toxoplasmdosis
Vinyl chlorie
Vitamin deficencies
Xylene

APPENDIX IV

LIST OF SELECT CARCINOGENS

LIST C

Occupational and Environmental Reproductive Hazards: a Guide for Clinicians, Edited by Maureen Paul, Williams and Wilkins, Baltimore, Maryland, 1993

Catalog of Teratogenic Agents,Thomas Shepard, John Hopkins University Press, Baltimore, Maryland, 1995

Case Studies in Environmental Medicine: Reproductive and Developmental Hazards, Laura S. Welch, Monograph 29, U.S. Department of Health & Human Services, Agency for Toxic Substances and Disease Registry, September 1993

APPENDIX IV

EXAMPLES OF TERATOGENIC HAZARDS
LIST D

Teratogens are those substances or conditions known to cause the production of physical defects in the developing embryo.

Substances involving industrial processes or manufacturing conditions which are not generally present at DMACC may have been omitted from this list. To ensure the current status of the chemical, check with the coordinating agency at the locations noted at the end of this list, or call your CCHO. Also, consult the material safety data sheet (MSDS) for specific information related to potential birth defects.

Alcoholism
Aminopterin and methyl aminopterin
Androgenic hormones
Antithyroid drugs
Busulfan
Cytomegalovirus
Captopril
Carbon Monoxide
Chlorobiphenyls
Cocaine
Coumarin anticoagulants
Chronic villus sampling (before day 60)
Cyclophosphamide
Cretinism, endemic
Diabetes
Folic acid
Diethylstilbestrol
Diphenylhydantoin
Enalapril
Etretinate
Ethylene glycol monoethyl ether
Hepatitis B virus
Hyperthermia
Herpes virus hominis I and II
Iodides and goiter
Ionizing radiation
Lithium
Methimazole and scalp defects
Mercury, organic
Methyl parathion
Methylene blue via intraamniotic injection
Pencillamine
Parovirus B-19 (Erthema infectiosum)
Phenylketonuria & Sjogren's syndrome
Radioiodine
Rubella virus
Rheumatic disease & congenital heart block
1,3-cis-Retinoic acid (Isotretinoin & Accutane)
Rubella virus
Syphillis
Toxoplasmosis
Tetracyclines
Thalidomide
Toluene
Trimethadione
Trichlorophe-noxy-acetic acid (2,4,5-T)
1,3-cis-retinoic acid (isotretinoin & Accutane)
Varicella virus (chicken pox)
Venezuelan equine encephalitis virus
Virilizing
Valproic acid
Warfarin
Xylene

APPENDIX IV

EXAMPLES OF TERATOGENIC HAZARDS
LIST D

Occupational and Environmental Reproductive Hazards: a Guide for Clinicians, Edited by Maureen Paul, Williams and Wilkins, Baltimore, Maryland,1993

Catalog of Teratogenic Agents,Thomas Shepard, John Hopkins University Press, Baltimore, Maryland, 1995

Casarett and Doul's Toxicology: The Basic Science of Poisons, MO Amdur, CD Klaassen, New York: Pergamon Press, 1991
Studies in

Case Environmental Medicine: Reproductive and Developmental Hazards, Laura S. Welch, Monograph 29, U.S. Department of Health & Human Services, Agency for Toxic Substances and Disease Registry, September 1993

Appendix V
Section A
ACUTE HAZARDOUS WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
P023	107-20-0	Acetaldehyde, chloro-
P002	591-08-2	Acetamide,N-(aminothioxomethyl)-
P057	640-19-7	Acetamide,2-fluoro-
P058	62-74-8	Acetic acid, fluoro-, sodium salt
P002	591-08-2	1-Acetyl-2-thiourea
P003	107-02-8	Acrolein
P070	116-06-3	Aldicarb
P004	309-00-2	Aldrin
P005	107-18-6	Allyl Alcohol
P006	20859-73-8	Aluminum phosphide (R,T)
P007	2763-96-4	5-(Aminomethyl)-3-isoxazolol
P008	504-24-5	4-Aminopyridine
P009	131-74-8	Ammonium picrate (R)
P119	7803-55-6	Ammonium vanadate
P099	506-61-6	Argentate(1-),bis(cyano-C)-, potassium
P010	7778-39-4	Arsenic acid H_3AsO_4
P012	1327-53-3	Arsenic oxide As_2O_3
P011	1303-28-2	Arsenic oxide As_2O_5
P011	1303-28-2	Arsenic pentoxide
P012	1327-53-3	Arsenic trioxide
P038	692-42-2	Arsine, diethyl-
P036	696-28-6	Arsonous dichloride, phenyl-
P054	151-56-4	Aziridine
P067	75-55-8	Aziridine, 2-methyl-
P013	542-62-1	Barium cyanide
P024	106-47-8	Benzenamine, 4-chloro-
P077	100-01-6	Benzenamine, 4-nitro-
P028	100-44-7	Benzene, (chloromethyl)-
P042	51-43-4	1,2-Benzenediol, 4-[1-hydrozy-2-(methylamino)ethyl]-(R)-
P046	122-09-8	Benzeneethanamine,alpha,alpha-dimethyl-
P014	108-98-5	Benzenethiol
P001	81-81-2	2H-1-Benzopyran-2-one, 4-hydrozy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%
P028	100-44-7	Benzyl chloride
P015	7440-41-7	Beryllium
P017	598-31-2	Bromoacetone
P018	357-57-3	Brucine
P045	39196-18-4	2-Butanone, 3,3-dimethyl-1-(methylthio)-, O-[methylamino)carbonyl] oxime
P021	592-01-8	Calcium cyanide
P021	592-01-8	Calcium cyanide $Ca(CN)_2$

Appendix V
Section A
ACUTE HAZARDOUS WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
P022	75-15-0	Carbon disulfide
P095	75-44-5	Carbonic dichloride
P023	107-20-0	Chloroacetaldehyde
P024	106-47-8	p-Chloroaniline
P026	5344-82-1	1-(o-Chlorophenyl)thiourea
P027	542-76-7	3-Chloropropiontrile
P029	544-92-3	Copper cyanide
P029	544-92-3	Copper cyanide Cu(CN)
P030		Cyanides (soluble cyanide salts), not otherwise specified
P031	460-19-5	Cyanogen
P033	506-77-4	Cyanogen chloride
P033	506-77-4	Cyanogen chloride (CN)Cl
P034	131-89-5	2-Cyclohexyl-4,6-dinitrophenol
P016	542-88-1	Dichloromethyl ether
P036	696-28-6	Dichlorophenylarsine
P037	60-57-1	Dieldrin
P038	692-42-2	Diethylarsine
P041	311-45-5	Diethyl-p-nitrophenyl phosphate
P040	297-97-2	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	55-91-4	Diisopropylfluorophosphate (DFP)
P004	309-00-2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a -hexahydro-(1alpha,4alpha,4abeta,5alpha, 8alpha,8abeta)-
P060	465-73-6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a-hexahydro-, 1alpha,4alpha,4abeta,5beta,8beta, 8abeta)
P037	60-57-1	2,7:3,6-Dimethanonaphth [2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta, 6aalpha,7beta,7aalpha)-
P051	72-20-8	2,7:3,6-Dimethanonaphth [2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2abeta,3alpha, 6alpha6abeta,7beta,7aalpha)- & metabolites
P044	60-51-5	Dimethoate
P046	122-09-8	alpha,alpha-Dimethylphenethylamine
P047	534-52-1	4,6-Dinitro-o-cresol,& salts
P048	51-28-5	2,4-Dinitrophenol
P020	88-85-7	Dinoseb
P085	152-16-9	Diphosphoramide, octamethyl-

Appendix V
Section A
ACUTE HAZARDOUS WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
P111	107-49-3	Diphosphoric acid, tetraethyl ester
P039	298-04-4	Disulfoton
P049	541-53-7	Dithiobiuret
P050	115-29-7	Endosulfan
P088	145-73-3	Endothall
P051	72-20-8	Endrin
P051	72-20-8	Endrin, & metabolites
P042	51-43-4	Epinephrine
P031	460-19-5	Ethanedinitrile
P066	16752-77-5	Ethanimidothoic acid, N-[[(methylamino)carbonyl]oxy]-, methyl ester
P101	107-12-0	Ethyl cyanide
P054	151-56-4	Ethyleneimine
P097	52-85-7	Famphur
P056	7782-41-4	Fluorine
P057	640-19-7	Fluoroacetamide
P058	62-74-8	Fluoroacetic acid, sodium salt
P065	628-86-4	Fulminic acid, mercury(2+) salt(R,T)
P059	76-44-8	Heptachlor
P062	757-58-4	Hexaethyl tetraphosphate
P116	79-19-6	Hydrazinecarbothioamide
P068	60-34-4	Hydrazine, methyl-
P063	74-90-8	Hydrocyanic acid
P063	74-90-8	Hydrogen cyanide
P096	7803-51-2	Hydrogen phosphide
P060	465-73-6	Isodrin
P007	2763-96-4	3(2H)-Isoxazoione, 5-(aminomethyl)-
P092	62-38-4	Mercury, (acetato-O)phenyl-
P065	628-86-4	Mercury fulminate (R,T)
P082	62-75-9	Methanamine, N-methyl-N-nitroso-
P064	624-83-9	Methane, isocyanato-
P016	542-88-1	Methane, oxybis[chloro-
P112	509-14-8	Methane, tetranitro- (R)
P118	75-70-7	Methanethiol, trichloro-
P050	115-29-7	6,9-Methano-2,4,3-benzodioxathiepin,6,7, 8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-,3-oxide
P059	76-44-8	4,7-Methano-1H-indene, 1, 4, 5, 6, 7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P066	16752-77-5	Methomyl
P068	60-34-4	Methyl hydrazine
P064	624-83-9	Methyl isocyanate
P069	75-86-5	2-Methyllactonitrile
P071	298-00-0	Methyl parathion
P072	86-88-4	alpha-Naphthylthiourea
P073	13463-39-3	Nickel carbonyl

Appendix V
Section A
ACUTE HAZARDOUS WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
P073	13463-39-3	Nickel carbonyl $Ni(CO)_4$,(T-4)-
P074	557-19-7	Nickel cyanide
P074	557-19-7	Nickel cyanide $Ni(CN)_2$
P075	54-11-5	Nicotine, & salts
P076	10102-43-9	Nitric oxide
P077	100-01-6	p-Nitroaniline
P078	10102-44-0	Nitrogen dioxide
P076	10102-43-9	Nitrogen oxide NO
P078	10102-44-0	Nitrogen oxide NO_2
P081	55-63-0	Nitroglycerine (R)
P082	62-75-9	N-Nitrosodimethylamine
P084	4549-40-0	N-Nitrodomethylvinylamine
P085	152-16-9	Octamethylpyrophosphoramide
P087	20816-12-0	Osmium oxide OsO_4, (T-4)-
P087	20816-12-0	Osmium tetroxide
P088	145-73-3	7-oxabicyclo[2.2.1]heptane-2,3 dicarboxylic acid
P089	56-38-2	Parathion
P034	131-89-5	Phenol, 2-cyclohexyl-4,6-dinitro-
P048	51-28-5	Phenol, 2,4-dinitro-
P047	534-52-1	Phenol, 2-methyl-4,6-dinitro-,& salts
P020	88-85-7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
P009	131-74-8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P092	62-38-4	Phenylmercury acetate
P093	103-85-5	Phenylthiourea
P094	298-02-2	Phorate
P095	75-44-5	Phosgene
P096	7803-51-2	Phosphine
P041	311-45-5	Phosphoric acid, diethyl 4-nitrophenyl ester
P039	298-04-4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthic)ethyl] ester
P094	298-02-2	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
P044	60-51-5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
P043	55-91-4	Phosphorofluoridic acid, bis(1-methylethyl) ester
P089	56-38-2	Phosphorothioic acid, O,O-diethyl O-(4- nitrophenyl) ester
P040	297-97-2	Phosphorothioic acid, O,O-diethyl 0- pyrazinyl ester

Appendix V
Section A
ACUTE HAZARDOUS WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
P097	52-85-7	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P071	298-00-0	Phosphorothioic acid, O,O,-dimethyl O- (4-nitrophenyl) ester
P110	78-00-2	Plumbane,tetraethyl-
P098	151-50-8	Potassium cyanide K(CN)
P099	506-61-6	Potassium silver cyanide
P070	116-06-3	Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
P101	107-12-0	Propanenitrile
P027	542-76-7	Propanenitrile, 3-chloro-
P069	75-86-5	Propanenitrile, 2-hydorxy-2-methyl-
P081	55-63-0	1,2,3-Propanetriol, trinitrate (R)
P017	598-31-2	2-Propanone, 1-bromo-
P102	107-19-7	Propargyl alcohol
P003	107-02-8	2-Propenal
P005	107-18-6	2-Propen- 1-ol
P067	75-55-8	1,2-Propylenimine
P102	107-19-7	2-Propyn-1-ol
P008	504-24-5	4-Pyridinamine
P075	54-11-5	Pyridine, 3-(1-methyl-2-pyrroliidinyl)-, (S)-, & salts
P114	12039-52-0	Selenious acid, dithallium(+ 1) salt
P103	630-10-4	Selenourea
P104	506-64-9	Silver cyanide Ag(CN)
P105	26628-22-8	Sodium azide
P106	143-33-9	Sodium cyanide
P106	143-33-9	Sodium cyanide Na(CN)
P107	1314-96-1	Strontium sulfide SrS
P108	47-24-9	Strychnidin- 10-one, & salts
P018	357-57-3	Strychnidin- 10-one, 2,3-dimethoxy-
P108	57-24-9	Strychnine, & salts
P115	7446-18-6	Sulfuric acid, dithallium(+ 1) salt
P109	3689-24-5	Tetraethyldithiopyrophosphate
P110	78-00-2	Tetraethyl lead
P111	107-49-3	Tetraethyl pyrophosphate
P112	509-14-8	Tetranitromethane (R)
P062	757-58-4	Tetraphosphoric acid, hexaethyl ester
P113	1314-32-5	Thallic oxide
P113	1314-32-5	Thallium oxide Tl_2O_3
P114	12039-52-0	Thallium(I) selenite
P115	7446-18-6	Thallium(I) sulfate
P109	3689-24-5	Thiodiphosphoric acid, tetraethyl ester
P045	39196-18-4	Thiofanox

Appendix V
Section A
ACUTE HAZARDOUS WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
P049	541-53-7	Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$
P014	108-98-5	Thiophenol
P116	79-19-6	Thiosemicarbazide
P026	5344-82-1	Thiourea, (2-chlorophenyl)-
P072	86-88-4	Thiourea, 1-naphthalenyl-
P093	103-85-5	Thiourea, phenyl-
P123	8001-35-2	Toxaphene
P118	75-70-7	Trichloromethanethiol
P119	7803-55-6	Vanadic acid, ammonium salt
P120	1314-62-1	Vanadium oxide V_2O_3
P120	1314-62-1	Vanadium pentoxide
P084	4549-40-0	Vinylamine, N-methyl-N-nitroso-
P001	81-81-2	Warfarin, & salts, when present at concentrations greater than 0.3%
P121	557-21-1	Zinc cyanide
P121	557-21-1	Zinc cyanide $Zn(CN)_2$
P122	1314-84-7	Zinc phosphide Zn_3P_2, when present at concentrations greater than 10% (R,T)

(I) = Ignitability
(C) = Corrosivity
(R) = Reactivity
(T) = Toxicity

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U001	75-07-0	Acetaldehyde (I)
U034	75-87-6	Acetaldehyde, trichloro-
U187	62-44-2	Acetamide, N-(4-ethoxyphenyl)-
U005	53-96-3	Acetamide, N-9H-fluoren-2-yl-
U240	94-75-7	Acetic acid, (2,4-dichlorophenoxy)- salts & esters
U112	141-78-6	Acetic acid ethyl ester (I)
U144	301-04-2	Acetic acid, lead(2+) salt
U214	563-68-8	Acetic acid, thallium(1+) salt
see F027	93-76-5	Acetic acid, (2,4,5-trichlorophenoxy)-
U002	67-64-1	Acetone (I)
U003	75-05-8	Acetonitrile (I,T)
U004	98-86-2	Acetophenone
U005	53-96-3	2-Acetylaminofluorene
U006	75-36-5	Acetyl chloride (C,R,T)
U007	79-06-1	Acrylamide
U008	79-10-7	Acrylic acid (I)
U009	107-13-1	Acrylonitrile
U011	61-82-5	Amitrole
U012	62-53-3	Aniline (I,T)
U136	75-60-5	Arsinic acid, dimethyl-
U014	492-80-8	Auramine
U015	115-02-6	Azaserine
U010	50-07-7	Azirino[2',3':3,4]pyrrolo[1,2-a] indole-4,7-dione, 6-amino-8-[[(aminocarbonyl)oxy]methyl]-1,1a,2, 8,8a,8b-hexahydro-8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta,8aalpha,8balpha)]-
U157	56-49-5	Benz[j]aceanthrylene, 1,2-dihydro-3- methyl-
U016	225-51-4	Benz[c]acridine
U017	98-87-3	Benzal chloride
U192	23950-58-5	Benzamide, 3,5-dichloro-N-(1,1-dimethyl- 2-propynyl)-
U018	56-55-3	Benz[a]anthracene
U094	57-97-6	Benz[a]anthracene, 7,12-dimethyl-
U012	62-53-3	Benzenamine (I,T)
U014	492-80-8	Benzenamine, 4,4'-carbonimidoylbis [N,N-dimethyl-
U049	3165-93-3	Benzenamine, 4-chloro-2-methyl-, hydrochloride
U093	60-11-7	Benzenamine, N,N-dimethyl-4-(phenylazo)-
U328	95-53-4	Benzenamine, 2-methyl-
U353	106-49-0	Benzenamine, 4-methyl-
U158	101-14-4	Benzenamine, 4,4'-methylenebis[2-

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
		chloro-
U222	636-21-5	Benzenamine, 2-methyl-, hydrochloride
U181	99-55-8	Benzenamine, 2-methyl-5-nitro-
U019	71-43-2	Benzene(I,T)
U038	510-15-6	Benzeneacetic acid, 4-chloro-alpha (4-chlorophenyl)-alpha-hydroxy-, ethyl ester
U030	101-55-3	Benzene, 1-bromo-4-phenoxy-
U035	305-03-3	Benzenebutanoic acid, 4-[(bis(2-chloroethyl)amino]-
U037	108-90-7	Benzene, chloro-
U221	25376-45-8	Benzenediamine, ar-methyl-
U028	117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U069	84-74-2	1,2-Benzenedicarboxylic acid, dibutyl ester
U088	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
U102	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
U107	117-84-0	1,2-Benzenedicarboxylic acid, dioctyl ester
U070	95-50-1	Benzene, 1,2-dichloro-
U071	541-73-1	Benzene, 1,3-dichloro-
U072	106-46-7	Benzene, 1,4-dichloro-
U060	72-54-8	Benzene, 1,1'-(2,2-dichloroethylidene) bis[4-chloro-
U017	98-87-3	Benzene, (dichloromethyl)-
U223	26471-62-5	Benzene, 1,3-diisocyanatomethyl- (R,T)
U239	1330-20-7	Benzene, dimethyl- (I,T)
U201	108-46-3	1,3-Benzenediol
U127	118-74-1	Benzene, hexachloro-
U056	110-82-7	Benzene, Hexahydro- (l)
U220	108-88-3	Benzene, methyl-
U105	121-14-2	Benzene, 1-methyl-2,4-dinitro-
U106	606-20-2	Benzene, 2-methyl- 1,3-dinitro-
U055	98-82-8	Benzene, (1-methylethyl)- (l)
U169	98-95-3	Benzene, nitro-
U183	608-93-5	Benzene, pentachloro-
U185	82-68-8	Benzene, pentachloronitro-
U020	98-09-9	Benzenesulfonic acid chloride (C,R)
U020	98-09-9	Benzenesulfonyl chloride (C,R)
U207	95-94-3	Benzene, 1,2,4,5-tetrachloro-
U061	50-29-3	Benzene, 1,1'-(2,2,2-trichloroethylidene) bis[4-chloro-
U247	72-43-5	Benzene, 1,1'-(2,2,2-

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
		trichloroethylidene) bis[4-methoxy-
U023	98-07-7	Benzene, (trichloromethyl)-
U234	99-35-4	Benzene, 1,3,5-trinitro-
U021	92-87-5	Benzidine
U202	81-07-2	1,2-Benzisothiazol-3(2H)-one, 1,1-dioxide, & salts
U203	94-59-7	1,3-Benzodioxole, 5-(2-propenyl)-
U141	120-58-1	1,3-Benzodioxole, 5-(1-propenyl)-
U090	94-58-6	1,3-Benzodioxole, 5-propyl-
U064	189-55-9	Benzo[rst]pentaphene
U248	81-81-2	2H-1-Benzopyran-2-one, 4hydroxy-3-(3-oxo- 1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U022	50-32-8	Benzo[a]pyrene
U197	106-51-4	p-Benzoquinone
U023	98-07-7	Benzotrichloride (C,R,T)
U085	1464-53-5	2,2'-Bioxirane
U021	92-87-5	[1,1'-Biphenyl]-4,4'-diamine
U073	91-94-1	[1,1'-Biphenyl]-4,4'-diamine, 3,3' -dichloro-
U091	119-90-4	[1,1'-Biphenyl]-4,4'-diamine, 3,3' -dimethoxy-
U095	119-93-7	[1,1'-Biphenyl]-4,4'-diamine, 3,3' -dimethyl-
U225	75-25-2	Bromoform
U030	101-55-3	4-Bromophenyl phenyl ether
U128	87-68-3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U172	924-16-3	1-Butanamine, N-butyl-N-nitroso-
U031	71-36-3	1-Butanol (l)
U159	78-93-3	2-Butanone (l,T)
U160	1338-23-4	2-Butanone, peroxide (R,T)
U053	4170-30-3	2-Butenal
U074	764-41-0	2-Butene, 1,4-dichloro- (l,T)
U143	303-34-4	2-Butenoic acid, 2-methyl-, 7-[[2,3-diihydroxy- 2-(1-methoxyethyl)-3-methyl-1-oxobutoxy] methyl]- 2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester, {1S-[1alpha(Z),7(2S*3R*), 7a alpha]]-
U031	71-36-3	n-Butyl alcohol (l)
U136	75-60-5	Cacodylic acid
U032	13765-19-0	Calcium chromate
U238	51-79-6	Carbamic acid, ethyl ester
U178	615-53-2	Carbamic acid, methylnitroso-, ethyl ester

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U097	79-44-7	Carbamic chloride, dimethyl-
U114	111-54-6	Carbamodithioic acid, 1,2-ethanediylbis-, salts & esters
U062	2303-16-4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl)ester
U215	6533-73-9	Carbonic acid, dithallium(1+)salt
U033	353-50-4	Carbonic difluoride
U156	79-22-1	Carbonochloridic acid, methyl ester, (l,T)
U033	353-50-4	Carbon oxyfluoride (R,T)
U211	56-23-5	Carbon tetrachloride
U034	75-87-6	Chloral
U035	305-03-3	Chlorambucil
U036	57-74-9	Chlordane, alpha & gamma isomers
U026	494-03-1	Chlornaphazin
U037	108-90-7	Chlorobenzene
U038	510-15-6	Chlorobenzilate
U039	59-50-7	p-Chloro-m-cresol
U042	110-75-8	2-Chloroethyl vinyl ether
U044	67-66-3	Chloroform
U046	107-30-2	Chloromethyl methyl ether
U047	91-58-7	beta-Chloronaphthalene
U048	95-57-8	o-Chlorophenol
U049	3165-93-3	4-Chloro-o-toluidine, hydrochloride
U032	13765-19-0	Chromic acid H2Cro4, calcium salt
U050	218-01-9	Chrysene
U051		Creosote
U052	1319-77-3	Cresol (Cresylic acid)
U053	4170-30-3	Crotonaldehyde
U055	98-82-8	Cumene (l)
U246	506-68-3	Cyanogen bromide (CN)Br
U197	106-51-4	2,5-Cyclohexadiene-1,4-dione
U056	110-82-7	Cyclohexane (l)
U129	58-89-9	Cyclohexane, 1,2,3,4,5,6-hexachloro-1alpha,2alpha,3beta,4alpha,5alpha,6 beta)-
U057	108-94-1	Cyclohexanone (l)
U130	77-47-4	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U058	50-18-0	Cyclophosphamide
U240	94-75-7	2,4-D, salts & esters
U059	20830-81-3	Daunomycin
U060	72-54-8	DDD
U061	50-29-3	DDT

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U062	2303-16-4	Diallate
U063	53-70-3	Dibenz[a,h]anthracene
U064	189-55-9	Dibenzo[a,i]pyrene
U066	96-12-8	1,2-Dibromo-3-chloropropane
U069	84-74-2	Dibutyl phthalate
U070	95-50-1	o-Dichlorobenzene
U071	541-73-1	m-Dichlorobenzene
U072	106-46-7	p-Dichlorobenzene
U073	91-94-1	3,3'-Dichlorobenzidine
U074	764-41-0	1,4-Dichloro-2-butene (l,T)
U075	75-71-8	Dichlorodifluoromethane
U078	75-35-4	1,1 Dichloroethylene
U079	156-60-5	1,2-Dichloroethylene
U025	111-44-4	Dichloroethyl ether
U027	108-60-1	Dichloroisopropyl ether
U024	111-91-1	Dichloromethoxy ethane
U081	120-83-2	2,4-Dichlorophenol
U082	87-65-0	2,6-Dichlorophenol
U084	542-75-6	1,3-Dichloropropene
U085	1464-53-5	1,2:3,4-Diepoxybutane (l,T)
U108	123-91-1	1,4-Diethyleneoxide
U028	117-81-7	Diethylhexyl phthalate
U086	1615-80-1	N,N'-Diethylhydrazine
U087	3288-58-2	O,O-Diethyl S-methyl dithiophosphate
U088	84-66-2	Diethyl phthalate
U089	56-53-1	Diethylstilbesterol
U090	94-58-6	Dihydrosafrole
U091	119-90-4	3,3'-Dimethoxybenzidine
U092	124-40-3	Dimethylamine (l)
U093	60-11-7	p-Dimethylaminoazobenzene
U094	57-97-6	7,12-Dimethylbenz[a]anthracene
U095	119-93-7	3,3'-Dimethylbenzidine
U096	80-15-9	alpha,alpha-Dimethylbenzylhydroperoxide (R)
U097	79-44-7	Dimethylcarbamoyl chloride
U098	57-14-7	1,1-Dimethylhydrazine
U099	540-73-8	1,2-Dimethylhydrazine
U101	105-67-9	2,4-Dimethylphenol
U102	131-11-3	Dimethyl phthalate
U103	77-78-1	Dimethyl sulfate
U105	121-14-2	2,4-Dinitrotoluene
U106	606-20-2	2,6-Dinitrotoluene
U107	117-84-0	Di-n-octyl phthalate
U108	123-91-1	1,4-Dioxane
U109	122-66-7	1,2-Diphenylhydrazine
U110	142-84-7	Dipropylamine (l)

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U111	621-64-7	Di-n-propylnitrosamine
U041	106-89-8	Epichlorohydrin
U001	75-07-7	Ethanal (l)
U174	55-18-5	Ethanamine, N-ethyl-N-nitroso-
U155	91-80-5	1,2-Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2-thienylmethyl)-
U067	106-93-4	Ethane, 1,2-dibromo-
U076	75-34-3	Ethane, 1,1-dichloro-
U077	107-06-2	Ethane, 1,2-dichloro-
U131	67-72-1	Ethane, Hexachloro-
U024	111-91-1	Ethane,1,1'-[methylenebis(oxy)]bis[2-chloro-
U117	60-29-7	Ethane, 1,1' -oxybis-(l)
U025	111-44-4	Ethane, 1,1' -oxybis[2-chloro-
U184	76-01-7	Ethane, pentachloro-
U208	603-20-6	Ethane, 1,1,1,2-tetrachloro-
U209	79-34-5	Ethane, 1,1,2,2-tetrachloro-
U218	62-55-5	Ethanethioamide
U226	71-55-6	Ethane, 1,1,1-trichloro-
U227	79-00-5	Ethane, 1,1,2-trichloro-
U359	110-80-5	Ethanol, 2-ethoxy-
U173	1116-54-7	Ethanol,2,2'-(nitrosoimino)bis-
U004	98-86-2	Ethanone, 1-phenyl-
U043	75-01-4	Ethene, chloro-
U042	110-75-8	Ethene, (2-chloroethoxy)-
U078	75-35-4	Ethene, 1,1-dichloro-
U079	156-60-5	Ethene, 1,2-dichloro- (E)-
U210	127-18-4	Ethene, tetrachloro-
U228	79-01-6	Ethene, trichloro-
U112	141-78-6	Ethyl acetate (l)
U113	140-88-5	Ethyl acrylate (l)
U238	51-79-6	Ethyl carbamate (urethane)
U117	60-29-7	Ethyl ether (l)
U114	111-54-6	Ethylenebisdithiocarbamic acid, salts & esters
U067	106-93-4	Ethylene dibromide
U077	107-06-2	Ethylene dichloride
U359	110-80-5	Ethylene glycol monoethyl ether
U115	75-21-8	Ethylene oxide (l,T)
U116	96-45-7	Ethylenethiourea
U076	75-34-3	Ethylidene dichloride
U118	97-63-2	Ethyl methacrylate
U119	62-50-0	Ethyl methanesulfonate
U120	206-44-0	Fluoranthene
U122	50-00-0	Formaldehyde
U123	64-18-6	Formic acid (C,T)
U124	110-00-9	Furan (l)

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U125	98-01-1	2-Furancarboxaldehyde (l)
U147	108-31-6	2,5-Furandione
U213	109-99-9	Furan, tetrahydro-(l)
U125	98-01-1	Furfural (l)
U124	110-00-9	Furfuran (l)
U206	18883-66-4	Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-,D-
U206	18883-66-4	D-Glucose, 2-deoxy-2-[[(methylnitrosoamino)-carbonyl]amino]-
U126	765-34-4	Glycidylaldehyde
U163	70-25-7	Guanidine, N-methyl-N'-nitro-N-nitroso-
U127	118-74-1	Hexachlorobenzene
U128	87-68-3	Hexachlorobutadiene
U130	77-47-4	Hexachlorocyclopentadiene
U131	67-72-1	Hexachloroethane
U132	70-30-4	Hexachlorophene
U243	1888-71-7	Hexachloropropene
U133	302-01-2	Hydrazine (R,T)
U086	1615-80-1	Hydrazine, 1,2-diethyl-
U098	57-14-7	Hydrazine, 1,1-dimethyl-
U099	540-73-8	Hydrazine, 1,2-dimethyl-
U109	122-66-7	Hydrazine, 1,2-diphenyl-
U134	7664-39-3	Hydrofluoric acid (C,T)
U134	7664-39-3	Hydrogen fluoride (C,T)
U135	7783-06-4	Hydrogen sulfide
U135	7783-06-4	Hydrogen sulfide H_2S
U096	80-15-9	Hydroperoxide, 1-methyl-1-phenylethyl-(R)
U116	96-45-7	2-Imidazolidinethione
U137	193-39-5	Indeno[1,2,3-cd]pyrene
U190	85-44-9	1,3-isobenzofurandione
U140	78-83-1	Isobutyl alcohol (l,T)
U141	120-58-1	Isosafrole
U142	143-50-0	Kepone
U143	303-34-4	Lasiocarpine
U144	301-04-2	Lead Acetate
U146	1335-32-6	Lead, bis(acetato-O)tetrahydroxytri-
U145	7446-27-7	Lead phosphate
U146	1335-32-6	Lead subacetate
U129	58-89-9	Lindane
U163	70-25-7	MNNG
U147	108-31-6	Maleic anhydride
U148	123-33-1	Maleic hydrazide
U149	109-77-3	Malononitrile

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U150	148-82-3	Melphalan
U151	7439-97-6	Mercury
U152	126-98-7	Methacrylonitrile (l,T)
U092	124-40-3	Methanamine, N-methyl-(l)
U029	74-83-9	Methane, bromo-
U045	74-87-3	Methane, chloro- (l,T)
U046	107-30-2	Methane, chloromethoxy-
U068	74-95-3	Methane, dibromo-
U080	75-09-2	Methane, dichloro-
U075	75-71-8	Methane, dichlorodifluoro-
U138	74-88-4	Methane, iodo-
U119	62-50-0	Methanesulfonic acid, ethyl ester
U211	56-23-5	Methane, tetrachloro-
U153	74-93-1	Methanethiol (l,T)
U225	75-25-2	Methane, tribromo-
U044	67-66-3	Methane, trichloro-
U121	75-69-4	Methane, trichlorofluoro-
U036	57-74-9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-
U154	67-56-1	Methanol (I)
U155	91-80-5	Methapyrilene
U142	143-50-0	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahy dro-
U247	72-43-5	Methoxychlor
U154	67-56-1	Methyl alcohol (l)
U029	74-83-9	Methyl bromide
U186	504-60-9	1-Methylbutadiene (l)
U045	74-87-3	Methyl chloride (l,T)
U156	79-22-1	Methyl chlorocarbonate (l,T)
U226	71-55-6	Methyl chloroform
U157	56-49-5	3-Methylcholanthrene
U158	101-14-4	4,4'-Methylenebis(2-chloroaniline)
U068	74-95-3	Methylene bromide
U080	75-09-2	Methylene chloride
U159	78-93-3	Methyl ethyl ketone (MEK) (l,T)
U160	1338-23-4	Methyl ethyl ketone peroxide (R,T)
U138	74-88-4	Methyl iodide
U161	106-10-1	Methyl isobutyl ketone (l)
U162	80-62-6	Methyl methacrylate (l,T)
U161	108-10-1	4-Methyl-2-pentanone (l)
U164	56-04-2	Methylthiouracil
U010	50-07-7	Mitomycin C
U059	20830-81-3	5,12-Naphthacenedione, 8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
		L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11 -trihydroxy-1 -methyoxy-,(8S-cis)-
U167	134-32-7	1-Naphthalenamine
U168	91-59-8	2-Naphthalenamine
U026	494-03-1	Naphthalenamine, N,N'-bis(2-chloroethyl)-
U165	91-20-3	Naphthalene
U047	91-58-7	Naphthalene, 2-chloro-
U166	130-15-4	1,4-Naphthalenedione
U236	72-57-1	2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl [1,1'-biphenyl[1,1'-biphenyl]-4,4' -diyl)bis(azo)bis[5-amino -4-hydroxy]-, tetrasodium salt
U166	130-15-4	1,4-Naphthoquinone
U167	134-32-7	alpha-Naphthylamine
U168	91-59-8	beta-Naphthylamine
U217	10102-45-1	Nitric acid, thallium(1+)salt
U169	98-95-3	Nitrobenzene(l,T)
U170	100-02-7	p-Nitrophenol
U171	79-46-9	2-Nitropropane (l,T)
U172	924-16-3	N-Nitrosodi-n-butylamine
U173	1116-54-7	N-Nitrosodiethanolamine
U174	55-18-5	N-Nitrosodiethylamine
U176	759-73-9	N-Nitroso-N-ethylurea
U177	684-93-5	N-Nitroso-N-methylurea
U178	615-53-2	N-Nitroso-N-methylurethane
U179	100-75-4	N-Nitrosopiperidine
U180	930-55-2	N-Nitrosopyrrolidine
U181	99-55-8	5-Nitro-o-toluidine
U193	1120-71-4	1,2-Oxathiolane, 2,2-dioxide
U058	50-18-0	2H- 1,3,2-Oxazaphosphorin-2-amine, N,N-bis(2-chloroethyl)tetrahydro-, 2-oxide
U115	75-21-8	Oxirane (l,T)
U126	765-34-4	Oxiranecarboxyaldehyde
U041	106-89-8	Oxirane, (chloromethyl)-
U182	123-63-7	Paraldehyde
U183	608-93-5	Pentachlorobenzene
U184	76-01-7	Pentachloroethane
U185	82-68-8	Pentachloronitrobenzene(PCNB)
See F027	87-86-5	Pentachlorophenol
U161	108-10-1	Pentanol, 4-methyl-
U186	504-60-9	1,3-Pentadiene (l)
U187	62-44-2	Phenacetin

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U188	108-95-2	Phenol
U048	95-57-8	Phenol, 2-chloro-
U039	59-50-7	Phenol, 4-chloro-3-methyl-
U081	120-83-2	Phenol, 2,4-dichloro-
U082	87-65-0	Phenol, 2,6-dichloro-
U089	56-53-1	Phenol 4,4'-(1,2-diethyl-1,2-ethenediyl)bis-, (E)-
U101	105-67-9	Phenol, 2,4-dimethyl-
U052	1319-77-3	Phenol, methyl-
U132	70-30-4	Phenol, 2,2'-methylenebis[3,4,6-trichloro-
U170	100-02-7	Phenol, 4-nitro-
See F027	87-86-5	Phenol, pentachloro-
See F027	58-90-2	Phenol, 2,3,4,6-tetrachloro-
See F027	95-95-4	Phenol, 2,4,5-trichloro-
See F027	88-06-2	Phenol, 2,4,6-trichloro-
U150	148-82-3	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-
U145	7446-27-7	Phosphoric acid, lead(2+) salt (2:3)
U087	3288-58-2	Phosphorodithioic acid, O,O-diethyl S-methyl ester
U189	1314-80-3	Phosphorus sulfide (R)
U190	85-44-9	Phthalic anhydride
U191	109-06-8	2-Picoline
U179	100-75-4	Piperidine, 1-nitroso-
U192	23950-58-5	Pronamide
U194	107-10-8	1-Propanamine (l,T)
U111	621-64-7	1-Propanamine, N-nitroso-N-propyl-
U110	142-84-7	1-Propanamine, N-propyl- (l)
U066	96-12-8	Propane, 1,2-dibromo-3-chloro-
U083	78-87-5	Propane, 1,2-dichloro-
U149	109-77-3	Propanedinitrile
U171	79-46-9	Propane, 2-nitro- (l,T)
U027	108-60-1	Propane, 2,2'-oxybis[2-chloro-
U193	1120-71-4	1,3-Propane sultone
See	93-72-1	Propanoic acid, -2-(2,4,5-trichlorophenoxy)-
U235	126-72-7	1-Propanol, 2,3-dibromo-, phosphate(3:1)
U140	78-83-1	1-Propanol, 2-methyl- (l,T)
U002	67-64-1	2-Propanone (l)
U007	79-06-1	2-Propenamide

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U084	542-75-6	1-Propene, 1,3-dichloro-
U243	1888-71-7	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	107-13-1	2-Propenenitrile
U152	126-98-7	2-Propenenitrile, 2-methyl- (l,T)
U008	79-10-7	2-Propenoic acid (l)
U113	140-88-5	2-Propenoic acid, ethyl ester (l)
U118	97-63-2	2-Propenoic acid, 2-methyl-, ethyl ester
U162	80-62-6	2-Propenoic acid, 2-methyl-, methyl ester (l,T)
U194	107-10-8	n-Proplyamine (l,T)
U083	78-87-5	Propylene dichloride
U148	123-33-1	3,6-Pyridazinedione, 1,2-dihydro-
U196	110-86-1	Pyridine
U191	109-06-8	Pyridine, 2-methyl-
U237	66-75-1	2,4-(1H,3H)-Pyrimidinedione, 5-[bis(2-chloroethyl)amino]-
U164	56-04-2	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U180	930-55-2	Pyrrolidine, 1-nitroso-
U200	50-55-5	Reserpine
U201	108-46-3	Resorcinol
U202	81-07-2	Saccharin, & salts
U203	94-59-7	Safrole
U204	7783-00-8	Selenious acid
U204	7783-00-8	Selenium dioxide
U205	7488-56-4	Selenium sulfide
U205	7488-56-4	Selenium sulfide SeS_2 (R,T)
U015	115-02-6	L-Serine, diazoacetate (ester)
See F027	93-72-1	Silvex (2,4,5-TP)
U206	18883-66-4	Streptozotocin
U103	77-78-1	Sulfuric acid, dimethyl ester
U189	1314-80-3	Sulfur phosphide (R)
See F027	93-76-5	2,4,5-T
U207	95-94-3	1,2,4,5-Tetrachlorobenzene
U208	630-20-6	1,1,1,2-Tetrachloroethane
U209	79-34-5	1,1,2,2-Tetrachloroethane
U210	127-18-4	Tetrachloroethylene
See F027	58-90-2	2,3,4,6-Tetrachlorophenol
U213	109-99-9	Tetrahydrofuran (l)
U214	563-68-8	Thallium(l) acetate
U215	6533-73-9	Thallium(l) carbonate
U216	7791-12-0	Thallium(l) chloride

Appendix V
Section B
TOXIC WASTES
(40 CFR Part 261.33)

EPA Hazardous Waste No.	Chemical Abstract No.	Substance
U216	7791-12-0	Thallium chloride Tlcl
U217	10102-45-1	Thallium(l) nitrate
U218	62-55-5	Thioacetamide
U153	74-93-1	Thiomethanol (l,T)
U244	137-26-8	Thioperoxydicarbonic diamide $[(H_2N)C(S)]_2S_2$, tetramethyl-
U219	62-56-6	Thiourea
U244	137-26-8	Thiram
U220	108-88-3	Toluene
U221	25376-45-8	Toluenediamine
U223	26471-62-5	Toluene diisocyanate (R,T)
U328	95-53-4	o-Toluidine
U353	106-49-0	p-Toluidine
U222	636-21-5	o-Toluidine hydrochloride
U011	61-82-5	1H-1,2,4-Triazol-3-amine
U227	79-00-5	1,1,2-Trichloroethane
U228	79-01-6	Trichloroethylene
U121	75-69-4	Trichloromonofluoromethane
See F027	95-95-4	2,4,5-Trichlorophenol
See F027	88-06-2	2,4,6-Trichlorophenol
U234	99-35-4	1,3,5-Trinitrobenzene (R,T)
U182	123-63-7	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	126-72-7	Tris(2,3-dibromopropyl) phosphate
U236	72-57-1	Trypan blue
U237	66-75-1	Uracil mustard
U176	759-73-9	Urea, N-ethyl-N-nitroso-
U177	684-93-5	Urea, N-methyl-N-nitroso-
U043	75-01-4	Vinyl chloride
U248	81-81-2	Warfarin, & salts, when present at concentrations of 0.3% or less
U239	1330-20-7	Xylene(l)
U200	50-55-5	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxyben zoyl)oxy]-, methyl ester, 3beta, 16beta, 17alpha, 18beta, 20alpha)-
U249	1314-84-7	Zinc phosphide Zn_3P_2, when present at concentrations of 10% or less

(I) = Ignitability
(C) = Corrosivity
(R) = Reactivity
(T) = Toxicity

---

[1] CAS Number given for parent compound only.

Appendix V
Section C
TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)
(40 CFR Part 261.24)

Parameter	Regulatory Level	
Arsenic	5.0	mg/l
Barium	100.0	mg/l
Benzene	0.5	mg/l
Cadmium	1.0	mg/l
Carbon Tetrachloride	0.5	mg/l
Chlordane	0.03	mg/l
Chlorobenzene	100.0	mg/l
Chloroform	6.0	mg/l
Chromium	5.0	mg/l
m-Cresol	200.0	mg/l
o-Cresol	200.0	mg/l
p-Cresol	200.0	mg/l
Cresols (total)	200.0	mg/l
1,4-Dichlorobenzene	7.5	mg/l
1,2-Dichloroethane	0.5	mg/l
1,1-Dichloroethylene	0.7	mg/l
2,4-Dinitrotoluene	0.13	mg/l
Endrin	0.02	mg/l
Heptachlor (and its hydroxide)	0.008	mg/l
Hexachlorobenzene	0.13	mg/l
Hexachloro-1,3-butadiene	0.5	mg/l
Hexachloroethane	3.0	mg/l
Lead	5.0	mg/l
Lindane	0.4	mg/l
Mercury	0.2	mg/l
Methoxychlor	10.0	mg/l
Methyl ethyl ketone	200.0	mg/l
Nitrobenzene	2.0	mg/l
Pentachlorophenol	100.0	mg/l
Pyridine	5.0	mg/l
Selenium	1.0	mg/l
Silver	5.0	mg/l
Tetrachloroethylene	0.7	mg/l
Toxaphene	0.5	mg/l
Trichloroethylene	0.5	mg/l
Vinyl Chloride	0.2	mg/l
2,4-D	10.0	mg/l
2,4,5-TP	1.0	mg/l
2,4,5-Trichlorophenol	400.0	mg/l
2,4,6-Trichlorophenol	2.0	mg/l

Appendix V
Section D
CLASSES OF CARCINOGENIC SUBSTANCES

Alkylating agents
- α-Halo ethers
  - Bis(chloromethyl) ether
  - Methyl chloromethyl ether
- Sulfonates
  - 1,4-Butanediol dimethanesulfonate (myleran)
  - Diethyl sulfate
  - Dimethyl sulfate
  - Ethyl methanesulfonate
  - Methyl methanesulfonate
  - Methyl trifluoromethanesulfonate
  - 1,3-Propanesultone
- Epoxides
  - Ethylene oxide
  - Diepoxybutane
  - Epichlorohydrin
  - Propylene oxide
  - Styrene oxide
- Aziridines
  - Ethylenimine
  - 2-methylaziridine
- Diazo, azo, and azoxy compounds
  - 4-Dimethylaminoazobenzene
- Electrophilic alkenes and alkynes
  - Acrylonitrile
  - Acrolein
  - Ethyl acrylate

Acylating agents
- β-Propiolactone
- β-Butyrolactone
- Dimethylcarbamyl chloride

Organohalogen compounds
- 1,2-Dibromo-3-chloropropane
- Mustard gas (bis(2-chloroethyl)sulfide)
- Vinyl chloride
- Carbon tetrachloride
- Chloroform
- 3-Chloro-2-methylpropane
- 1,2-Dibromoethane
- 1,4-Dichlorobenzene

Hydrazines
- Hydrazine (and hydrazine salts)
- 1,2-Diethylhydrazine
- 1,1-Dimethylhydrazine
- 1,2-Dimethylhydrazine

***N*-Nitroso compounds**
- *N*-Nitrosodimethylamine
- *N*-Nitro-*N*-alkylureas

Aromatic amines
- 4-Aminobiphenyl
- Benzidine (4,4'-diaminobiphenyl)
- α-Naphthylamine
- β-Naphthylamine
- Aniline
- o-Anisidine (2-methoxyaniline)
- 2,4-Diaminotoluene
- o-Toluidine

Aromatic hydrocarbons
- Benzene
- Benz[*a*]anthracene
- Benzo[*a*]pyrene

Natural products (including antitumor drugs)
- Adriamycin
- Aflatoxins
- Bleomycin
- Cisplatin
- Progesterone
- Reserpine
- Safrole

Miscellaneous organic compounds
- Formaldehyde (gas)
- Acetaldehyde
- 1,4-Dioxane
- Ethyl carbamate (urethane)
- Hexamethylphosphoramide
- 2-Nitropropane
- Styrene

Appendix V
Section D
CLASSES OF CARCINOGENIC SUBSTANCES

Organohalogen compounds (continued)
- 1,2-Dichloroethane
- 2,2-Dichloroethane
- 1,3-Dichloropropene
- Hexachlorobenzene
- Methyl iodide
- Tetrachloroethylene
- Trichloroethylene
- 2,4,6-Trichlorophenol

Miscellaneous organic compounds (continued)
- Thiourea
- Thioacetamide

Miscellaneous inorganic compounds
- Arsenic and certain arsenic compounds
- Chromium and certain chromium compounds
- Thorium dioxide
- Beryllium and certain beryllium compounds
- Cadmium and certain cadmium compounds
- Lead and certain lead compounds
- Nickel and certain nickel compounds
- Selenium sulfide

Reference

National Research Council. Prudent Practices in the Laboratory. National Academy Press, Washington D.C., 1995.

Appendix V
Section E
EXAMPLES OF WASTES CONSIDERED TO BE NON-HAZARDOUS

Small amounts of non-hazardous chemical liquid wastes can be safely flushed (using a plentiful amount of water) down a sanitary sewer which is connected to a sewage treatment plant. Solids should be placed in dumpster units.

Compounds or solutions which contain chemicals not on the list below must be handled in some other way. Individual disposal quantities should be limited to two pounds of solids and one liter of liquid unless they are approved by EH&S.

Actin
Adenosine
Acetyl glucosamine
Acetylsalicyclic acid
Agar
Agarose
Alanine
Albumen
Alconox alginic acid
Aluminum hydroxide
Aluminum oxides
Aluminum silicate
Aluminum sodium sulfate
Aluminum sulfate
Amber
Amberlite
Amino acid
Aminoacetic acid
Ammonium bicarbonate
Ammonium carbonate
Ammonium chloride
Ammonium citrate
Ammonium lactate
Ammonium phosphate
Ammonium stearate
Ammonium sulfate
Ammonium valerate
Amylopectin
Arabinose
Arginine
Ascorbic acid
Asparagine
Aspartic acid
Beef extract
Bees wax
Bentonite
Benzoic acid
Bitumen
Boric acid
Borneol
Calcium glycerophosphate
Calcium acetate
Calcium borate
Calcium carbonate
Calcium chloride
Calcium citrate
Calcium fluoride
Calcium gluconate
Calcium lactate
Calcium pantothenate
Calcium phosphate
Calcium sulfate
Carborundum
Carbowax
Carnotine
Carotene
Casein
Celite
Cellulose
Cellulose acetate
Cellulose phosphate
Cerium oxide
Charcoal
Chlorophyll
Cholesterol
Choline
Choline chloride
Chromatographic absorbent
Citric acid
Corn oil
Corticotropin
Creatinine
Cysteine
Cytopsine

Appendix V
Section E
EXAMPLES OF WASTES CONSIDERED TO BE NON-HAZARDOUS

Deoxyribonuclease
Dextran
Dextrose
Diathymosulfone
Drierite
Epsom salts
Ethylenediaminetetraacetic acid (EDTA)
Ferric chloride
Ferric sulfate
Ferritin
Ferrous ammonium sulfate
Fluorescein
Fructose
Fullers earth
Galactose
Gelatin
Globulin
Gluconic acid
Glutamic acid
Glutamine
Glutaric acid
Glycerophosphate
Glycylglycine
Guaiac
Guanine
Guanosine
Gum arabic
Gypsum
Hemoglobin
Heparin
Hippuric acid
Histamine
Histidine
Hydroxyproline
Inositol
Insulin
Iron Oxide
Isoleucine
Kaolin
Keratin
Lactic acid
Lactose
Lanolin
Lecithin
Leucine
Lithium carbonate
Lithium chloride
Lithium sulfate
Litmus
Magnesium borate
Magnesium carbonate
Magnesium citrate
Magnesium lactate
Magnesium phosphate
Magnesium sulfate
Malt extract
Maltose
Manganese acetate
Manganese chloride
Manganese sulfate
Mannitol
Methionine
Methyl cellulose
Methyl histidine
Methyl lactate
Molecular seives
NADP
Naphthoflavone
Niacinamide
Nicotinamide
Nicotinic acid
Olelic acid
Pancreatin
Papain
Parafin
Pepsin
Peptone
Petrolatum
Petroleum jelly
Phenylalanine
Phosphatidyl choline
Phosphotungstic acid
Phthalic acid
Potassium phosphate
Potassium acetate
Potassium acid phosphate
Potassium bicarbonate
Potassium bisulfate
Potassium borate

Appendix V
Section E
EXAMPLES OF WASTES CONSIDERED TO BE NON-HAZARDOUS

Potassium bromide
Potassium carbonate
Potassium chloride
Potassium citrate
Potassium hydrogen phthalate
Potassium iodide
Potassium lactate
Potassium pyrophosphate
Potassium sodium tartrate
Potassium sulfite
Potassium sulfate
Potassium bitartrate
Pumice Riboflavin
Riboflavin-5-phosphate
Ribonucleic acid
Salicylic acid
Saponin
Sephadex
Serine
Silica gel
Silicon carbide
Silicon dioxide
Sodium acetate
Sodium ammonium phosphate
Sodium benzoate
Sodium bicarbonate
Sodium bisulfate
Sodium bisulfite
Sodium borate
Sodium bromide
Sodium carbonate
Sodium chloride
Sodium citrate
Sodium dodecyl sulfate
Sodium fluoride
Sodium formate
Sodium iodide
Sodium lactate
Sodium phosphate
Sodium salicylate
Sodium silicate
Sodium succinate
Sodium sulfate
Sodium sulfite
Sodium thiosulfate
Sodium trimetaphosphate
Sodium tungstate
Sorbitol
Sorbose
Starch
Steapsin
Stearic acid
Strontium carbonate
Succinic acid
Sucrose
Sulfur
Talcum powder
Tartaric acid
Thiamine hydrochloride
Tin oxide
Titanium dioxide
Tocopherol
Tricalcium phosphate
Trisodium phosphate
Triton X
Trypsin
Trypticase
Tryptone
Tryptophan
Tyrosine
Urea
Uricase
Uridine
Valine
Vanillic acid
Vanillin
Xanthine
Yeast extract
Zinc oxide
Zinc phosphate

Appendix VI

SPECIFIC CHEMICAL INCOMPATIBILITIES

Chemical	Is Incompatible With
Acetic Acid	Chromic acid, nitric acid, peroxides, permanganates
Acetic anhydride	Hydroxyl-containing compounds such as ethylene glycol, perchloric acid
Acetone	Concentrated nitric and sulfuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals, such as sodium, potassium, lithium, magnesium, calcium, powered aluminum	Carbon dioxide, carbon tetrachloride, other chlorinated hydrocarbons (also prohibit the use of water, foam, and dry chemical extinguishers on fires involving these metals-dry sand should be employed.
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Bromine	Ammonia, acetylene, butadiene, butane, methane, propane, (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Calcium Oxide	Water, acids
Carbon, activated	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, turpentine, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, other petroleum gases, hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide

Appendix VI

SPECIFIC CHEMICAL INCOMPATIBILITIES

Chemical	Is Incompatible With
Copper	Acetylene, hydrogen peroxide
Cyanides, inorganic	Acids, strong bases
Dimethylsulfoxide	Iodine pentaflouride, periodic acid, potassium permanganate, acid chlorides, silver fluoride, and other strong oxidizing agents such as magnesium perchlorate and perchloric acid
Fluorine	Isolate from everything
Hydrazine	Hydrogen peroxide, nitric acid, any other oxidant
Hydrocarbons (butane, propane, benzene, gasoline, turpentine, etc.)	Fluorine, chlorine, bromine, chromic acid, peroxides
Hydrocyanic Acid	Nitric acid, alkalis
Hydrofluoric Acid, anhydrous	Ammonia, aqueous or anhydrous
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, aniline, nitromethane, flammable liquids, combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Iodine	Acetylene, ammonia (aqueous or anhydrous)
Mercury and its amalgams	Acetylene, fulminic acid*, ammonia
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, hydrocyanic acid, hydrogen sulfude, flammable liquids, flammable gases, nitratable substances
Nitroparaffins	Inorganic bases, amines
Organic acyl halides	Bases Organic hydroxy and amino compounds

Appendix VI

SPECIFIC CHEMICAL INCOMPATIBILITIES

Chemical	Is Incompatible With
Organic anhydrides	Bases Organic hydroxy and amino compounds
Organic halogen compounds	Group IA and IIA metals Aluminum
Organic nitro compounds	Strong bases
Oxalic acid	Silver, mercury and their salts
Oxygen	Oils, grease, hydrogen, flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils (all organics)
Peroxides, organic	Acids, (organic or mineral) avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, oxidizing agents
Phosphorus pentoxide	Alcohols, strong bases, water
Potassium	Carbon tetrachloride, carbon dioxide, water and other halogenated hydrocarbons
Potassium chlorate	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials, sulfuric and other acids
Potassium perchlorate	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils (all organics), sulfuric and other acids
Potassium permanganate	Hydrogen peroxide, oxidizable substances, nitric acid, ethylene glycol, benzaldehyde, sulfuric acid, glycerol
Selenides	Reducing agents, e.g. active metals: zinc
Silver and silver salts	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Water, carbon dioxide, halogens, halogenated organic compounds, oxidizing agents, acids, halogenating agents carbon tetrachloride, and other halogenated hydrocarbons

Appendix VI

SPECIFIC CHEMICAL INCOMPATIBILITIES

Chemical	Is Incompatible With
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural, any oxidizable substance
Sodium nitrite	Any oxidizable substance, such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldhyde, carbon disulfide, gycerol. ethylene glycol, ethyl acetate, methyl acetate, furfural, ammonium nitrate and other ammonium salts
Sulfides, inorganic	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium) bases, perchlorates, water, chlorates, permanganates
Tellurides	Reducing agents, e.g. sodium, magnesium, hydrogen, zinc *****produced in nitric acid-ethanol mixtures

Reference

The above list is a compilation from various sources, some of which are unknown. However, a large number were referenced in the NATIONAL ACADEMY PRESS -- Prudent Practices for Disposal of Chemicals from Laboratories. Washington, D.C.: National Academy Press, 1995, and Hazards in the Chemical Laboratory, 4th edition, L. Bretherick, Ed. (1986).

Appendix VI

SHOCK-SENSITIVE COMPOUNDS

Acetylenic compounds - especially polyacetylenes, haloacetylenes and heavy metal salts of acetylenes (copper, silver and mercury salts are particularly sensitive)

Acyl nitrates

Alkyl nitrates - particularly polyol nitrates (i.e. nitrocellulose and nitroglycerine)

Alkyl and acyl nitrites

Alkyl perchlorates

Amminemetal oxosalts - metal compounds with coordinated ammonia, hydrazine or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate or other oxidizing groups

Azides - including metal, nonmetal and organic azides

Chlorite salts of metals (i.e. $AgClO_2$ and $Hg(ClO_2)_2$

Diazo compounds (i.e. CH_2N_2)

Diazonium salts (when dry)

Fulminates - silver fulminate (AgCNO) can form in the reaction mixture from the Tollens' test for aldehydes if it is allowed to stand for some time; this can be prevented by adding dilute nitric acid to the test mixture as soon as the test has been completed

Hydrogen peroxide - becomes increasingly treacherous as the concentration rises above 30 percent, forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals

***N*-Halogen compounds** (i.e. difluoroamino compounds and halogen azides)

***N*-Nitro compounds** (i.e. *N*-nitromethylamine, nitrourea, nitroguanidine and nitric amide)

Oxo salts of nitrogenous bases - perchlorates, dichromates, nitrates, iodates, chlorites, chlorates and permanganates of ammonia, amines, hydroxylamine, guanidine, etc.

Perchlorate salts - most metal, nonmetal and amine perchlorates can be detonated and may undergo violent reaction in contact with combustible materials

Peroxides and hydroperoxides

Peroxides (solid) - crystallized from or are left from evaporation of peroxidizable solvents

Peroxides - transition-metal salts

Appendix VI

SHOCK-SENSITIVE COMPOUNDS

Picrates - especially salts of transition and heavy metals (i.e. Ni, Pb, Hg, Cu and Zn); picric acid is explosive but is less sensitive to shock or friction than its metal salts and is relatively safe as a water-wet paste

Polynitroalkyl compounds (i.e. tetranitromethane and dinitroacetonitrile)

Polynitroaromatic compounds - especially polynitro hydrocarbons, phenols and amines

---

Reference

National Academy Press. *Prudent Practices for Disposal of Chemicals from Laboratories*. Washington, D.C.: National Academy Press, 1983.

Appendix VI

POTENTIALLY EXPLOSIVE COMBINATIONS OF COMMON REAGENTS

Acetone + chloroform in the presence of base

Acetylene + copper, silver, mercury, or their salts

Ammonia (including aquesous solutions) + Cl_2, Br_2 or I_2

Carbon disulfide + sodium azide

Chlorine + an alcohol

Chloroform or carbon tetrachloride + powdered Al or Mg

Decolorizing carbon + an oxidizing agent

Diethyl ether + chlorine (including a chlorine atmosphere)

Dimethyl sulfoxide + an acyl halide, $SOCl_2$, or $POCI_3$

Dimethyl sulfoxide + CrO_3

Ethanol + calcium hypochlorite

Ethanol + silver nitrate

Nitric acid + acetic anhydride or acetic acid

Picric acid + a heavy-metal salt, such as of Pb, Hg, or Ag

Silver oxide + ammonia + ethanol

Sodium + a chlorinated hydrocarbon

Sodium hypochlorite + an amine

References

Bretherick, L. *Handbook of Reactive Chemical Hazards*, 2nd ed. London-Boston: Butterworths, 1979. P. 60.

National Fire Protection Association, NFPA. *Manual of Hazardous Chemical Reactions, A Compilation of Chemical Reactions Reported to be Potentially Hazardous*. Boston: NFPA, 1975.

Appendix VI

CLASSES OF CHEMICALS THAT CAN FORM PEROXIDES UPON AGING

Class I: Unsaturated materials, especially those of low molecular weight, may polymerize violently and hazardously due to peroxide initiation.

Acrylic Acid
Acrylonitrile
Butadiene
Chlorobutadiene (chloroprene)
Chlorotrifluoroethylene
Methyl methacrylate
Styrene
Tetrafluoroethylene
Vinyl acetate
Vinyl acetylene
Vinyl chloride
Vinyl pyridine
Vinylidene chloride

Class II: The following are a peroxide hazard upon concentration (distillation/evaporation). A test for peroxide should be performed if concentration is intended or suspected.

Acetal
Cumene
Cyclohexene
Cyclooctene
Cylopentene
Diacetylene
Dicyclopentadiene
Diethylene glycol dimethyl ether
Diethyl ether
Dioxane (*p*-dioxane)
Ethylene glycol dimethyl ether (glyme)
Furan
Methyl acetylene
Methyl cyclopentane
Methyl-*i*-butyl ketone
Tetrahydrofuran
Tetrahydronaphthalene
Vinyl ethers

Class III: Peroxides derived from the following compounds may explode without concentration.

Organic:
- **Divinyl ether**
- **Divinyl acetylene**
- **Isopropyl ether**
- **Vinylidene chloride**

Inorganic:
- **Potassium metal**
- **Potassium amide**
- **Sodium amide (sodamide)**

Reference

National Research Council. Prudent Practices in the Laboratory. National Academy Press, Washington D.C., 1995.

Appendix VI

COMMON PEROXIDE-FORMING CHEMICALS

List A: Severe Peroxide Hazard on Storage with Exposure to Air

Discard within three months

Diisopropyl ether (isopropyl ether)
Divinylacetylene (DVA)[1]
Potassium metal
Sodium amide (sodamide)
Vinylidene Chloride (1.1-dichloroethylene)[1]
Potassium amide

List B: Peroxide Hazard on Concentration; Do Not Distill or Evaporate Without First Testing for the Presence of Peroxides

Discard or test for peroxides after six months

Acetaldehyde diethyl acetal (acetal)
Cumene (isopropylbenzene)
Cyclopentene
Cyclopentene
Decalin (decahydronaphthalene)
Dioxane
Ethylene glycol dimethyl ether (glyme)
Ethylene glycol ether acetates
Ethylene glycol monoethers (cellosolves)
Diacetylene (butadiene)
Dicyclopentadiene
Diethyl ether (ether)
Diethylene glycol dimethyl ether (diglyme)
Furan
Methylacetylene
methylcyclopentane
Methyl isobutyl ketone
Tetrahydrofuran (THF)
Tetralin (tetrahydronaphthalene)
Vinyl ethers[1]

List C: Hazard of Rapid Polymerization Initiated by Internally Formed Peroxides[1]

a. *Normal Liquids; Discard or test for peroxides after six months*[2]

Chloroprene (2-chloro-1,3-butadiene)[3]
Styrene
Vinyl acetate
Vinylpyridine

b. Normal Gases; Discard after 12 months[4]

Butadiene[3]
Tetrafluoroethylene (TFE)[3]
Vinylacetylene (MVA)[3]
Vinyl chloride

Appendix VI

COMMON PEROXIDE-FORMING CHEMICALS

[1] Polymerizable monomers should be stored with a polymerization inhibitor from which the monomer can be separated by distillation just before use.

[2] Although common acrylic monomers such as acrylonitrile, acrylic acid, ethyl acrylate and methyl methacrylate can form peroxides, they have not been reported to develop hazardous levels in normal use and storage.

[3] The hazard from peroxides in these compounds is substantially greater when they are stored in the liquid phase and if so stored without an inhibitor they should be considered as in LIST A.

[4] Although air will not enter a gas cylinder in which gases are stored under pressure, these gases are sometimes transferred from the original cylinder to another in the laboratory and it is difficult to be sure that there is no residual air in the receiving cylinder. An inhibitor should be put into any such secondary cylinder before one of these gases is transferred into it; the supplier can suggest inhibitors to be used. The hazard posed by these gases is much greater if there is a liquid phase in such a secondary container, and even inhibited gases that have been put into a secondary container under conditions that create a liquid phase should be discarded within 12 months.

References

Jackson, H. L., W. B. McCormack, C. S. Rondesvedt, K. C. Smeltz and I. E. Viele. *Safety in the Chemical Laboratory*. Vol. 3. Easton, PA.

NRC Committee on Hazardous Substances in the Laboratory. *Prudent Practices for Handling Hazardous Chemicals in the Laboratory*. Washington, D.C.: National Academy Press, 1981.

Appendix VI

TYPES OF COMPOUNDS KNOWN TO AUTOOXIDIZE TO FORM PEROXIDES

- Aldehydes
- Ethers, especially cyclic ethers and those containing primary and secondary alkyl groups (*never* distill an ether before it has been shown to be free of peroxide)
- Compounds containing benzylic hydrogens
- Compounds containing allylic hydrogens (C=C-CH), including most alkenes; vinyl and vinylidene compounds
- Compounds containing a tertiary C-H group (e.g.), decalin and 2,5-dimethylhexane

---

Reference

National Research Council. Prudent Practices in the Laboratory. National Academy Press, Washington, D.C., 1995.

Appendix VI
CLASSES OF INCOMPATIBLE CHEMICALS

A Incompatible With	B
Alkali and alkaline earth	Water
Carbides	Acids
Hydrides	Halogenated organic compounds
Hydroxides	Halogenating agents
Metals	Oxidizing agents*
Oxides	
Peroxides	
Azides, inorganic	Acids
	Heavy metals and their salts
	Oxidizing agents*
Cyanides, inorganic	Acids
	Strong bases
Nitrates, inorganic	Acids
	Reducing Agents*
Nitrites, inorganic	Acids
	Oxidizing agents*
Organic compounds	Oxidizing agents*
Organic acyl halides	Bases
	Organic hydroxy and amino compounds
Organic anhydrides	Bases
	Organic hydroxy and amino compounds
Organic halogen compounds	Group IA and IIA metals
	Aluminum
Organic nitro compounds	Strong bases
Oxidizing agents*	Reducing agents*
Chlorates	Ammonia, anhydrous and aqueous
Chromates	
Chromium trioxide	Carbon
Dichromates	Metals
Halogens	Metal hydrides
Halogenating agents	Nitrites

Appendix VI
CLASSES OF INCOMPATIBLE CHEMICALS

A Incompatible With	B
Hydrogen Peroxide	Organic compounds
Nitric Acid	Phosphorus
Nitrates	Silicon
Perchlorates	Sulfur
Peroxides	
Permanganates	
Persulfates	
Reducing agents*	Oxidzing agents*
	Arsenates
	Arsenites
	Phosphorus
	Selenites
	Selenates
	Tellurium salts and oxides
Sulfides, inorganic	Acids

*The examples of oxidizing and reducing agents are illustrative of common laboratory chemicals; they are not intended
to be exhaustive.

Reference

National Research Council. Prudent Practices in the Laboratory. National Academy Press, Washington D.C., 1995.

APPENDIX VII

College and Campus Chemical Hygiene Officers
DMACC

	Name	Title	Phone	Fax
DMACC Chemical Hygiene Officer DCHO	**Doug Johnson**	**Chemistry Instructor**	**515-964-6529**	**515-965-7083**
CCHO				
Ankeny Campus Hygiene Officer	**Richard Roberts**	**Chemistry Instructor**	**515-964-6292**	**515-965-7083**
Boone Campus Hygiene Officer	**Cindy Martin**	**Chemistry Instructor**	**515-433-5063**	**515-432-5033**
Carroll Campus Hygiene Officer	**Karen Friedlein**	**Biology Instructor**	**712-792-8507**	**712-792-6358**
Newton Campus Hygiene Officer	**not required for current academic labs offered at Newton**			
Urban Campus Hygiene Officer	**David Vanderlinden**	**Chemistry Instructor**	**515-248-7224**	**515-248-7253**
West Campus Hygiene Officer	**not required for current academic labs offered at West**			

APPENDIX VIII
Additional Local Safety Resources

1. The Iowa Division of Labor Services, located at 1000 East Grand Avenue, Des Moines, IA 50319-0209, has a large library of safety videos available for loan free-of-charge. You may access the video lists online at www.iowaworkforce.org/labor; click on the link Iowa Occupational Safety and Health IOSH) Consultation and Education; then click on the Safety Videos List. You may FAX or email loan requests to the division. You may also contact Sue Sirna at sirna.sue@dol.gov or by phone at 515-281-0202.

2. DMACC's insurance carrier EMC, located at 717 Mulberry, Des Moines, IA 50309, has a collection of safety orientation videos available free to us as policy holders. Contact Roger Kilborn at 515-280-2522 to make arrangements.

3. The Iowa-Illinois Safety Council, located at 6200 Aurora Avenue, Des Moines, IA 50322-2838 is a nongovernmental, not for profit, public service organization, and has a large audiovisual safety catalog. You may download the safety catalog online at www.iisc.org; then click on Services; then click the link to download the Audiovisual Catalog. DMACC is a member of the Iowa-Illinois Safety Council and members only pay shipping and handling charges for use of the audiovisual library. Call 515-276-4724 for further information.