DOCUMENTATION OF CHEMICAL HYGIENE TRAINING

Kansas State University

The Kansas State University Chemical Hygiene Plan requires that each laboratory worker be aware of the location and understand the contents of the laboratory's Chemical Hygiene Plan. By your signature below, you acknowledge that you know its location within the laboratory and that you have read and understand the contents of this plan.

Name	Bldg & Room	Campus Phone	Classification	Supervisor

_____

Employee Signature Date

_____

Employee Signature Date

_____

Employee Signature Date

_____

Employee Signature Date

_____

Employee Signature Date

_____

Employee Signature Date

The Plan further requires that the worker's supervisor provide training that 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 worker's initial assignment and on a refresher basis thereafter. Specific worker training should be documented below:

Description of Training	**Date**	**Provided by**	**Employee Signature**

A copy of this form should be maintained in each laboratory's Chemical Hygiene Plan.

CHEMICAL HYGIENE PLAN
Department of Chemistry
Kansas State University
Manhattan, KS 66506
Approved by the faculty on October 28, 2004

I. INTRODUCTION

The purpose of this plan is to provide a safe and healthy work environment for all laboratory employees in the Chemistry Department at Kansas State University. Laboratory workers include classified and unclassified personnel, graduate students and student employees but do not include students in a laboratory classroom situation. This occupational health rule is patterned after the Federal Occupational Safety and Health Administration's (OSHA) 29 CFR 1910.1450 as adopted by the Kansas Department of Human Resources under K.S.A. 44-636 and -637. Kansas State University is subject to regulations promulgated by the Kansas Department of Human Resources and not OSHA. The Federal OSHA has no authority on campus. The University voluntarily adopted the Federal standard as a means of providing safe laboratory practices on campus.

This plan does not apply to those laboratories which use hazardous chemicals that provide no potential for employee exposure. Examples are: the use of "Dip and Read" test where a reagent strip is dipped into the specimen and the results are interpreted by comparing the color reaction to a color chart; and the use of completely self-contained, commercially prepared kits.

II. RESPONSIBILITIES

The Department of Chemistry will designate an employee as the Chemical Hygiene Officer. The Chemistry Department Chemical Hygiene Officer (CDCHO) will provide technical guidance and assistance for the implementation of the Chemical Hygiene Plan. This individual will work with laboratory workers to ensure proper compliance with the safety rules of Kansas State University. These rules include, but are not limited to, the rules in the "Laboratory Safety Manual", the "Safety with Chemical Carcinogens in Research and Teaching", the "Radiation Safety Manual", "Respirator Program" and the "Hazard Communication Program".

The Chemistry Department Head, who has ultimate responsibility for chemical hygiene within the Chemistry Department, shall provide, along with other administrators and chemical hygiene officers, continuing support for departmental chemical hygiene.

The Chemistry Department Chemical Hygiene Officer (CDCHO), who is the chair of the Department's Safety Committee, shall:

1. Work with administrators, the University CHO, Chemistry Department laboratory directors/supervisors and workers to develop and implement appropriate chemical hygiene policies and practices.
2. Monitor procurement, use and disposal of chemicals used in the laboratory.
3. Know the current legal requirements concerning regulated substances.

The Laboratory Director/Supervisor, has overall responsibility for chemical hygiene in his/her laboratory, including the following specific responsibilities:

1. Appoint a primary chemical safety representative from the lab to act as liaison with the CDCHO and to ensure compliance with all chemical hygiene regulations.
2. Ensure
   a. that workers know and follow the chemical hygiene rules
   b. that protective equipment is available and in working order
   c. that appropriate training has been provided.
3. Provide regular, formal chemical hygiene and housekeeping inspections of the laboratory and emergency equipment.
4. Know the current legal requirements concerning regulated substances.
5. Determine the requisite levels of protective apparel and equipment for laboratory operations.
6. Ensure that the facilities and training are adequate for the operation.

Laboratory Workers have the following specific responsibilities:

1. Plan and conduct each operation in accordance with the University's Chemical Hygiene Plan.
2. Attend designated training sessions and reporting hazardous or unsafe conditions to the Laboratory Director, CDCHO or University CHO.
3. Develop and use good personal chemical hygiene habits.

III. CHEMICAL HYGIENE PLAN

A. Basic Rules and Procedures

B. All workers will comply with the published campus "Laboratory Safety Manual", the "Safety with Chemical Carcinogens in Research and Teaching", the "Radiation Safety Manual", the "Respirator Program", the "Hazard Communication Program", this Chemical Hygiene Plan and any other rules that have been brought forth by the Department of Environmental Health and Safety and the Chemical Hygiene officers. Basic laboratory rules and procedures include:

1. Avoidance of "routine" exposure:
   a. Develop and encourage safe habits; always avoid unnecessary exposure to chemicals.
   b. Do not smell or taste chemicals. Vent every apparatus that may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into the fume exhaust system.
   c. Inspect gloves and test glove boxes before use.
   d. Do not release toxic substances in cold rooms, warm rooms or others areas that have re-circulated atmospheres.
2. Eating, smoking, etc.:
   a. Do not eat, drink, smoke, chew gum or apply cosmetics in areas where laboratory chemicals are present.
   b. Do not store, handle or consume food or beverages in storage areas, refrigerators, glassware or utensils that are used for laboratory operations.
3. Equipment and glassware: Handle and store laboratory glassware with care. Do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur. Use equipment only for its designed purpose.
4. Leaving the Laboratory: Wash hands, arms and face upon completion of your work in the laboratory.
5. Horseplay: Avoid practical jokes or other behavior that might confuse, startle or distract another worker.
6. Mouth suction: Do not use mouth suction for pipeting or starting

a siphon.

7. Planning: Seek information and advice about hazards, plan appropriate protective procedures and plan positioning of equipment before beginning any new operation.
8. Unattended operations: Leave lights on, place appropriate signs on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water).
9. Fume hood use:
    a. Confirm adequate hood performance before use; keep hood sash closed at all times, except when adjustments to equipment within the hood are being made. Do not allow equipment and materials to block air flow in the hood. Do not use the fume hood for chemical storage or evaporation of waste solvents.
    b. Use the hood for operations that might result in release of toxic chemical vapors or dust.
    c. Use a hood when working with any appreciably volatile substance with a TLV of less than 50 ppm.
10. Vigilance: Be alert to unsafe conditions and see that they are corrected when detected.
11. Working alone: Avoid working alone in a building, especially if the procedures being conducted are potentially hazardous.
12. All equipment shall be inspected for defects prior to use.
13. Sink and floor traps shall be kept filled with water at all times to prevent escape of dangerous or noxious gases to other building areas.
14. Adequate, skid-proof foot stands and stepladders should be used for reaching upper shelves. Do not stand on a chair or easily moveable objects.
15. Gas, air vacuum and other services shall be turned off at the bench when services are not in use.
16. Follow all departmental and laboratory standard operating procedures.

C. Personal Protective Apparel and Equipment

1. Eye protection:
   a. Appropriate eye protection must be worn by all persons, including visitors, where chemicals are stored or used. Contact lenses should not be worn in the laboratory unless corrected vision cannot be achieved in any other manner. If contact lenses are worn, wrap-around goggles must also be used. Eyes and contact lenses should be washed and cleaned frequently, especially if ammonia or other irritant vapors are present.
   b. Face shields that protect the neck, ears and face and approved standing shields should be available for vacuum work or where there is a potential for explosions, implosions or splashing.
2. Wear shoes that protect your feet at all times in the laboratory. Exposed body area should be minimized. Laboratory coats or aprons are encouraged. Confine long hair and loose clothing.
3. Wear appropriate gloves when the possibility for contact with toxic materials exists. Inspect the gloves before each use, wash them before removal and replace them frequently.
4. Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls. Inspect the respirator apparatus before each use.
5. Laboratory outer wear that is worn to protect clothing should be fire resistant. Nonflammable, nonporous aprons are the most satisfactory. Remove laboratory coats immediately upon significant contamination and launder separately from other clothing.
6. Wash arms and hands immediately after working with allergens, carcinogens, pathogenic organisms or toxic chemicals.
7. Emergency showers and eyewash stations:
   a. Operating chains shall be freely accessible so that the shower can be used in the event of an emergency.
   b. The area beneath each safety shower and eyewash station shall be kept clear and unobstructed .
8. Safety equipment such as fire extinguishers and safety blankets should be in an unblocked area of the laboratory.

NOTE: Fire extinguisher demonstrations and training are provided by the Fire Safety Officer on request.

D. Housekeeping, Maintenance and Inspections

1. Keep the work area clean and uncluttered of chemicals, equipment and paper. Clean the work area upon completion of an operation or at the end of each day.
2. Stairways, hallways and passages should not be used as storage areas. Access to exits, emergency equipment and utility controls should never be blocked.
3. Chemicals and equipment should be clearly labeled and properly stored.
4. Inspections: Formal housekeeping and chemical hygiene inspections should be held at least monthly for units that have frequent personnel changes and quarterly for others; informal inspections should be continual.
5. The CDCHO will inspect laboratories on a routine basis. The results of the inspections will be communicated in writing to the research director of each laboratory. It is the research director's responsibility to ensure each violation is corrected.
6. All laboratory personnel are to cooperate with EPA or campus inspectors.
7. Maintenance: Laboratory personnel will inspect eye wash stations or fountains at intervals of not less than 3 months. Respirators for routine use should be inspected periodically by the laboratory supervisor. Emergency respirators should be checked monthly. Safety showers will be tested annually by University facilities personnel. Other safety equipment will be inspected regularly (e.g., every 3-6 months).

E. Signs and Labels

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

1. Emergency information, including the name and telephone number of the responsible party to be called in the event of a fire, a spill or other accident, must be posted on the entrance to each laboratory.
2. Information shall be placed on the entrance of each laboratory if hazards such as high magnetic fields, potentially dangerous radiation sources (e.g., lasers and radioactive materials), electrical, flammable materials and restricted areas are present

within the laboratory. Standard warning signs and symbols have been established for many of these hazards. An inventory of the chemicals and a list of potentially hazardous instrumentation within the laboratory must be posted at the laboratory entrance.

3. Highly visible signs, which may be either temporary or permanent (as appropriate) should be posted in areas or near equipment where hazardous operations are being conducted or where toxic, reactive or highly flammable chemicals are being used.
4. Location signs for safety showers, eyewash stations, first aid equipment and exits shall be posted.
5. All chemicals must be labeled with the date received, the date of initial opening and the decision date for disposal or recycling. Chemicals that are repackaged should have secure, waterproof labels marked with waterproof ink that contain the name of the chemical, date repackaged, the manufacturer's date of packaging, purity and a summary description of any hazards.
6. Areas where food and beverage consumption and storage are permitted must be labeled.

F. Chemical Spills

1. Chemicals on the skin:
    a. Before working with a chemical, laboratory workers should review the MSDS information about hazards of the chemical and spill clean-up and remediation. For spills covering small amounts of skin, usually the standard procedure would be to immediately flush the skin with sufficient water to remove all materials. Remove any jewelry to facilitate removal of any residual material. Check the MSDS to see if any delayed effects should be expected. Seek immediate medical attention if a delayed reaction is noted and explain to the medical personnel what chemicals were involved.
    b. For larger spills, quickly remove all contaminated clothing, shoes, jewelry, etc. while using the safety shower. Do not attempt to wash chemicals from clothing. To prevent contamination of hair, eyes, and other parts of the body, cut affected garments from the body. Check the MSDS to see what action should be taken and if any delayed effects should be expected. Seek medical attention as soon as possible.
2. Chemicals in the eye:
    a. For chemical splashes, flush the eye with a copious amount of water under gentle pressure, removing contact lenses at once.
    b. After flushing, seek immediate medical attention, regardless of the apparent degree if injury. Keep the eyes immobilized with clean, wet, soft, cold pads while transporting the injured person to a medical facility.
3. Clean-up procedures:
    a. If a volatile, flammable or toxic material is spilled, immediately warn everyone to extinguish flames and turn off spark-producing equipment such as brush-type motors including vacuum pumps. Avoid skin contact and wear a respirator to prevent inhalation of vapors. Proceed to clean up as directed in the MSDS. Contact the Department of Environmental Health and Safety (532-5856) if information or assistance is required.
    b. If there is no fire hazard and the material is not particularly volatile or toxic, proceed to clean up as

directed in the MSDS.

c. After clean up, all materials, including material used in the clean-up, must be disposed of as hazardous waste. Be particularly careful that flammable liquids absorbed during clean up do not become an absorbent fire hazard.

d. The Department of Environmental Health and Safety should be notified of the spill. In some instances, the EPA must be notified by the Department of Environmental Health and Safety.

e. Every laboratory should have access to the necessary materials to clean up chemical spills. The materials include: protective clothing, chemical absorbent material, acid/base neutralization chemicals, polypropylene squeegee, drain stopper and polypropylene shovel and pan (in CB 136).

G. Information and Training Program

The Chemistry Department Chemical Hygiene Plan requires that chemical laboratory workers be informed of the hazards to which they may be exposed. Additionally, they must be trained in practices for the safe use and handling of chemicals and how to respond to emergency situations. This training and information must be provided when workers are initially assigned to a laboratory where chemicals are present and prior to assignments involving new hazardous chemicals or work procedures. Departments and laboratory supervisors are responsible for ensuring that appropriate information and training have been provided to their workers.

1. Required training topics:
    a. Locations, availability and contents of the Chemical Hygiene Plan, including the laboratory's Standard Operating Procedures and Materials Safety Data Sheets (MSDS).
    b. The physical and health hazards of various types of chemicals in the work area.
    c. The measures that workers can take to protect themselves from laboratory hazards (e.g., personal protective apparel and general laboratory safety equipment, emergency response procedures, following basic rules and procedures, observing good housekeeping and personal hygiene and proper monitoring of environmental hazards).
    d. Permissible exposure limits of hazardous chemicals and signs and symptoms associated with exposure to laboratory chemicals.
    e. Proper chemical storage and waste management.
    f. Proper use of laboratory equipment including vacuum lines, glove boxes, fume hoods and any specialized equipment used in the laboratory.
2. Training and educational resources:
    a. Training sessions offered periodically by the Department of Environmental Health and Safety and the Department of Chemistry.
    b. The Prudent Practices for Handling Hazardous Chemicals in Laboratories, NRC, is available on line at http://www.nap.edu/books/0309052297/html/
    c. It is the accepted manual on chemical handling in the

laboratory. There are additional resources available in the CDCHO office and in the Kansas State University Chemical Hygiene Officer's office.

3. Documentation of training:

The Chemistry Department and individual laboratory directors and supervisors are responsible for documenting that their workers have been provided the requisite training. This documentation must be maintained in the laboratory's Chemical Hygiene Plan and be made available upon request to the Chemical Hygiene Officer and other authorized officials. The first page of this plan is a sample of the information that must be maintained as proof of training for laboratory personnel, including students who work in a research laboratory

H. Chemical Waste Disposal Management

Kansas State University is regulated as a generator of hazardous waste and must comply with all laws and regulations governed by the Kansas Department of Health and Environment and the Environmental Protection Agency.

The hazardous waste management regulations apply to materials only when they become wastes and only if they are deemed hazardous under specific evaluation criteria. If a chemical is no longer needed and the decision date of the chemical's container has been reached, the chemical should be recycled to the Chemical Storage Facility for possible subsequent use by other researchers. To do this, call the Department of Environmental Health and Safety (532-5856) for chemical pick-up.

Generally, a material is considered to be waste once the material can no longer be used for its intended purpose or as starting material or reagent in another operation. When the material has been determined to be waste, the generator of the waste is required to determine whether the waste is hazardous waste. In the first test, the generator must consult with lists that cover process wastes, discarded commercial products and residues from spills (e.g., spent halogenated solvents, numerous operations and operations involving cyanide. For a complete list, see "The Waste Management Manual for Laboratory Personnel" (American Chemical Society, 1990, pp. 17-24). In the

second test, the waste is hazardous if it possesses one or more of four hazardous characteristics: ignitibility (e.g., flashpoint below 60E C), corrosivity (e.g., is aqueous and has a pH #2 or $12.5), reactivity (e.g., reacts violently with water, detonates or readily undergoes violent change) and toxicity (e.g., mercury, selenium, silver and halogenated organics). Definitions of the characteristics are listed in Appendix II.

It is imperative to note that mixtures of hazardous wastes and nonhazardous wastes are treated as hazardous waste. In order to minimize the cost of disposing of hazardous waste, it is important not to mix these types of waste.

1. Accumulation of wastes:
    a. As a large quantity generator of chemical waste, up to 55 gallons of hazardous waste or one quart of acutely hazardous waste (R-list) may be stored in containers in the same room in which the waste is generated before the 90-day accumulation time limitation becomes effective. Containers of hazardous waste must be properly labeled and kept closed at all times except for when adding or removing wastes and stored in a secondary container.
    b. Initial segregation of chemical wastes should be made on the basis of chemical compatibilities. Collect inorganic substances separately and do not mix solids with liquids unless the generation of a process waste is involved. Do not mix halogenated and non-halogenated solvents. Collect nonhalogenated solvents separately. When they must be mixed, record the volume of each nonhalogenated solvent.
    c. All reasonable and appropriate safety precautions must be enforced to prevent spills, leaks and other accidents. Secondary containers are necessary for all waste containers.
    d. Only one container for each type of chemical waste may be stored in each room for each stream of waste generation. Full containers must be properly labeled and collected by the Department of Environmental Health and Safety within 3 days of the container being full.
2. Labeling of waste:
    a. Laboratory personnel and directors who are responsible for

the generation of the chemical waste are also responsible for properly identifying the chemical waste. Laboratory workers should identify the waste before it enters the waste receptacles.

b. The waste label or tag should provide the names of all materials. If a waste is not identifiable as a specific compound, the label should describe the waste's probable hazards, chemical class, functional groups, and compatibility. The label must be dated as to when waste was first placed in the container.
c. Use only permanent labels and permanent markers.
d. Use proper chemical or proper names in identifying chemical compounds. Do not use chemical formulas, symbols or structural formulas to identify a chemical intended for disposal. When a trade name or proprietary name is used for the active ingredient, consult the MSDS or the manufacturer to identify the materials.
e. Unknowns require testing for the class of hazard and, therefore, this disposal is expensive. These additional costs of disposal may be assessed to the laboratory that generated the unknown chemical waste.

3. Segregation and in-lab treatment of hazardous waste
   a. Segregation of chemical waste should be made on the basis of chemical compatibilities (e.g., acids should not be mixed with bases, oxidizers should never be mixed with organics and cyanides should never be mixed with acids).
   b. Elementary neutralization is exempt from the prohibition on waste treatment. Wastes that are hazardous only on the basis of their corrosive characteristics may be neutralized by the addition of bases or acids, as appropriate, producing a waste that is no longer hazardous. This waste may then be placed into the sanitary sewer system. Other in-lab treatments that are permitted include phase separation of organics/aqueous solutions and liquids/solids, precipitation of toxic metals, oxidations of inorganic cyanides and sulfides and treatment of organic peroxides and hydroperoxides.

4. Disposal procedures:
    a. Organic and organometallic materials
        i. Solvents and liquids, aliphatic or aromatic
            a. Spent solvents should NOT be evaporated into the fume hood (including acetone, methanol and hexane). Waste solvents should be collected and placed in a waste container.

            b. Flammable solvents that are not water soluble, are poorly biodegradable or would form explosive mixtures (e.g., diethyl ether, hexane and aliphatic nitro compounds) should be stored separately and picked up by the Department of Environmental Health and Safety.
            c. Nonflammable solvents and liquids that are poorly biodegradable should be stored separately from flammables and should be picked up by the Department of Environmental Health and Safety.
            d. No ethers, including diethyl ether, should be evaporated in a fume hood (Caution: ethers that have been exposed to the air or stored for more than six months after opening may have become contaminated with their peroxides. Do not evaporate peroxide-containing ethers to dryness. Call the Department of Environmental Health and Safety for disposal advice, especially if the decision date on the container has been greatly exceeded.
            e. Halogenated hydrocarbon solvents such as chloroform and trichloroethylene should be picked up by the Department of Environmental Health and Safety.
        ii. Aromatic compounds
            a. Low toxicity (LD_{50} > 15 g/kg body weight), nonbiodegradable dry materials may be placed in a trash dumpster. Solutions of these materials should be handled in the same manner as the solvent.
            b. Any other aromatic compounds should be

picked up by the Department of Environmental Health and Safety.

iii. Confirmed carcinogens
   a. All carcinogens should be disposed of as hazardous waste.
   b. Containers of confirmed carcinogens should be additionally packed in plastic bags for pick up by the Department of Environmental Health and Safety.

iv. Reactive materials
   a. Do not place any reactive compounds in solid waste.
   b. Alert personnel from the Department of Environmental Health and Safety as to the nature of the reactive (e.g., explosives such as peroxides, diazoalkanes, azides, and picric acid; and water reactives such butyl lithium). Make sure they are labeled as reactives.

v. Special materials with restrictive disposal regulations
   a. Pesticides: Disposal of waste pesticides is regulated by the EPA and other agencies. Call the Department of Environmental Health and Safety for pick up. The containers must be clearly labeled with the pesticides' proper chemical names.
   b. Polyhalogenated biphenyls (PCBs and PBBs): The containers must be clearly labeled with the proper chemical names. Call the Department of Environmental Health and Safety for pick up.

vi. Used vacuum pump and other lubricating oils are not considered hazardous waste but their disposal is controlled. Call the Department of Environmental Health and Safety for pick-up.

b. Inorganic materials
   i. Acids and bases should be neutralized to a pH of 7 " 2.5 and then disposed into the sink drain.
   ii. Perchloric acid should be flushed down the drain immediately after use with copious amounts of water. Do not store the acid or perchlorates except the reagent grades that contain water.

iii. Oxidizers should not go to solid waste. Many can be reduced in the laboratory or dissolved and flushed down the drain.

iv. Chromic acid may not be eluted down the drain. Chromic acid will also be picked up by the Department of Environmental Health and Safety.

v. Cyanides and sulfides in a quantity up to 100 grams per day may be treated with an excess of alkali hydroxide and flushed down the drain. A 4% solution of potassium permanganate may also be used to oxidize cyanides and sulfides. After 24 hours, the neutralized solution may be flushed down the drain.

vi. Pyrophoric and water-reactive materials should be picked up by the Department of Environmental Health and Safety or neutralized on site. Examples include alkali metals, tin hydride and aluminum chloride.

vii. Azides should never be disposed down the drain. Neutralize by oxidation with ceric ammonium nitrate and request a pick up by the Department of Environmental Health and Safety.

viii. Osmium, selenium and their compounds should be placed in a closed container that is sealed inside a plastic bag. Request pick-up by the Department of Environmental Health and Safety.

ix. Rare metals, such as silver, gold and mercury should be properly labeled and picked up by the Department of Environmental Health and Safety. Many of these can be recycled.

x. Asbestos must be picked up. It should be moist with water and sealed in an impermeable container. Six mil thick plastic bags are acceptable containers for waste asbestos.

c. Special materials

i. Gases contained in cylinders may require pick up, especially when the gas is leaking through a defective valve. Keep the cylinder in a hood or well-ventilated area prior to its pick up. Communicate the problem to personnel who are picking up the cylinder.

ii. Lecture bottles need to have the valve removed and the tank discarded if the gas is not hazardous. If the gas is hazardous request pick up by Public Safety. For all other size cylinders give the information for the routing of the empty cylinder. Most cylinders can be returned to the manufacturer.

iii. Biological materials may require special disposal procedures. Contact the Department of Environmental Health and Safety for assistance.

5. Hazardous waste pick up:
   a. After the waste containers are full, the container must be dated and shipped to the central accumulation area within three days.
   b. Tops, caps or lids are required on all containers. Box compatible groups of containers so that they can be carried easily by hand. Label the box "EH&S - Waste". Request waste pick up from the Department of Environmental Health and Safety (532-5856). Provide a description and volume of the material to be handled, the specific location of the material and the name of the responsible individual.

I. Medical Consultation and Examinations

1. The Department Head will provide all employees covered by this Chemical Hygiene Program an opportunity to receive medical attention that an examining physician determines to be necessary whenever:
   a. an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
   b. an environmental monitoring reveals an exposure level above the TLV.
   c. a chemical spill, leak, explosion or other event takes place that results in the likelihood of a hazardous chemical exposure.
2. All medical examinations and consultations should be performed by or under the direct supervision of a licensed physician and should be provided without cost to the employee, without loss of pay and at a reasonable time and place.
3. The Department Head will provide the following information to

the physician:

a. the hazardous chemical(s) to which the employee may have been exposed.
b. the exposure conditions including any quantitative data.
c. any signs or symptoms exhibited by the employee.

4. The physician's written opinion:
   a. The examining physician will submit to the Department Head a written opinion that includes the following:
      i. any recommendation for medical follow-up care.
      ii. the results of the medical examination and any associated tests.
      iii. any medical condition that may be revealed in the course of the examination that may place the employee at increased risk as a result of exposure to a hazardous chemical found in the work place.
      iv. a statement that the employee has been informed by the physician of the results of the consultation, medical examination or treatment.
   b. The written opinion shall not reveal findings from the diagnosis of medical history unrelated to occupational exposure.
5. When respirator use is necessary to maintain exposure below the TLV, the Department Head will provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with 29 CFR 1910.134 as adopted by K.S.A. 44-636 and -637, and the Respirator Program at Kansas State University. Every effort will be made by the Department Head to provide the necessary engineering controls to relieve the need for respirators.
6. Record keeping:
   a. The university shall establish and maintain for each laboratory employee an accurate record of any measurement taken to monitor employee exposures and any medical consultation and examination including tests or written opinions required by this standard.
   b. The university shall assure that such records are kept, transferred and made available in accordance with 29 CFR 1910.20 as adopted by K.S.A.44-636 and 0637.

IV. STANDARD OPERATING PROCEDURES

A. Chemical Procurement and Distribution

1. Procurement:
    a. Use only chemicals for which the ventilation system is adequate.
    b. Carefully estimate the amount of each chemical that is required for the experimental procedures. Whenever possible, order chemicals in small container lots to avoid hazards and additional difficulties that are associated with repackaging.
    c. Obtain prior approval from the laboratory director or supervisor whenever a new or significantly modified laboratory procedure is to be documented or it is likely that a threshold limit value or other hazard limit could be exceeded during a procedure. Before a chemical is received, information on the proper handling, storage and disposal should be known by those who will be involved.
    d. Proper labeling: No container should be accepted that lacks an adequate identity label.
2. Distribution:
    a. Chemicals should be transported using the container-within-a-container concept. Large containers of corrosives must be transported from central storage in a chemically resistant bucket or other container that has been designed for this purpose.
    b. When transporting chemicals by cart, ensure that the cart is stable and has wheels that are large enough to negotiate uneven surfaces, such as expansion joints, without tipping or stopping suddenly.
    c. When transporting gas cylinders, use an appropriate cylinder tank carrier. Leave the protective gas valve cap in place until the cylinder is ready to be used.
    d. Whenever possible, transport chemicals on freight-only elevators to minimize potential danger to others. Negotiate stairs and doorways carefully.

B. Chemical Storage and Inventory Management

1. Ensure adequate security to prevent unauthorized access.

2. Housekeeping in the storage areas must be neat and orderly.
3. Storage shelves and units must be stable and secure against sliding and collapse and not subject to flooding.

4. Keep only the minimum quantities of flammables and combustibles in the laboratory. See Table II for maximum quantities that can be stored in a single container, and Table III for maximum quantities that can be stored in a single fire area (100 square feet).
5. Refrigerators that are used for chemical storage must be explosion proof.
6. The label of a chemical should have its date of receipt, the date of its initial opening and the decision date for disposal or recycling.
7. Segregate chemicals by chemical compatibility. See Appendix III for a brief list of chemicals and their incompatibilities. The storage area must be adequate to separate chemicals from the most reactive groups (e.g., do not store acids with bases or oxidizers with organics).
8. It is desirable to maintain a computer data base for all chemicals, and especially carcinogens, suspected carcinogens and toxic materials, to allow their tracking from the date of receipt to the date of disposal or recycling.

C. Handling Corrosive Chemicals

1. Corrosives, such as acids and bases, are materials that cause visible damage at the site of contact. Corrosive materials attack the skin and eyes, causing potentially permanent disfigurement and loss of sight.
2. General Procedures: Wear eye protection and rubber gloves. If splashing is considered to be a possibility, then a face shield, rubber apron, rubber boots and other appropriate safety apparel and protection should also be used. Always add the corrosive material to water (never the reverse). Eyewash and safety shower must be readily accessible in areas where corrosives are used and stored. In the event of contact with the skin or eye, immediately flush the area of contact for 15 minutes with cool water. Remove all affected clothing and seek medical attention.

D. Handling Acids

1. Hydrogen halides: All hydrogen halides are acids and all are serious respiratory irritants. Hydrogen fluoride is particularly dangerous - both its gas and solutions are toxic and is rapidly absorbed through the skin. Serious burns or death may result. Immediate attention by a physician who is prepared to treat hydrogen fluoride burns are imperative. The fluoride ion can penetrate skin, causing destruction of deep tissue layers including bone. Unlike other acids that easily can be neutralized, this process may continue for days. A MSDS for HF should be kept in the immediate area of use. If an HF accident occurs, call the emergency desk at Mercy Hospital for information and to alert medical personnel that an HF burn has occurred and transport the patient to the hospital immediately.
    a. First Aid
        i. Skin contact:
            a. Remove the victim from the contaminated area and immediately (within seconds) shower or flush with plenty of water for 5 min.
            b. Remove all clothing while in the shower. (Remove goggles last and double-bag contaminated clothes.)
            c. Take a tube of Calcium gluconate gel from the CB 111 First Aid kit or the Departmental Spill Cart in CB 136. Use gloves while applying to prevent contact with uncontaminated skin. Massage the gel promptly and repeatedly into the burned area until pain is relieved. Even if pain subsides within 20 to 30 minutes, get medical help (Call 9-911).
        ii. Breathing vapor:
            a. Immediately get to fresh air.
            b. Keep the victim lying down, quiet and warm.
            c. Call or have someone call for medical help (Call 9-911).
        iii. Ingestion:
            a. Drink large amounts of water. Do not induce vomiting.
            b. Drink several glasses of milk or several ounces of milk of magnesia for a soothing effect.
            c. Take the victim to a physician (Call 9-911).

iv. Eye contact:
    a. Irrigate eyes for at least 15 minutes with large amounts of gently flowing water.
    b. Seek medical attention immediately after flushing the eyes.
    c. Apply ice water compresses and if possible, continue irrigating the eyes until attended to by a physician (Call 9-911).

b. In case of a spill
    i. Use the ACID spill Emergency Cleanup Kit in CB 111 or the Departmental Spill Cart in CB 136. It is located to the lower right of the bookcase next to the freezer.
    ii. Protect yourself.
        a. Put on goggles, apron, gloves and shoe coverings.
        b. Contain the spill by surround the spill with absorbent/neutralizer mixture then fill the circle with the remaining mixture.
        c. Dispose of used mixture bottle and kit contents.
        d. After the mixture turns blue, put it into a waste bag using a dustpan and brush. Seal the bag tightly and place in kit along with kit contents. Close kit securely and dispose of in the appropriate manner.
        e. Call the Department of Environmental Health and Safety for pick-up.

2. Oxyacids:
    a. Sulfuric acid is a strong dehydrating agent. Because of the large heat of solution, always add the acid to water.
    b. Nitric acid is a strong oxidizing agent that turns the exposed skin brown as the denaturing reaction occurs. Wear protective gloves and avoid contact with skin.
    c. Perchloric acid is a strong oxidizing agent that may react explosively with organic compounds and other reducing agents, especially at elevated temperatures and in concentrated solution. The acid must only be handled in a water wash-down fume hood that is non-combustible. Do not allow solutions of perchloric acid to dry out.
3. Picric acid is a high explosive that is especially dangerous when

dry. Avoid use unless absolutely necessary. Maintain as a hydrated solution.

E. Handling Bases

1. Alkali metal hydroxides are extremely destructive to skin and the tissues of the eye. Use extreme caution when preparing concentrated solutions.
2. Ammonia vapors are a strong irritant. Liquid ammonia can cause severe burns. Always use ammonia in a well ventilated area, preferably a fume hood.

F. Handling Reactives

1. Reactive materials are materials that react rapidly with themselves or with other materials to produce large amounts of energy, flammable or toxic materials or other hazardous conditions.
2. Peroxides and peroxide-forming chemicals:
   a. Label the container of all ethers with the date that it is opened. Isopropyl ether, isoamyl ether and anhydrous ethers can not be kept more than six months. The hazard of peroxide formation increases rapidly upon opening the container. Diethyl ether and other ethers shall not be kept over one year unless they are stored in an oxygen-free environment.
   b. Ethers must not be distilled unless they are known to be free of peroxides.
   c. Materials that are suspected of having very high peroxide levels because of unusual viscosity, crystal formation or age should be considered extremely dangerous. Such containers must not be opened, because detonation of peroxide crystals could result.
   d. Do not refrigerate liquid peroxides or solutions that may contain peroxides at or below the temperature at which the peroxide freezes or precipitates. Peroxides in these forms are extremely sensitive to shock and heat.
   e. Never use a metal spatula with organic peroxides. Contamination by metals can cause explosive decomposition. Use ceramic or plastic spatulas instead.
   f. Avoid friction, grinding and all forms of impact, especially

with solid organic peroxides. Never use glass containers with screw cap lids or glass stoppers. Instead, use plastic bottles and sealers.

g. Examples of chemicals other than ether, that form dangerous concentrations of peroxides upon exposure to air include: cyclohexene, decalin, p-dioxiane, tetrahydrofuran, tetralin, cyclic ketones and other compounds that have readily abstracted hydrogen atoms (e.g., benzylic compounds, cumene and vinyl acetate).

3. Pyrophorics: compounds that ignite spontaneously upon contact with oxygen. Examples include metal alkyls, phosphorus, fine powders of metals such as magnesium, aluminum and zinc. Precautions: use these materials only in an inert atmosphere.

4. Water sensitive materials: compounds that react with water to produce a flammable or toxic gas or creates a hazardous condition. Examples: alkali metals, such as sodium and potassium, acid anhydrides, acid chlorides and calcium hydride. Precautions: avoid contact with and handle away from water sources. Use dry sand to smother fires. Provide appropriate ventilation to disperse flammable gases.

5. Oxidizers: compounds that may react violently with organic materials and reducing agents (e.g., perchloric acid, chromic acid and fuming nitric acid).

   a. Perchloric acid: use of hot acid or concentrations above 72% greatly increase the hazard. Acid strengths of 90-100% are especially hazardous and may explode spontaneously upon contact with reducing agents. Fuming perchloric acid shall be used only in a perchloric acid fume hood that has wash-down capabilities. The quantity of perchloric acid stored in a perchloric acid fume hood shall not exceed 500 mL.

   b. Fuming nitric acid: use the minimum quantity that is needed for the procedure. Store away from flammable materials and other reducing agents.

G. Flammables and Combustibles

1. A flammable substance is one whose vapors will ignite when exposed to an ignition source at temperatures below 100E F (37.8° C); a combustible substance is one that must be heated above 100E F (37.8° C) to achieve ignition. Flammable liquids

are divided into classes IA, IB and IC on the basis of flash points and boiling points; combustible liquids are divided into classes II, IIIA and IIIB on the basis of flash point (Table I). Class IA liquids are the most easily ignited, whereas class IIIB liquids are the most difficult to ignite. Know the class and combustibility of all chemicals you use in the laboratory.

2. The maximum allowable container sizes for each class of flammable and combustible liquid are given in Table II. Although up to 4 gallons of flammable liquids are permitted in a single fire area (100 square feet), note that the maximum permissible quantity of class IA liquid that can be stored in a glass container is only one pint!
3. In order for ignition to occur, three elements must be present: fuel, an oxidizer and an ignition (energy) source. Because air is usually present, removal of the ignition source and limiting the quantity of available fuel are the most common ways of minimizing unwanted combustion:
    a. Eliminate ignition sources such as open flames, hot surfaces, heat guns, sparks from cutting and welding tools and electric motors (e.g., electric motors on vacuum pumps), and static electricity from areas where flammable and combustible materials are stored or handled. Post appropriate warning signs.
    b. Store flammables and combustibles in proper storage containers and storage cabinets. Store away from oxidizers.
    c. Refrigerators and freezers used for the storage of flammable or combustible liquids must be explosion proof. If possible, operate all electric motors on benches rather than on floors where vapors of flammable and combustible materials tend to accumulate.
    d. Make certain that metal containers are properly grounded when making a transfer of a flammable or combustible liquid from one container to another.
    e. Do not dispose of flammable and combustible materials down the sanitary sewer. Ensure that all sink and floor drain traps are filled with water.
    f. Make certain that an appropriate fire extinguisher is readily available in the event of an emergency, i.e. fire.

Table I. Classes of Flammable and Combustible Liquids

Class	Flash Point	Boiling Point	Examples
IA	<73°C (22.8°C)	<100°F	Diethyl ether, pentane, vinylidene chloride, acetaldehyde
IB	<73°F (22.8°C)	(37.8°C) 100°F	Acetone, ethanol, hexane, toluene
IC	73°F (22.8°C)	(37.8°C)	Styrene, nonane, xylenes, chlorobenzene
II	<100°F (37.8°C) <140°F (60°C)		N,N-dimethylformamide, mesitylene, hydrazine, decane
IIIA	140°F (60°C), <200°F (93.3°C)		Dodecane, aniline, phenol, o-dichlorobenzene
IIIB	200°F (93.3°C)		Ethylene glycol, mineral oil, hexadecane, trichlorobenzenes

Table II. Maximum Allowable Container Capacities

	Flammable Liquids[1,2]			Combustible Liquids[1,2]	
Container Type	IA	IB	IC	II	III
Glass	1 pt	1 qt	1 gal	1 gal	1 gal
Metal or Approved Plastic	1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	2 gal	5 gal	5 gal	5 gal	5 gal

1. See Table I for definitions of the various classes of flammable and combustible liquids.

2. In instructional laboratory work areas, no container for Class I or II liquids shall exceed a capacity of 1 gallon, except that safety cans may be of 2-gallon capacity.

H. Cooling Baths, Cold Traps and Temperature Control

Combinations of ice, water and sodium chloride will provide temperature control in the range -20°C to 0°C. When lower temperatures are required, dry ice or cryogenic liquids, usually in combination with organic liquids, may be used if appropriate caution is exercised.

The ideal cooling liquid should be nontoxic, have low viscosity, be nonflammable and have low volatility. Although no substance is ideal, liquids that have been recommended for use with dry ice as the coolant include Isopar L, ethylene glycol mixed 3:2 with water and thinned with isopryopyl alcohol (caution: flammable) and isopropyl alcohol (caution: flammable). When a cryogenic liquid such as nitrogen (b.p. -196°C) is used as the coolant, be aware that oxygen (b.p. -183°C), water and other gases may condense into the liquid nitrogen. Because many of the liquids that are used in slush baths (for example, see D. F. Shriver, The Manipulation of Air-Sensitive Compounds, McGraw-Hill, New York, 1969, Chapter 1) are flammable, combustible or toxic, special precautions must be exercised when these materials are employed in experiments. Additional recommendations for handling cryogenic liquids include:

1. Dewar flasks should be constructed of metal (preferable) or borosilicate glass. The latter should be wrapped with cloth backed friction or duct tape or enclosed in a metal case in the event of an implosion.
2. Contact of the cryogenic liquid with skin could result in severe frostbite. Use appropriate protective apparel, but do not wear gloves that could become frozen to the skin (potholders are preferable). The use of a face shield is recommended.
3. Add the cryogenic liquid slowly to the material to be cooled to avoid vigorous boiling and overflow of the coolant.
4. Use care and appropriate hand trucks in transporting cryogenic containers.
5. Minimize contact of moisture with cryogenic storage containers to avoid ice formation and possible plugging of pressure-relief valves.
6. Cryogenic liquids must be stored in properly vented containers and in properly ventilated areas to avoid possible displacement of air.

7. Cryogens may alter the physical characteristics of materials (e.g., susceptibility to shattering upon impact). Select all work materials carefully.

I. Compressed Gases

1. Most gases that are used in the chemical laboratory are supplied in cylinders at high pressure. Rules for the safe use of high-pressure gases include:
2. Handle cylinders of compressed gases as high energy sources and therefore as potential explosives.
3. Restrain cylinders of all sizes, empty or full, individually by straps, chain or a suitable stand to prevent them from falling.
4. Store cylinders in appropriately ventilated cabinets or in an open storage area.
5. When storing or moving cylinders, have the protective caps in place to protect the valve stems.
6. When moving large cylinders, strap them to properly designed wheeled carts to ensure stability.
7. Do not expose cylinders to temperatures higher than 50°C. Some rupture devices on cylinders will release at about 65°C. Some small cylinders, such as lecture bottles, are not fitted with rupture devices and may explode if exposed to high temperatures.
8. Never use cylinders with unidentified contents.
9. Never lubricate, modify, force or tamper with cylinder valves or regulators.
10. Use toxic, flammable or reactive gases in fume hoods only.
11. Do not use compressed gas or compressed air to blow away dust or dirt; the resultant flying particles are dangerous and could become embedded in skin and eyes.
12. Be aware that rapid release of a compressed gas could cause an unsecured gas hose to whip dangerously or build up a static charge that could ignite a combustible gas.
13. Do not extinguish a flame involving a highly combustible gas until the source of gas has been shut off; otherwise, it can reignite causing an explosion.
14. Close the main cylinder valves tightly when the cylinder is not in use.
15. Use the appropriate regulator on each gas cylinder.
16. Do not put oil or grease on the high pressure side of a regulator

used with oxygen, chlorine or other oxidizing agent cylinder. An explosion can result.

17. Always wear safety glasses when handling and using compressed gases.
18. Never bleed cylinders completely empty. Leave a slight pressure to keep contaminants out.
19. Promptly remove the regulators from empty cylinders and replace the protective caps at once. Mark the cylinder as empty and arrange for return to the supplier.
20. Observe the following special rules when working acetylene cylinders:
    a. Acetylene cylinders are partially filled with acetone; always store them upright.
    b. Do not use an acetylene cylinder that has been stored or handled in a non-upright position until it has remained in an upright position for at least 30 minutes.
    c. Ensure that the outlet line of an acetylene cylinder is protected with a flash arrester.
    d. Never exceed the pressure limit indicated by the warned red line of an acetylene pressure gauge.
    e. Use the correct kind of tubing to transport the gaseous acetylene. Tubing materials such as copper and some brass alloys form explosive acetylides.
    f. Always place a trap between the compressed gas cylinder and the reactor vessel to avoid accidental "suck-back" of reactant liquid into the cylinder on other reaction apparatus.

J. Reduced Pressure Operations

Precautions for reduced pressure operations should include:

1. Vacuum desiccators:
   a. Protect user from the dangers of possible implosion by wrapping the vacuum desiccator with cloth-backed friction or duct tape, by enclosing it in a box, or by using an approved shield.
   b. Only chemicals being dehydrated should be stored in a vacuum desiccator.
   c. Restore normal atmospheric pressure before opening a vacuum desiccator that is under reduced pressure.
2. Vacuum pumps:
   a. A cold trap should be placed between the apparatus and the vacuum pump so that volatiles from a reaction or distillation do not get into the pump oil or into the laboratory atmosphere.
   b. Exhausts from vacuum pumps should be vented to the fume exhaust system.
   c. All vacuum pumps must be operated with appropriate belt guards.
3. Aspirators and rotary evaporators:
   a. Place a trap and check valve between the aspirator and the apparatus so that water cannot re-enter the potable water supply.
   b. Solvents or materials that would be classified as hazardous waste or as flammable must not be permitted to enter the sewer system. Use an appropriate cold trap to collect these materials.
   c. Use only approved glassware. Never apply reduced pressure to a flat-bottom flask unless the flask is heavy walled and designed for the vacuum work.

K. Radioactive Materials

1. Personnel working with radioactive materials must adhere strictly to the general safety precautions of the chemical laboratory. In addition, special procedures and regulations for working with radioactive materials apply. These include:
2. The procurement, storage, use, handling and disposal of any

radioactive material, as specified in the Department of Environmental Health and Safety's "Radiation Safety Manual".

3. A license must be obtained by the faculty member (academic rank: instructor or higher) who is responsible for the direction of research. Applications must be made to the Kansas State University Safety Officer. The license will be limited to the radioisotopes and quantities that have been approved.
4. All radioisotopes must be shipped to the Department of Environmental Health and Safety, Edwards Hall. Department of Environmental Health and Safety personnel will deliver all shipments of radioactive materials to the authorized laboratory.

L. Lasers and Ultraviolet Radiation

1. Lasers: Overexposure and possibly permanent damage of the eye and skin are the principal hazards of improper laser use. Other hazards include fires or vaporization of hazardous materials that may be caused by the laser beam or electrical shock that may result from accidental contact with the laser's power supply. For regulatory purpose, lasers are classified as continuous (CW) or pulsed, by the wavelength of the radiation emitted: visible (400 nm-700 nm), ultraviolet (400 nm) or infrared (700 nm), and their power.
   a. Class I: very low power and exempt from laser beam hazards control
   b. Class II: low power (1 mW for CW visible laser)
   c. Class III: medium power (1-500 mW for CW visible lasers and up to 3 J/cm^2 for long-pulse ruby lasers)
   d. Class IV: high-power lasers with power or beam intensities greater than Class III
2. General safety procedures for the laboratory work area include:
   a. Avoid looking directly into the laser beam.
   b. Do not aim the laser with the eye because direct reflection could cause permanent eye damage. When high-power pulsed lasers are energized, a countdown system with eyes closed during firing should be used.
   c. Safety glass should not be relied upon to view the laser beam directly. If laser safety goggles are used, they should be suitable for the specific energy and wavelength of the laser beam under consideration.
   d. Any afterimage, resulting from exposure to either a direct laser beam or a reflection, should be reported to an ophthalmologist, preferably a specialist in retinal burns.
   e. Operators shall not permit specularly reflective materials to be placed in the beam path when not needed for the intended use.
   f. Each laser product shall be operated in a controlled area.
   g. Each controlled area shall be posted with suitable warning signs.
   h. When there is a reasonable probability that the maximum physical exposure level (MPEL) for the skin will be exceeded, appropriate personal protection apparel is required.

i. Each laser beam shall be terminated by a block of material that does not allow laser radiation to be reflected.
j. Each laser product shall be secured against unauthorized operation.
k. Each laser product, regardless of its class, shall have a protective housing, which, when in place, prevents human access during normal operation. Each laser product or installation, regardless of its class, shall be provided with a safety interlock for each portion of the protective housing or enclosure that is designed to be removed or displaced during normal operation or maintenance.
l. Each Class II, III or IV laser system shall provide visual or audible indication immediately before and during the emission of accessible laser radiation in excess of limits for Class I.
m. Personnel who are routinely exposed to potentially hazardous laser radiation should have an annual eye examination.
n. A detailed operating procedure should be prepared prior to laser use and should always be retained and followed by operators.

3. General safety procedures for working with ultraviolet radiation includes:
   a. While ordinary spectacles will offer adequate eye protection in many cases, tinted safety glasses or goggles with solid side pieces are recommended.
   b. Skin protection provided by ordinary clothing.

M. Carcinogens and Chemicals with Moderate Chronic or High Acute Toxicity

In accordance with recommendations of the American Chemical Society, quantities less than 10 mg are exempt from special handling procedures. Nevertheless, due caution must be exercised in handling any material that may be a carcinogen, toxic or otherwise dangerous to one's health.

1. Carcinogens (see www.cdc.gov/niosh/npotocca.html for the list of carcinogens as defined by NIOSH)
   a. Categories of Risk
      i. The risk from chemical carcinogens is greater or less

depending on the quantity, the chemical properties or the intended operation. High-risk situations are those that involve the use of a highly potent chemical carcinogen, large quantities of chemical carcinogens, use of compounds with high vapor pressure or procedures that have a high potential for aerosol production or contamination. Operations such as blending or manipulation of powders are high-risk situations. In low-risk situations, the minimum safeguards are strict adherence to good laboratory practices. Personnel with medical condition, such as depressed immune response or steroid cytotoxic drug treatment, that makes them unusually susceptible to possible harmful effects of a carcinogen must be excluded from any area where accidental exposure might occur. Fertile men and women, or pregnant women may be at greater risk, since many carcinogens are also mutagens or teratogens.

b. Personnel Protection

i. Clothing. Fully fastened lab coat or disposable coveralls should be worn over street clothing for low risk work. Personnel working with high risk chemical carcinogens should wear full-length overalls constructed of chemical resistant and particle impervious spunbonded olefin.

ii. Protective equipment. Personnel engaged in procedures where exposure to airborne particulates contaminated with chemical carcinogens could occur (i.e., a high risk situation) shall wear an appropriate respirator as determined by the Chemical Hygiene Officer. The respirator shall not be worn outside the work area. Used filters shall be replaced and the respirator housing shall be decontaminated after use. See the "Respirator Program" concerning the use of respirators. Copies of the rule are available upon request.

iii. There shall be no eating, drinking, smoking, chewing of gum or tobacco, using smokeless tobacco, application of cosmetics or storage of food in areas where chemical carcinogens are used.

iv. Pipetting. Oral pipetting is prohibited. Mechanical pipetting aids shall be used for all pipetting procedures.

v. Personal hygiene. All personnel shall wash their hands with detergent immediately after completion of any procedures in which chemical carcinogens have been used.

c. Work practices

i. Work area identification. Entrances to all work and storage areas where chemical carcinogens are present shall be posted with a sign bearing the legend:

DANGER – CHEMICAL CARCINOGEN

Authorized Personnel Only

ii. Work and storage areas shall be entered only by personnel authorized by the research director only.

iii. All work surfaces on which chemical carcinogens are used shall be covered with stainless steel trays, uncracked glass plates, dry absorbent plastic-backed paper or other impervious material. Immediately after use, the contaminated surface shall be decontaminated or disposed of as is appropriate.

iv. Procedures shall be conducted in a laboratory hood or other suitable containment device when:

a. The procedure involves the use of volatile chemical carcinogens

b. The procedure results in the generation of aerosols, such as from the opening of closed vessels, transfer operations, weighing, preparation of feed mixtures and the application, injection and intubation of a chemical carcinogen to experimental animals.

v. Each laboratory hood or containment device used for containment of chemical carcinogens shall display a label bearing the legend:

DANGER–CHEMICAL

vi. Only the minimum quantities of chemical carcinogens necessary for research shall be present in a work area.

d. Identification, storage and inventory

i. Storage vessels containing chemical carcinogens shall be labeled:

DANGER–CHEMICAL CARCINOGEN

ii. Stock quantities of chemical carcinogens shall be catalogued and stored in a specific storage area that is secured at all times.

iii. An inventory of all chemical carcinogens shall be maintained by the research supervisor. The inventory records shall include the quantities of chemical carcinogens acquired, dates of acquisition and their dispositions.

e. Laboratory transport

i. Stock quantities of chemical carcinogens shall be transported using an unbreakable outer container.

ii. Contaminated materials that are transferred from work areas to disposal areas shall be placed into separate closed, plastic bags or other suitable impermeable and sealed container for each carcinogen and labeled with both the name of the carcinogen and "DANGER-CHEMICAL CARCINOGEN" before being transported.

f. Housekeeping. Wet mopping or vacuuming with a HEPA filter equipped vacuum cleaner shall be used. Dry sweeping and dry mopping are prohibited. In those instances where a carcinogen is spilled, special procedures shall be followed.

g. Protection of vacuum lines. Each vacuum service shall be protected with a disposable HEPA filter and liquid trap to prevent entry of any chemical carcinogen into the vacuum system. When using a volatile carcinogen, a separate vacuum pump or other device shall be used in conjunction with an appropriate laboratory hood or other approved containment device.

h. Decontamination and disposal

i. Chemical carcinogens that have spilled and constitute a hazard shall be deactivated in situ or absorbed for subsequent disposal.
ii. Contaminated wastes, cleaning devices, animal waste and animal carcasses shall be collected in impermeable containers, which are closed prior to removal from the work areas, and disposed of by incineration or approved burial.

i. Laboratory hoods and exhaust air treatment.
  i. Laboratory hoods
    a. The chemical fume hood shall have an average linear face velocity of 100 feet per minute (fpm). The minimum air velocity at any point in the face of the fully opened hood shall not be less than 80 fpm, and maximum of 150 fpm.
    b. Glove boxes shall be kept under negative air pressure of 0.5 inches water gauge relative to the surrounding atmosphere.
    c. Laminar-flow biological safety cabinets may be used for the containment of in vitro procedures involving the use of chemical carcinogens provided that:
      1. The exhaust airflow is sufficient to provide an inward air flow at the face opening of the cabinet equal to 100 feet per minute times the face opening area;
      2. Contaminated air plenums that are under positive air pressure are leak tight;
      3. The cabinet exhaust air is to be discharged into the exhaust system.
  ii. Exhaust Air Treatment
    a. The exhaust air from laboratory type hoods and other ventilated containment devices shall be appropriately treated by filtration, reaction, absorption, adsorption, incineration or dilution, so that the concentration of any chemical carcinogen or combination of chemical carcinogens in the final effluent that is discharged outdoors shall not exceed 1 ppb or natural background levels, whichever is

greater.

b. Exhaust air treatment systems that remove chemical carcinogens from the exhaust air by collection mechanisms such as filtration, absorption and adsorption shall be operated in a manner that permits maintenance so as to avoid direct contact with the collection medium.

iii. Performance of laboratory hoods and exhaust air treatment systems shall be checked at least annually by the Department of Environmental Health and Safety.

j. Facilities

i. General exhaust air from work areas shall be discharged outdoors and dispersed to the atmosphere so as to prevent re-entry into the facility. No re-circulation of exhaust air from work areas is permitted.

ii. Air pressure in work areas shall be kept under negative air pressure with respect to the access corridor. For facilities where work areas have "clean" access corridors with"dirty" egress corridors, the "dirty" egress corridor shall be kept under negative air pressure with respect to the work area.

2. Chemicals of moderate chronic or high acute toxicity:
   (Examples include hydrofluoric acid and hydrogen cyanide)
   a. Use and store these compounds only in areas of restricted access with special warning signs.
   b. Always use a fume hood with a face velocity of at least 80 linear feet per minute or another confinement device for procedures that might produce aerosols or vapors. Trap released vapors to prevent their discharge.
   c. Always avoid skin contact by use of gloves and other appropriate protective apparel.
   d. Always wash hands, arms and face immediately after working with these materials.
   e. Maintain records of the amounts of these materials in inventory, the disposition of these materials and the names of laboratory personnel involved.

N. Allergens and Embryotoxins

1. Examples of allergens are diazomethane, formaldehyde, isocyanates and some phenols; examples of embryotoxins are organomercurials, lead compounds and thalidomide.
2. Use only in a well-functioning fume hood.
3. Use appropriate protective apparel to prevent contact with skin.
4. Review each use of these materials with the laboratory director and review continuing uses annually or whenever a procedural change is made.
5. Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.
6. Notify laboratory director of all incidents involving exposure or spills.
7. Consult a qualified physician when appropriate.

O. Neutralization of sodium remaining after distillation of THF or diethyl ether or other source:
   1. Procedure: A still (containing sodium and THF or diethyl ether) is stirred and cooled over an ice-water bath. To it, methanol should be carefully added until sodium has completely reacted (forming sodium methoxide which is soluble in THF and methanol). Sodium, wire or metal plug (a solid), should disappear. An excess of methanol should be added to ensure that the sodium is completely reacted. The resulting solution

should be carefully added to an ice-water bath, and aqueous HCl added until the solution is neutral (pH = 7). The solution is then given to Public Safety for disposal.

2. Safety precautions: wear eye protection and complete the procedure in a fume hood.

V. EMPLOYEE EXPOSURE MONITORING

A. Initial Monitoring. The Department Head will provide adequate employee monitoring for substances that are regulated by a health standard that require monitoring, such as formaldehyde or ethylene oxide, if there is a reason to believe that exposure levels routinely exceed the threshold limit value (TLV).

B. Periodic Monitoring. If initial monitoring discloses employee exposure above the TLV, the Department Head will comply with the exposure monitoring provisions of the relevant standard.

APPENDIX I: Material Safety Data Sheets (MSDSs)

A material safety data sheet must be available in the laboratory or on a book-marked computer site available in the laboratory, for every chemical used. The MSDS must include the following information:

a. Chemical name - usually the IUPAC (International Union of Pure Applied Chemistry) or Chemical Abstracts Service chemical name is given, but it also may be a common name for the chemical (e.g. ethylene glycol is acceptable instead of 1,2-ethanediol). Trade names may be supplied, but the chemical name is also required, unless it is considered to be a trade secret.

b. CAS Registry Number - This number is not required by OSHA but most state Right-to-Know laws require it. This number is assigned to each chemical by Chemical Abstracts Service. There are a few instances where a chemical has several different numbers, a few chemicals have no assigned number and most mixtures do not have assigned numbers.

c. Date Prepared - OSHA requires that the date of preparation, or latest update, be on the MSDS.

d. Composition of Mixtures - This includes all hazardous materials over 1% and all carcinogens over 0.1%. Trade name can be used but chemical names must be included unless this information is considered a trade secret.

e. OSHA PEL - This is either a time-weighted average limit for an 8 hour day or a maximum concentration exposure limit for those items on the OSHA list. The figures may be in parts per million (ppm) or mg per cubic meter (mg/m^3).

f. ACGIH TLV - Maximum exposure limits recommended by the American Conference of Governmental Industrial Hygienists. The same measuring units specified in the OSHA PEL are applicable. The ACGIH TLV list is updated each year.

g. Health Effects - Identification of target organs or systems adversely affected by overexposure.

h. Physical/Chemical Characteristics - This usually includes the following items;

$ Boiling point - the value may be at reduced pressure and either in degrees Celsius or Fahrenheit
$ Melting point
$ Vapor pressure - usually in mm Hg; the temperature must be specified (usually in the range of room temperature)
$ Solubility in water - approximate values are acceptable
$ Appearance and odor
$ Evaporation rate - usually relative to butyl acetate

i. Fire and Explosion Hazard Data

- Flash point - There are several methods of establishing the flash point; the method should be specified. In general, the flash point of the chemical is the temperature at which its vapor can be ignited.
- Auto ignition temperature - the temperature at which a vapor ignites spontaneously in the air.
- Flammability limits - Most volatile chemicals have lower and upper concentrations in air below and above which they cannot be ignited.
- Recommended extinguishing media
- Unusual fire and explosion hazards

j. Reactivity Hazard Data - Information should include whether the material is unstable and under what conditions instability exists, incompatibilities and whether hazardous decomposition products can be produced.

k. Health Hazard Data - Hazards are explicitly listed (if known):

- LD_{50} (lethal dose 50) - This is lethal single does (usually oral) in mg/kg (milligrams of chemical per kilogram of animal body weight) of a chemical that is expected to kill 50% of a test animal population in one exposure.

In the Health Hazard Data Section, MSDSs often use words or phrases such as avoid contact, flammable and others. Generalized descriptions of many of these phrases and the precautions to be practiced follow:

- AVOID CONTACT: General rule for all chemicals, even if they are considered nonhazardous.

  PRECAUTIONS: Do not breathe vapors and avoid contact with skin, eyes and clothing for all chemicals handled.

- CARCINOGEN: Substances that are suspected or known to cause cancer. Some may have threshold limits of exposure.

  PRECAUTIONS: Exercise extreme care when handling! Do not breathe vapors and avoid all contact with skin, eyes and clothing by wearing suitable protective equipment and using appropriate confining apparatus.

- CORROSIVE: Living tissue destroyed on contact with these chemicals.

  PRECAUTIONS: Do not breathe vapors and avoid contact with skin, eyes and clothing. Use suitable protective equipment.

- DANGER: Substances that have known harmful effects or that may have harmful effects, but have no available literature citing such effects.

  PRECAUTIONS: Treat as if these are the most dangerous chemicals that exist. There may or may not be hazards associated with these chemicals.

- EXPLOSIVE: Substances known to explode under some conditions.

  PRECAUTIONS: Avoid shock (dropping), friction, sparks and heat. Isolate from other chemicals that become hazardous when spilled.

- FLAMMABLE: Substances that give off vapors that readily ignite under usual working conditions.

  PRECAUTIONS: Spontaneously flammable - Avoid contact with air flammable liquids, gases, vapor – keep away from heat, sparks or open flame - sensitive to moisture - keep dry.

- IRRITANT: Substances that have an irritant effect on skin, eyes, respiratory tract, etc.

  PRECAUTIONS: Do not breathe vapors and avoid contact with skin and eyes.

- LACHRYMATOR: Substances that have an irritant or burning effect on skin, eyes or respiratory tract. These are dangerous in very small quantities (opening the cap has an immediate effect on eyes).

  PRECAUTIONS: Only open in a hood! Do not breathe vapors. Avoid contact with skin, eyes. Avoid heating.

- MUTAGEN: Chemical or physical agents that cause genetic alterations.

  PRECAUTIONS: Handle with extreme care! Do not breathe vapors and avoid contact with skin, eyes and clothing.

- PEROXIDE FORMER: Substances that form peroxides or hydroperoxides upon standing or when in contact with air.

  PRECAUTIONS: Many peroxides are explosive! Do not open bottle if a residue is present on the outside of the cap

or inside of the bottle!

- POISON: Substances that have very serious and often irreversible effects on the body. Hazardous when breathed, swallowed, or in contact with the skin and in sufficient quantity lead to death. The Department of Transportation regulations classify many poisons for transportation.

  PRECAUTIONS: Avoid all contact with the body. When handling use suitable protective equipment.

- STENCH: Substances that have or generate bad smelling odors.
  PRECAUTIONS: Open only in a hood.

- TERATOGEN: Substances that cause the production of physical defects in a developing fetus or embryo.
  PRECAUTIONS: Handle with extreme care! Do not breathe vapors and avoid contact with skin, eyes and clothing. Use suitable protective equipment when handling.

- TOXIC: Substances that are hazardous to health when breathed, swallowed or are in contact with the skin. There is danger of serious damage to health by short or prolonged exposure.
  PRECAUTIONS: Avoid all contact with the body. When handling use suitable protective equipment.

i. First Aid - Appropriate procedures for emergency first aid should be given in the MSDS.

j. Precautions for Spills and Cleanup - Appropriate steps for safe cleanup of a spill or release should be given. An appropriate waste disposal method including whether the material can be pout in a landfill or other EPA approved disposal facility should be supplied in the MSDS.

k. Control Measures - Types of protective clothing, gloves and respiratory protection should be listed. If the material should always be handled in a hood, glove box or with extra ventilation, it should be listed under this heading.

APPENDIX II: Definitions of Hazardous Wastes

Ignitability: A solid waste exhibits the characteristic of ignitability, if the waste exists in any of the following forms:

- a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume, with a flash point below 60°C;
- a non-liquid, which under standard conditions is capable of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burns in a manner that creates a hazard;
- an ignitable compressed gas, which include gases that form

flammable mixtures at a concentration of 13 percent or less in air; or

- an oxidizer, such as a permanganate, inorganic peroxide or nitrate, that readily stimulates combustion of organic materials.

Reactivity: A solid waste exhibits the characteristics of reactivity if the waste:

- is normally unstable and readily undergoes violent change without detonation;
- reacts violently with water;
- forms potentially explosive mixtures with water;
- generates, when mixed with water, toxic gases, vapors or fumes in a quantity sufficient to present a danger;
- is a cyanide- or sulfide-bearing waste that generates toxic gases, vapor or fumes at a pH between 2 and 12.5;
- is capable of detonation or explosive reaction when subject to a strong initiating source or if heated in confinement;
- is readily capable of detonation, explosive decomposition or reaction at standard temperature; or
- is an explosive.

Corrosivity: A solid waste exhibits the characteristics of corrosivity if the waste:

- is aqueous and has a pH #2, or $12.5, using EPA-specified or approved test methods; or
- is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 millimeters per year at a test temperature of 55°C.

Toxicity:

A solid waste exhibits the characteristics of toxicity when EPA-defined test procedures indicate that an extract derived from the waste contain certain toxicants. EPA requires toxicity to be tested using the Toxicity Characteristic Leaching Procedure (TCLP), which stimulates the leaching of materials in a landfill into the surrounding ground water. The toxicants to be tested for are:

arsenic
barium
benzene
cadmium
carbon tetrachloride
chlordane
chlorobenzene
chloroform
chromium
o-, m-, and p-cresol
2,4-D
1,4-dichlorobenzene
1,2-dichloroethane
1,1-dichloroethylene

2,4-dinitrotoluene
endrin
heptachlor (and its hydroxide)
hexachlorobenzene
hexachlorobutadiene
hexachloroethane
lead
lindane
mercury
methoxychlor
methyl ethyl ketone
nitrobenzene
pentachlorophenol
pyridine
selenium
silver
tetrachloroethylene
toxaphene
trichloroethylene
2,4,5- and 2,4,6-trichlorophenol
2,4,5-TP(Silvex)
vinyl chloride

An updated form of this list can be found on the EPA website.

APPENDIX III: Incompatible Chemicals

The following list is to be used only as a guide. Material safety data sheets should always be examined for specific incompatibilities.

Chemical	Incompatible With
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury (e.g., in manometers), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Acids	Acids
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials

Chemical	Incompatible With
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane, (or other petroleum, gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxides	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	All other chemicals
Hydrazine	Hydrogen peroxide, nitric acid, any other oxidant
Hydrocarbons (such as butane, propane, benzene, gasoline)	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, any flammable liquid, combustible materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen

Chemical	Incompatible With
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids and gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury and their salts
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils (all organics)
Phosphorus (white)	Air, oxygen, alkalies, reducing agents
Phosphorus pentoxide	Alcohols, strong bases, water
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids (see also chlorates)
Potassium perchlorate (see also chlorates)	Sulfuric and other acids (see also perchloric acid)
Potassium permanganate	Glycerol, ethylene, glycol, benzaldehyde, sulfuric acid
Selenides	Acids
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts

Chemical	Incompatible With
Sodium peroxide	Ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds) of light metals, such as sodium, lithium)
Tellurides	Acids

APPENDIX IV: CHEMICAL CARCINOGENS LIST WEB SITES

A complete list of chemical carcinogens has been compiled by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), the National Institute for Occupational Safety and health (NIOSH), the Occupational Safety and Health Administration (OSHA) and the American conference of Governmental Industrial Hygienists (ACGIH). The following references and web sites reference these chemicals.

ACGIH Handbook of Toxic and Hazardous Chemicals and Carcinogens, 4th Ed, 2001, Marshall Sittig

NIOSH list: www.cdc.gov/niosh/npotocca.html

The following website gives links to NIOSH, OSHA, IARC, NTP:
www.cdc.gov/niosh/topics/cancer

OSHA index: www.osha.gov/SLTC/carcinogens/index.html

NTP List: http:// ehp.niehs.nih.gov/roc/toc10.html
http:// ehp.niehs.nih.gov/roc/tenth/known.pdfl

Suggested sources for information about Teratagens and Mutagens

Environmental Health science, Morton Lippmann, Beverly Cohen, and Richard Schlesinger, Department of Environmental Medicine, New York University Medical Center, Oxford University Press, New Your, NY 2003.

Catalog of Teratogenic Agents, T. H. Shepard, 10th Ed., Johns Hopkins Press, 2001.

GLOSSARY

Most terms and abbreviations that are used in the Plan are defined below. For a complete list of abbreviations that are used in Materials Safety Data Sheets, see the MSDS glossary.

action level: concentration designated for a specific substance, calculated as an eight-hour time-weighted average, that initiates certain required activities such as exposure monitoring and medical surveillance.

acute toxicity: harmful effects produced by a single or short-duration exposure. The effects usually appear immediately or within a short time after exposure. Examples of acutely toxic substances are hydrogen cyanide and other inorganic cyanides, carbon monoxide, phosgene and hydrofluoric acid.

autoignition temperature: the temperature at which a particular substance will ignite spontaneously without an external source of energy (flame, spark, etc.).

carcinogen: a cancer-causing substance that meets one of the following criteria: regulated by OSHA as a carcinogen, listed as "know to be carcinogen", carcinogenic to humans" or "reasonably anticipated to be carcinogen".

ceiling limit: an inhalation exposure limit (PEL or TLV) that may not be exceeded even for short periods of time.

Chemical Hygiene Officer: an employee of Kansas State University who is designated by KSU and who is qualified by training or experience to provide technical guidance in the development and implementation of the Chemical Hygiene Plan.

Chemical Hygiene Plan: a written plan that sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular work place.

chronic toxicity: harmful effects that occur only after repeated or prolonged exposure, or that appear only after a prolonged latency period.

Examples of chronically toxic substances are lead, mercury and carcinogens, such as benzene and vinyl chloride.

combustible: having a flash point of 37.8°C (100°F) or higher.

corrosive: causing visible destruction of, or irreversible alterations in living tissue by chemical action at the site of contact.

DOT: The Department of Transportation

designated area: an area that may be used for work with "select carcinogens", reproductive toxins or substances that have a high degree of toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as glove box or fume hood.

EPA: Environmental Protection Agency

explosive: a chemical that causes a sudden release of pressure, gas and heat when subjected to shock, an electric spark, high pressure or high temperature.
face velocity: the speed of airflow at the front of a fume hood and measured in feet per minute.

flammable: having a flash point less than 37.8°C (100°F).

flammable range: the range of concentrations in air, from the lower explosive limit (LEL) to the upper explosive limit (UEL), over which a vapor is flammable; expressed in percent by volume.

flash point: the lowest temperature at which the vapors from a liquid will ignite and sustain a flame under specified conditions.

fume hood: an enclosure exhausted through the back to keep fume or other emissions generated within it away from the user.

hazardous chemical: a chemical for which there is statistically significant evidence that acute or chronic health effects may occur in exposed employees. These include chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic

systems and agents that damage the lungs, skin, eyes or mucous membranes.

laboratory: a facility where relatively small quantities of hazardous chemical are used on a non-production basis.

lower explosive limit (LEL): the lowest concentration in air at which a particular vapor will burn or explode when ignited by a source of energy.

MSDS: material safety data sheet

medical consultation: a consultation that 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.

OSHA: Occupational Safety and Health Administration. Also sometimes, the Occupational Safety and Health Act.

oxidizer: a substance that can support combustion. Examples of oxidizers include chlorates, permanganates, nitrates and halogens. Note that an oxidizer does not necessarily contain oxygen.

permissible exposure limit (PEL): an OSHA regulatory term that specifies a worker's maximum permissible exposure to a contaminant in air. PELs include 8-hour time-weighted average limits, short-term exposure limits and ceiling limits.

peroxidizable: able to react with oxygen from the air to form a peroxide. Most aliphatic ethers are peroxidizable compounds.

physical hazard: a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.

pyrophoric: igniting spontaneously upon contact with air.

RCRA: the Resource Conservation and Recovery Act.

SARA: The Superfund Amendments Reauthorization Act, also known as the Community Right-to-Know Act.

short-term exposure limit (STEL): an inhalation exposure limit (PEL or TLV) designed to limit worker exposure for a short time (usually 15 minutes).

threshold limit value (TLV): a maximum permissible exposure for a worker to a contaminant in air. Expressed either as parts per million or milligrams per cubic meter. TLVs include 8-hour time-weighted average limits, short-term exposure limits and ceiling limits.

time-weighted average: an average over time. Here, it applies to averaging the concentration of a contaminant in a worker's breathing air, usually over 8 hours. It is calculated by multiplying each different concentration value by the duration in hours the worker was exposed to that concentration adding these individual products, and dividing by 8 hours. There are PELs and TLVs that set limits on this time-weighted average exposure.

upper explosive limit (UEL): the highest concentration in air at which a particular vapor will burn or explode when ignited by a source of energy.

unstable (reactive): a chemical that will vigorously polymerize, decompose, condense or become self-reactive under conditions of shock, pressure or temperature.

water reactive: a chemical that will react with water to produce a gas that is either flammable or presents a health hazard.