Kansas State University College of Veterinary Medicine Policy or Operating Procedure		
SOP Title: CVM Chemical Hygiene Plan		
Author: Jacque Staats	**Date**:	**Date Revised:** March 22, 2010 By Mylissia Stukey
SOP #: **Rev.**	**Area:**	

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GLOSSARY

I. INTRODUCTION

A. The purpose of this plan is to provide a safe and healthy work environment for all laboratory employees in Diagnostic Medicine Pathobiology (DMP). Laboratory workers include classified and unclassified personnel, graduate students, post-docs, residents 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 is voluntarily adopting this Federal standard as a means of providing safe laboratory practices on campus.

B. This plan does not apply in those laboratory uses of 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

A. The Department of Public Safety will designate an employee as the university's Chemical Hygiene Officer.

B. The Chemical Hygiene Officer (CHO) will provide technical guidance and assistance for the implementation of the Chemical Hygiene Plan. This individual will work with departments 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, the RESPIRATOR PROGRAM, and the HAZARD COMMUNICATION PROGRAM. The written Chemical Hygiene Plan is contained in this CHEMICAL HYGIENE PROGRAM OF KANSAS STATE UNIVERSITY.

C. The Dean of Veterinary Medicine, who has ultimate responsibility for chemical hygiene within the College, shall provide, along with the University Chemical Hygiene Officer, and the Departmental Representatives from CVM EH&S Committee, continuing support for departmental chemical hygiene.

D. The Departmental Representatives from CVM EH&S Committee shall:

1. Work with administrators, the University CHO, and Department laboratory directors/supervisors, and workers to develop and implement appropriate chemical hygiene policies and practices.

E. Laboratory Director/Supervisor has overall responsibility for chemical hygiene in his/her laboratory, including responsibility to:

1. Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided.

2. Provide regular, formal chemical hygiene and housekeeping inspections of the laboratory and emergency equipment.

3. Determine the requisite levels of protective apparel and equipment for laboratory operations.

4. Ensure that the facilities and training are adequate for the operation.

F. Laboratory Worker is responsible for:

1. Planning and conducting each operation in accordance with the University's Chemical Hygiene Plan.

2. Attending designated training sessions and reporting hazardous or unsafe conditions to the Laboratory Director, Departmental Representatives from CVM EH&S Committee, or University CHO.

3. Develop and use good personal chemical hygiene habits.

III. 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 if there is reason to believe that exposure levels routinely exceed the threshold limit value (TLV).

IV. CHEMICAL HYGIENE PLAN

A. Basic Rules and Procedures

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 Public Safety and the Chemical Hygiene officers. Basic laboratory rules and procedures include:

1. Avoidance of "routine" exposure:
   a. Develop and encourage safe habits; avoid unnecessary exposure to chemicals by any route.
   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 allow release of toxic substances in cold rooms, warm rooms, or other areas that have recirculated 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 also used for laboratory operations.

3. Equipment and glassware: Handle and store laboratory glassware with care to avoid damage; 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. Exiting: Wash hands, arms and face well 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 an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation.

9. Fume Hood Use:
   a. Use the hood for operations that might result in release of toxic chemical vapors or dust.

b. Use a hood when working with any appreciably volatile substance with a TLV of less than 50 ppm.
c. Confirm adequate hood performance before use; keep hood closed at all times except when adjustments to equipment within the hood are being made. Do not allow equipment and materials to block vents or airflow. Do not use the fume hood for storage.

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 drain 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 footstands and stepladders should be used for reaching upper shelves. Do not stand on chairs 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.

B. Housekeeping and Maintenance
1. Keep the work area clean and uncluttered of chemicals and equipment. Clean up the work area on completion of an operation or at the end of the 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. Maintenance The laboratory supervisor should inspect respirators and eye wash stations for routine use periodically. Other safety equipment should be inspected regularly .

C. Protective Apparel and Safety Equipment
1. Eye protection

a. Appropriate eye protection should be worn by all persons, including visitors, especially if ammonia or other irritant vapors are present. Eye protection must be disinfected daily or after each use.
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, implosives, or splashing.

2. Wear shoes at all times in the laboratory, but do not wear sandals, perforated shoes, or high-heeled shoes. Shorts and cutoffs are also inappropriate. Confine long hair and loose clothing.

3. Wear appropriate gloves when the potential for contact with toxic materials exists. Inspect the gloves before each use, wash them before removal, and replace them periodically.

4. Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls. Inspect the respirator or self-contained breathing apparatus before use.

5. Laboratory outerwear should be worn to protect clothing. 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 at all times.

8. Safety equipment such as fire extinguishers and safety blankets are to be kept clear and readily accessible.

NOTE: the Fire Safety Officer on request provides Fire extinguisher demonstration and training.

D. 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 who is to be called in the event of fire, a spill, or other accident, shall 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 of many of these hazards. An inventory of the chemicals and a list of potentially hazardous instrumentation within the laboratory must be provided to the University Chemical Hygiene Officer so that the proper listing can be determined.

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.

5. All chemicals must be labeled. Chemicals that are repackaged should have secure, waterproof labels, marked with waterproof ink, which 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.

E. Chemical Spills – check the MSDS in the laboratory for specific information and instructions

1. Chemicals on the skin:

a. For spills covering small amounts of skin, immediately flush with sufficient water to remove all material. 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. Irrigate affected areas for a minimum of 15 minutes. Check the MSDS to see if any delayed effects should be expected. Seek medical attention as soon as possible.

2. Chemicals in the eye

a. For chemical splashes, immediately flush the eye with a copious amount of water under gentle pressure, checking for and removing contact lenses at once.
b. After flushing, seek immediate medical attention, regardless of the apparent degree of injury. Keep the eyes immobilized with clean, wet, soft, cold pads while transporting the injured to medical attention.

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. Avoid skin contact and wear a self-contained breathing apparatus to prevent inhalation of vapors. Proceed to clean up as directed in the MSDS. Contact the Department of Public Safety 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 paper towels used in the clean up, must be disposed of as hazardous wastes. Be particularly careful that flammable liquids absorbed during clean up do not present an absorbent fire hazard.

d. The Department of Public Safety should be notified of the spill. In some instances, the Department of Public Safety must notify the EPA.

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

F. Information and Training Program

The 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 prior to assignments involving hazardous chemicals or work procedures. 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. Proper chemical storage and waste management.

2. Training and Educational Resources

a. Training sessions offered periodically by the Department of Public Safety and the Department of Diagnostic Medicine Pathobiology.

b. Written Information

c. DVD Videos: Practicing Safe Science and Safety in the Research Laboratory. These videos include, but are not limited to, the following topics: Centrifugation Hazards, Chemical Hazards, Chemical Storage Hazards, Emergency Response, Glassware Washing hazards, Mammalian Cell Culture Hazards, Radionuclide Hazards.

d. Safety Books: Biosafety in the Laboratory, Biological Safety: Principles and Practices, Prudent Practices in the Laboratory.

e. Department of Safety Publications: Laboratory Safety Manual; Safety with Chemical Carcinogens in Research and Teaching, the Radiation Safety Manual, the Respirator Program, and the Hazard Communication Program.

f. Documentation of Training – Individual CVM Departments 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 Departmental Representatives from CVM EH&S Committee and other authorized officials.

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DOCUMENTATION OF CHEMICAL HYGIENE TRAINING
College of Veterinary Medicine
Kansas State University

Name _____ Department_____
Building & Room Number _____
Campus Phone _____
Employee Classification _____
Supervisor _____

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.

_____ _____

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 the laboratory's Chemical Hygiene Plan.

G. 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 picked up by the department of Public Safety for disposal or recycling. Generally, a material is considered to be waste once that the material can no longer be used for its intended purpose or as starting materials or reagents in other operations. 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 organic and inorganic compounds, waste water treatment sludges from most electroplating 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:

1. ignitability (e.g., flashpoint below 60 C),
2. corrosivity (e.g., is aqueous and has a pH 2 or 12.5),
3. reactivity (e.g., reacts violently with water, detonates, or readily undergoes violent change), and
4. toxicity (e.g., mercury, selenium, silver, and halogenated organics). Definitions of the characteristics are listed in Appendix I.

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

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 non-halogenated solvents separately. When they must be mixed, record the volume of each non-halogenated solvent.

c. All reasonable and appropriate safety precautions must be enforced to prevent spills, leaks, and other accidents. The satellite storage area must be equipped to meet minimum requirements for spill prevention and control, segregation of incompatible wastes, and emergency response.

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 are therefore expensive to dispose of. 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 mixed with organics, or cyanides 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 disposed 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*

(**a**) Flammable solvents should be stored separately and picked up by the Department of Public Safety.

(**b)** Nonflammable solvents and liquids should be picked up by the Department of Public Safety. They should be stored separately from flammables.

(**c**) Ethers, including diethyl ether should be stored separately and picked up by the Department of Public Safety. Call the Department of Public Safety for disposal advice, especially if the decision date on the container has been greatly exceeded).

(**d**) Halogenated hydrocarbons such as chloroform and trichloroethylene should be picked up by the Department of Public Safety.

(2) Aromatic compounds

(a) Any aromatic compounds should be picked up the Department of Public Safety.

(3) Confirmed carcinogens

(**a**) No carcinogen should be disposed of as either solid or liquid waste.

(**b**) Containers of confirmed carcinogens should be additionally packaged in plastic bags for pick up by the Department of Public Safety.

(4) Reactive materials

(**a**) Do not place any reactives in solid waste.

(**b**) Alert personnel from the Department of Public 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).

(5) Special materials with restrictive disposal regulations

(a) Pesticides

(**b**) Polyhalogenated biphenyls (PCBs and PBBs).

(6) Oil: Used vacuum pump and other lubricating oils are not considered hazardous waste but their disposal is controlled. Call the Department of Public Safety for pick up.

b. *Inorganic materials*

(1) Acids and bases should be neutralized to a pH of 7 ± 2.5 and then disposed into the sink drain. Amounts of less than 100 grams of per day may go the drain directly, if it diluted with copious amounts of water.

(2) 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.

(3) Oxidizers should not go to solid waste. Many can be reduced in the laboratory or dissolved and flushed down the drain
(Note: 100-gram limit of solid per day).

(4) Chromic acid may not be disposed down the drain. Instead, reduce to the chromous state, then dilute with water and discard down the drain. Chromic acid will also be picked up the Department of Public Safety.

(5) 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.

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

(7) Azides should never be disposed down the drain. Neutralize by oxidation with ceric ammonium nitrate and request a pick up by the Department of Public Safety.

(8) Osmium, selenium, and their compounds should be well sealed in a container that is sealed inside a plastic bag. Request pick up by the Department of Public Safety.

(9) Rare metals and mercury should be properly labeled and picked up by the Department of Public Safety. Many of these can be recycled.

(10) 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. *Pesticides*

The EPA and other agencies regulate disposal of waste pesticides. Call the Department of Public Safety for pick up. The containers must be clearly labeled with the pesticides' proper chemical names.

d. *Special Materials*

(1) 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. Also give the information for the routing of the empty cylinder. Most cylinders can be returned to the manufacturer.

(2) Biological materials may require special disposal procedures. Contact the Department of Public Safety for assistance.

5. Hazardous Waste Pick Up

a. After the 55-gallon or one-quart limits have been reached, the containers 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 "Public Safety - Waste". Request waste pick up from the Department of Public Safety (532-5856). Provide a description of the material to be handled, the specific location of the material, and the name of the responsible individual.

H. 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. 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 Departmental Representatives from CVM EH&S Committee 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:

(1) any recommendation for further medical follow-up.

(2) the results of the medical examination and any associated tests.

(3) 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.

(4) 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 specific findings of diagnoses unrelated to occupational exposure.

5. Recordkeeping.

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 -637.

V. STANDARD OPERATING PROCEDURES

i. Chemical Procurement and Distribution

Choice of chemicals: Use only those chemicals for which the ventilation system is adequate.

Quantities: 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.

Obtain prior approval from the laboratory director or supervisor whenever a new or significantly modified laboratory procedure is to be conducted or it is likely that a threshold limit value or other hazard limit could be exceeded during a procedure.

Safety information: Before a chemical is received, those who will be involved should know information on the proper handling, storage, and disposal.

Proper labeling: No container should be accepted without an adequate identifying label.

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.

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.

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.

Whenever possible, transport chemicals on freight-only elevators to minimize potential danger to others. Negotiate stairs and doorways carefully.

ii. Chemical Storage and Inventory Management
a. Ensure adequate security to prevent unauthorized access.
b. Housekeeping in the storage areas must be neat and orderly.
c. Storage shelves and units must be stable and secure against sliding and collapse and not subject to flooding.
d. 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 fire area.
e. Refrigerators that are used for chemical storage must be explosion proof.
f. 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.
g. 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 of the most reactive groups (e.g., do not store acids with bases or
oxidizers with organics).

h. It is desirable to maintain a computer database 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.

iii. Corrosives

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.

A. 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). Ensure that eyewash and safety showers are readily accessible in areas where corrosives are used and stored. In the event of contact, immediately flush the area of contact for 15 minutes with cool water. Remove all affected clothing and seek medical attention.

B. 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 it is rapidly absorbed through the skin. Serious burns may result. Immediate and thorough flushing
with water and immediate attention by a physician who is prepared to treat hydrogen fluoride burns are imperative.

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.

c. Perchloric acid: a strong oxidizing agent that may react explosively with organic compounds and other reducing agents, especially at elevated temperature and in concentrated solution. The acid must only be handled in a water wash-down fume hood that is noncombustible.

3. Picric acid: a high explosive that is especially dangerous when dry.

C. 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 strong irritant. Liquid ammonia can cause severe burns.

D. Reactives

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.

1. Peroxides and peroxide-forming chemicals

a. Label the container of ether with the date that it is opened. Isopropyl ether, isoamyl ether, and anhydrous ethers shall not be kept over six months. The hazard of peroxide formation increases rapidly upon opening of 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 that form dangerous concentrations of peroxides upon exposure to air include: cyclohexene, decalin, p-dioxane, tetrahydrofuran, tetralin, cyclic ketones, and other compounds that have readily abstracted hydrogen atoms (e.g., benzylic compounds, cumene, and vinyl acetate).

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

3. Water reactives: 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.

4. Oxidizers: compounds that may react violently with organic materials and reducing agents (e.g., perchloric acid, chromicacid, 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.

E. Flammables and Combustibles

A flammable substance is one whose vapors will ignite when exposed to an ignition source at temperatures below 37°C; a combustible substance is one that must be heated above 37°C to achieve ignition. Flammable liquids are divided into classes IA, IB, and IC on the basis of flash points and boiling points (Table I); combustible liquids are divided into classes II, IIIA, and IIIB on the basis of flash point. Class IA liquids are the most easily ignited, whereas class IIIB liquids are the most difficult to ignite.

The maximum allowable container sizes for each class of flammable and combustible liquid are given in Table II. Although up to 25 gallons of flammable liquids are permitted in a single fire area, note that the maximum permissible quantity of class IA liquid that can be stored in a glass or plastic container is only one pint!

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 combustions:

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. Be prepared to handle a spill.

F. Cooling Baths, Cold Traps, and Temperature Control
Combinations of ice, water, and sodium chloride will provide temperature control in the range -20°C T 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 isopropyl 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:

a. 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.
b. 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.
c. Add the cryogenic liquid slowly to the material to be cooled to avoid vigorous boiling and overflow of the coolant.
d. Use care and appropriate hand trucks in transporting cryogenic containers.
e. Minimize contact of moisture with cryogenic storage containers to avoid ice formation and possible plugging of pressure-relief valves.

f. Cryogenic liquids must be stored in properly vented containers and in properly ventilated areas to avoid possible displacement of air.
g. Cryogens may alter the physical characteristics of materials (e.g., susceptibility to shattering upon impact). Select all work materials carefully.

G. Compressed Gases

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:

a. Handle cylinders of compressed gases as high-energy sources and therefore as potential explosives.
b. Restrain cylinders of all sizes, empty or full, individually by straps, chains, or a suitable stand to prevent them from falling.
c. Store cylinders in appropriately ventilated cabinets or in an open storage area.
d. When storing or moving cylinders, have the protective caps securely in place to protect the valve stems.
e. When moving large cylinders, strap them to properly designed, wheeled carts to ensure stability.
f. 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.
g. Never use cylinders that cannot be identified positively.
h. Never lubricate, modify, force, or tamper with cylinder valves.
i. Use toxic, flammable or reactive gases in fume hoods only.
j. Never direct high-pressure gases at a person.
k. 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.
l. 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.
m. 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.
n. Close the main cylinder valves tightly when not in use.
o. Use only the appropriate regulator on each gas cylinder.
p. Do not put oil or grease on the high-pressure side of oxygen, chlorine, or other oxidizing agent cylinder. An explosion can result.
q. Always wear safety glasses when handling and using compressed gases.
r. Never bleed cylinders completely empty. Leave a slight pressure to keep contaminants out.
s. Promptly remove the regulators from empty cylinders and replace the protective caps at once. Mark the cylinder empty.

t. Observe the following special rules when working with acetylene cylinders.
Acetylene cylinders are partially filled with acetone; always store them upright.
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. Ensure that the outlet line of an acetylene cylinder is protected with a flash arrester. Never exceed the pressure limit indicated by the warning red line of an acetylene pressure gauge. Use the correct kind of tubing to transport the gaseous acetylene. Tubing materials such as copper and some brass alloys form explosive acetylides.
u. 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.

H. Reduced Pressure Operations
All vacuum lines should be trapped and shielded. Additional precautions 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. Carefully 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 the vacuum pump 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 for the operation. Never apply reduced pressure to a flat-bottom flask unless the flask is heavy walled and designed for the purpose.

I. Radioactive Materials

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:

a. The procurement, storage, use, handling, and disposal of any radioactive material, as specified in the Department of Public Safety's "Radiation Safety Manual".
b. A license must be obtained by the faculty member (academic rank: instructor or higher) who is responsible for the direction of the research. Licensees must apply to the Kansas State University Radiation Safety Officer. The license will be limited to the radioisotopes and quantities that have been approved.
c. All radioisotopes must be shipped to the Department of Public Safety, Edwards Hall. Department of Public Safety personnel will deliver all shipments of radioactive materials to the authorized laboratory.

J. Ultraviolet Radiation

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 sidepieces are recommended.
b. Skin protection can be accomplished by ordinary clothing.

K. 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 Appendix IV for lists of known or potential carcinogens and toxins).

a. The Categories of Risk

There are situations where the risk from chemical carcinogens is greater or less depending on the quantity, the chemical properties, or the intended operations.

High-risk situations are those that involve the use of a known 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 whose medical condition, such as depressed immune response, or steroid/cytotoxic drug treatment, may make them unusually susceptible to the possible

harmful effects of a carcinogen must be excluded from any area where accidental exposure might occur. Fertile men or women, or pregnant women may be at greater risk than others since many carcinogens are also mutagens or teratogens.

b. Personnel

(1) Laboratory and Animal Care Personnel. Must wear a fully fastened laboratory coat and appropriate gloves. Clean clothing shall be provided daily and shall not be worn outside the work area once the work area has been entered. Contaminated clothing shall be decontaminated or disposed of immediately after an overt exposure.

(2) Clothing. Fully fastened lab coat should be worn over street clothing for low risk work.

(3) 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 AT KANSAS STATE UNIVERSITY concerning the use of respirators. Copies of the rule are available upon request.

(4) Showers. Personnel engaged in procedures where exposure to airborne particulates contaminated with chemical carcinogens could occur (i.e., a high risk situation) are recommended to shower after each exit from the work area. All personnel should shower immediately after any overt exposure to a chemical carcinogen.

(5) Eating, Drinking, and Smoking. 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.

(6) Pipetting. Oral pipetting shall be prohibited. Mechanical pipetting aids shall be used for all pipetting procedures.

(7) Personal Hygiene. All personnel shall wash their hands immediately after completion of any procedures in which chemical carcinogens have been used.

c. Work Practices

(1) 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

Only personnel authorized by the research director shall enter work and storage areas.

(2) Work Surfaces. All work surfaces on which chemical carcinogens are used shall be covered with stainless steel trays, plastic 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.

(3) Use of Laboratory Hoods. 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.

Each laboratory hood or containment device used for containment of chemical carcinogens shall display a label bearing the legend: DANGER-CHEMICAL CARCINOGEN

d. Working Quantities. Minimum working quantities of chemical carcinogens shall be present in a work area.

e. Identification, Storage, and Inventory.

1. Labeling. Storage vessels containing chemical carcinogens shall be labeled: DANGER-CHEMICAL CARCINOGEN

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

3. Inventory. The research supervisor shall maintain an inventory of all chemical carcinogens. The inventory records shall include the quantities of chemical carcinogens acquired, dates of acquisition, and their dispositions.

f. Laboratory Transport

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

2. 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.

g. 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.

h. 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.

i. Decontamination and Disposal.

1. Spills and decontamination. Chemical carcinogens that have spilled and constitute a hazard shall be deactivated in situ or absorbed for subsequent disposal.

2. Disposal. 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.

L. Laboratory Hoods and Exhaust Air Treatment

1. Laboratory Hoods.

a. The chemical fume hood shall have an average linear face velocity of 100 feet per minute. The minimum air velocity at any point in the face of the fully opened hood shall not be less than 85 feet per minute.

b. Glove boxes shall be kept under negative air pressure of 0.5 inches water gauge with respect to the space in which they are located.

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 air flow 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 discharged outdoors.

2. 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.

3. Performance Certification. A certified inspector shall inspect performance of laboratory hoods annually. Exhaust air treatment systems shall be checked at least annually by the Department of Public Safety.

M. Facilities

1. 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 recirculation of exhaust air from work areas is permitted.

2. 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 and "dirty" egress corridors, the "dirty" egress corridor shall be kept under negative air pressure with respect to the work area.

3. Clothing change rooms and showers are recommended.

N. Chemicals of Moderate Chronic or High Acute Toxicity (Examples include hydrofluoric acid and hydrogen cyanide)

1. Storage. Use and store these compounds only in areas of restricted access with special warning signs.

2. Fume hood. Always use a fume hood with a face velocity of at least 60 linear feet per minute or another confinement device for procedures that might produce aerosols or vapors. Trap released vapors to prevent their discharge.

3. Personal protection. Always avoid skin contact by use of gloves and other appropriate protective apparel.

4. Chemical hygiene. Always wash hands, arms, and face immediately after working with these materials.

5. Records. Maintain records of the amounts of these materials on inventory, the disposition of these materials, and the names of laboratory personnel involved.

O. Allergens and Embryotoxins

Examples of allergens are diazomethane, formaldehyde, isocyanates, and some phenols; examples of embryotoxins are organomercurials, lead compounds, and thalidomide.

1. Use only in a well-functioning fume hood.

2. Use appropriate protective apparel to prevent contact with skin.

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

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

5. Notify laboratory director of all incidents involving exposure or spills.

5. Consult a qualified physician when appropriate.

TABLE I. Classes of Flammable and Combustible Liquids

Class	Flash Point	Boiling Point	Examples
1A	< 73 °F (22.8°C)	< 100°F (37.8°C)	Diethyl ether, pentane, vinylidene chloride, acetaldehyde
1B	< 73°F (22.8°C)	100°F (37.8°C)	Acetone, ethanol, hexane, toluene
1C	73°F (22.8°C)	< 100°F (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	1A	1B	1C	II	II
Glass	1 pt	1 qt	1 gal	1 gal	5 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.

APPENDIX I.

Material Safety Data Sheets (MSDSs). A material safety data sheet must be available for every chemical used.

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. Chemical Abstracts Service assigns this number to each chemical. 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 MSDA.

d. Composition of Mixtures - This includes all hazardous materials over 1% and all carcinogens over 0.1%. Trade names can be used but chemical names must also 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/m3).

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 where applicable:

- Boiling point - the value may be at reduced pressure and either in Celsius or Fahrenheit
- Melting point
- Vapor pressure-usually in mm Hg; the temperature must be specified (usually in the range of normal 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

- Flashpoint - 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 chemical 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-This topic includes one or more of the following:

LD50 (lethal dose 50) - This is lethal single dose (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 serious 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, vapors -- 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, eye 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 Substances that form peroxides or hydroperoxides

FORMER: 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.

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

m. 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 put in a landfill or other EPA approved disposal facility should be supplied in the MSDS.

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

APPENDIX II.
Characteristic Hazardous Wastes

Specific tests can be used to determine if a waste possesses any of the following characteristics:

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, vapors, 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 and pressure; or
- is an explosive.

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

- is aqueous and has a pH less than or equal to 2, or greater than or equal to 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 contains 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 groundwater. The toxicants to be tested for are:

arsenic hexachlorobutadiene
barium hexachloroethane
benzene lead
cadmium lindane
carbon tetrachloride mercury
chlordane methoxychlor
chlorobenzene methyl ethyl ketone
chloroform nitrobenzene
chromium pentachlorophenol
o-,m-, and p-cresol pyridine
2,4-D selenium
1,4-dichlorobenzene silver
1,2-dichloroethane tetrachloroethylene
1,1-dichloroethylene toxaphene
2,4-dinitrotoluene trichloroethylene
endrin 2,4,5- and 2,4,6-trichlorophenol
heptachlor (and its hydroxide) 2,4,5-TP(Silvex)
hexachlorobenzene vinyl chloride

This list will be expanded in the future as EPA completes additional testing.

APPENDIX III.
Incompatible Chemicals
The following list is to be used only as a guide. Specific incompatibilities are listed in the material safety data sheets.

Chemical	Incompatible With
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol,perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium,	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens

potassium)	
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
Azides	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
Chromic acid and chrominum trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
*Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane, (or other petroleum, gases), hydrogen, sodium carbine, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides Flammable liquids	Acids Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	All other chemicals
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen

Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, 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
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, and gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Phosphorus (white)	Air, oxygen, alkalies, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
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 salt
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethylacetate, 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 - SELECT CARCINOGENS

List A
Substances regulated by OSHA as carcinogens 1, group 1 substances listed as being carcinogenic to humans by the International Agency for Research on Cancer (IARC)2, and substances listed by the National Toxicology Program (NTP) as being known to be carcinogenic to humans, 3.

2-acetylaminofluorene	X		
acrylonitrile	X		
4-aminobiphen	X	X	X
arsenic and certain arsenic compounds	X	X	X
asbestos	X	X	X
azathioprine		X	X
benzene	X	X	X
benzidine and benzidine based dyes	X	X	X
N,N-bis(2-chloroethyl)-2-naphthylamine		X	
bis(chloromethyl)ether (BCME)	X	X	X
1,4-butanediol dimethane sulfonate (myleran)		X	X
chlorambucil		X	X
chloromethyl methyl ether (technical grade)	X	X	X
chromium and certain chrominum compounds		X	X
cyclophosphamide		X	X
1,2-dibromo-3-chloropropane (DBCP)	X		
3,3'-dichlorobenzidine and its salts	X		
diethylstilbestrol (DES)		X	
4-dimethylaminoazobenzene	X		
estrone		X	X
ethyleneimine	X		
ethylene oxide	X		
formaldehyde	X		
melphalan		X	X
mustard gas		X	X
-naphthylamine	X		
-naphthylamine	X	X	X
4-nitrobiphenyl	X		
N-nitrosodimethylamine	X		

N -propiolactone	X		
soots, tars and mineral oils		X	
thorium dioxide			X
treosulphan		X	

SELECT CARCINOGENS - LIST B
Reproductive Toxins

TERATOGENS AND MUTAGENS[1]

2,4,5-T 2,4-D
5-Fluorouracil Benzene
Cadmium sulfate Calcium arsenate
Dinitrogen pentoxide DDT (Dichloro-diphenyl-trichloro-ethane)
Dioxin
Formamide Dimethylmercury
Lead compounds Lead salts (some)
Organomercurials Methotrexate
Phenylmercuric acetate Nitrite
Sodium arsenate Ozone

DRUGS[2]
Aminopterin Lithium
Androgenic hormones
Methylaminopterin
Busulfan Methimazol
Chlorobiphenyls Penicillamine
Coumarin anticoagulants 13-cis-retinoic acid
Cyclophosphamide Tetracyclines
Diethylstilbestrol Thalidomide
Diphenylhydantoin Trimethadione
Etretinate Valproic acid

RADIATION[2]
Ionizing radiation

INFECTIONS[2]
Cytomegalovirus
Herpes virus hominis
Parvovirus B-19
Rubella virus
Syphilis organism
Toxoplasmosis
Venezuelan equine encephalitis

[1]Chemical Contamination in the Human Environment: Morton Lippmann and Richard Schlesinger, Department of Environmental Medicine, New York University Medical Center, Oxford University Press, New York, NY, 1979.

[2]Catalog of Teratogenic Agents, T.H. Shepard, 6th Edition, Johns Hopkins Press, 1989

SELECT CARCINOGENS - LIST C

Substances listed in group 2A (higher degree) and 2B (lower degree) by the International Agency for Research on Cancer (IARC) as probable carcinogens[1], and substances listed by the National Toxicology Program (NTP) as reasonably anticipated to be carcinogenic[2].

SUBSTANCE	IARC	NTP
2-acetylaminofluorene		X
Acrylonitrile	2B	X
actinomycin D	2B	
Adriamycin	2B	X
aflatoxins	2A	X
2-aminoanthraquinone		X
o-aminoazatoluene		X
4-aminobiphenyl		X
1-amino-2-methylanthraquinone		X
amitrole	2B	X
o-dianisidine		X
auramine	2B	
benz[a]anthracene		X
benzo[b]fluoranthene		X
benzo[i]fluoranthene		X
benzo[k]fluoranthene		X
benzo[a]pyrene	2A	X
benzotrichloride	2B	X
beryllium and beryllium compounds	2A	X
bis(chloroethyl)nitrosourea	2B	X
1,3-butadiene		X
C.E. Basic Red 9 Monohydrochloride		X
cacarbazine	2B	X
cadmium and cadmium compounds	2B	X
carbon tetrachloride	2B	X
chloendic acid		X
chloramphenicol	2B	
chlorinated parafins		X
chloro-2-methylpropene		X
chloro-o-phenylenediamine		X
1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)	2B	X

Chloroform	2B	X
Chlorophenols	2B	
cisplatin	2B	
Cupferron		X
DDT	2B	X
2,4-diaminoanisole sulfate		X
2,4-diaminotoluene		X
dibenz[a,h]acridine		X
v dibenz[a,h]anthracene		X
dibenz[a,j]acridine		X
7H-dibenzo[c,g]carbazol		X
dibenzo[a,e]pyrene		X
dibenzo[a,h]pyrene		X
dibenzo[a,i]pyrene		X
dibenzo(a,l)pyrene		X
1,2-dibromo-3-chloropropane		X
1,2-dibromoethane (EDB)		X
1,4-dichlorobenzene		X
3,3'-dichlorobenzidine	2B	X
1,2-dibromo-3-chloropropane		X
1,2-dibromoethane (EDB)		
1,2-dichloroethane		X
dichloromethane (methylene chloride)		X
dichloropropene (technical grade)		X
dienestrol	2B	X
diepoxybutane		X
di(2-ethylhexyl)phthalate		X
diethyl sulfate	2A	X
diglycidyl resorcinol ether		X
3,3'-dimethoxybenzidine	2B	X
dimethyl sulfate	2A	X
4-dimethylaminoazobenzene		X
3,3'-dimethylbenzidine		X
dimethylcarbamoyl chloride	2B	X
Dimethylhydrazine		X
dimethylvinyl chloride		X
1,4-dioxane	2B	X

direct black 38	2B	X
direct blue 6	2B	X
direct brown 95	2B	
epichlorohydrin	2B	X
estrogens (not conjugated): estradiol-17B		X
estrogens (not conjugated): estrone		X
estrogens (not conjugated): ethinylestradiol	2B	X
estrogens (not conjugated): mestranol		X
ethyl acrylate		X
ethylene dibromide	2B	
ethylene oxide	2B	X
ethylene thiourea	2B	X
formaldehyde (gas)	2B	X
hexachlorobenzene		X
hexamethylphosphoramide		X
hydrazine	2B	X
hydrazine sulfate		X
hydrazobenzene		X
ideno[1,2,3-cd]pyrene		X
iron dextran complex		X
kepone (chlordecone)		X
lead acetate		X
lead phosphate		X
lindane and other hexachlorocyclohexane isomers		X
mestranol	2B	
2-methylaziridine (propyleneimine)		X
5-methylchrysene		X
4,4'-methylenebis(N,N-dimethyl)benzenamine		X
4,4'-methylenebis(2-chloroaniline) (MBOCA)		X
4,4'-methylenedianiline dihydrochloride		X
metronidazole	2B	X
Michler's Ketone		X
Mirex		X
nickel and nickel compounds	2A	X
nitrilotriacetic acid		X
nitrogen		X
nitrogen mustard	2A	

nitrogen mustard hydrochloride		X
2-nitropropane		X
norethisterone	2B	X
N-nitrosodiethanolamine		X
N-nitrosodiethylamine		X
N-nitrosodimethylamine		X
p-N-nitrosodiphenylamine		X
N-nitrosodi-n-butylamine		X
N-nitrosodi-n-propylamine		X
N-nitrosomethylvinylamine		X
N-nitrosomorpholine		X
N-nitrosonornicotine		X
N-nitrosopiperidine		X
N-nitrosopyrrolidine		X
N-nitrososarcosine		X
N-nitroso-n-ethylurea		X
N-nitroso-n-methylurea		X
oestradiol-17B	2B	
oestrone	2B	
4,4'-oxydianiline (4-aminophenyl ether)		X
oxymetholone	2A	X
phenacetin	2A	X
phenazopyridine	2B	
phenazopyridine hydrochloride		X
phenoxyacetic acid herbicides	2B	
phenoxybenzamine hydrochloride		X
phenytoin and its sodium salt	2B	X
polybrominated biphenyls (PBB)		X
polychlorinated biphenyls (PCB)	2B	X
procarbazine	2A	
procarbazine hydrochloride		
progesterone		X
1,3-propane sultone (3-hydroxy-1-propanesultonic acid)		X
-propiolactone		X
propylene oxide		X
propylthiouracil	2B	X
reserpine		X

saccharin		X
safrole		X
selenium sulfide		X
streptozoticin		X
sulfallate		X
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)		X
tetrachloroethylene (perchloroethylene)		X
thioacetamide		X
thiourea		X
toluene diisocyanate		X
o-toluidine	2A	X
o-toluidine hydrochloride		X
toxaphene		X
2,4,6-trichlorophenol	2B	X
tris(1-aziridinyl)phosphine sulfide	2B	X
tris(2,3-dibromopropyl)phosphate		X
tris(aziridinyl)-p-benzoquinone	2B	
uracil mustard	2B	
urethane		X

[1]Monographics on the Evaluation of the Carcinogenic Risk to Humans, International Agency for Research on Cancer (IARC),
Volumes 1 to 29, Supplement 4, 1982.

[2]Fifth Annual Report on Carcinogens -Summary, National Toxicology Program (NTP), Technical Resources, Inc., Rockville,
MD 1989.

APPENDIX IV. Examples of Chemical Carcinogens, Potential Carcinogens and Tumor Promoters[1]

A
N-acetoxy-2-acetamidofluorene
N-acetoxy-2-acetamidostilbene
N-acetoxy-4-acetamidobiphenyl
N-acetoxy-N-acetamidophenanthrene
2-acetylaminofluorene
acrylonitrile
actinomycin D
adriamycin

aflatoxins
aldrin
alkanes (certain long chain ones)
allyl methylsulfonate
alpha,alpha-dichloromethyl methyl ether
anthralin
2-aminoanthraquinone
4-aminobiphenyl
1-amino-2-methylanthraquinone
amitrole
o-anisidine
o-anisidine hydrochloride
aramite
arsenic and certain arsenic compounds
asbestos
auramine (technical grade)
azathioprine

B

benz[a]anthracene
benzene
benzidine and benzidine based dyes
benzo[c]chrysene
benzo[b]fluoranthene
benzo[j]fluoranthene
benzo[k]fluoranthene
benzo[g,h,I]perylene
benzo[O]phenanthrene
benzo[a]pyrene
benzotrichloride
benzoyl peroxide
beryllium and certain beryllium compounds

N,N-bis(2-chloroethyl)-2-naphthylamine
bischloroethyl nitrosourea (BCNU)
bischloromethyl ether (BCME)
7-bromomethylbenz[a]anthracene
3-bromopropionic acid
1,3-butadiene
1,4-butanediol dimethane sulfonate
N-butyl-N-nitrosourethane

C

cadmium and certain cadmium compounds
carbon black
carbon tetrachloride
carrageenan (degraded)
chlorambucil
chloramphenicol
chloroacetone
1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
chloroethylene oxide
chloroform
chloromethyl methyl ether (technical grade)
chlorophenols
chloroprene
chromium and certain chromium compounds
chrysarobin
chrysene
cisplatin
citrus oils
coal gasification
coal liquefaction
coal-tar products
coal-tar pitch volatiles
coke oven emissions
coke production
conjugated estrogens
p-cresidine
croton oil
cupferron
cycasin
cyclophosphamide

D

dacarbazine

DDT
2,4-diaminoanisole and its salts
2,4-diaminotoluene
dibenz[a,h]acridine
dibenz[a,j]acridine
dibenz[a,h]anthracene
7H-dibenzo[c,g]carbazole
dibenzo[a,j]anthracenen
dibenzo[a,c]naphthacene
dibenzo[a,e]pyrene
dibenzo[a,h]pyrene
dibenzo[a,i]pyrene
dibenzo[a,l]pyrene
1,2-dibrom-3-chloropropane (DBCP)
3,3'-dichlorobenzidine and its salts
dieldrin
dienestrol
diepoxybutane
1,2,4,7-diepoxyhexane
1,2,4,5-diepoxypentane
di(2,3-epoxypropyl) ether (DGE)
di(2-ethylhexyl)phthalate
diethylstilbestrol (DES)
diethyl sulfate
dihydroteleocidin B
3,3'-dimethoxybenzidine
4-dimethylaminoazobenzene
dimethylcarbamoyl chloride
1,1'-dimethyl hydrazine
dimethyl sulfate
1,4-dioxane
direct black 38, technical
direct blue 6, technical
direct brown 95, technical
epichlorohydrin
1,2-epoxybutyronitrile
estradiol-17B
estrone
ethinylestradiol
ethylene dibromide (EDB)
ethylene dichloride (EDC)
ethyleneimine
ethylene oxide
ethylene thiourea
ethyl methanesulfonate
1-ethyl-1-nitrosourea
euphorbia lattices (certain ones)
fatty acids and fatty acid methyl esters (certain ones)
1-fluoro-2,4-dinitrobenzene
formaldehyde
2-(2-furyl)-3-(5-nitro-2-furyl)-acrylamide

G

glycidaldehyde
gyromitrin

H

hexachlorobenzene
hexachlorobutadiene
hexachloroethane
hexamethyl phosphoramide
hydrazine
hydrazine sulfate
hydrazobenzene
hexachlorobutadiene
hexachloroethane
N-hydroxy-2-aminoaphthalene
0beta-hydroxy-1-ethylaziridine

I

ICR 170
indeno[1,2,3-cd]pyrene
iodoacetic acid
iron dextran complex

K

kepone (chlordecone)

L

lead acetate
lead phosphate

lindane and other hexachlorocyclohexane isomers
M
malonaldehyde
melphalan
mestranol
7-methylbenz[a]anthracene
methyl bromide
methyl chloride
3-methylcholanthrene
5-methylchrysene
11-methylcyclopenta[a]phenanthren-17-one
4,4'-methylenebis(2-chloroaniline) (MOCA)
4,4'-methylenebis(n,n-dimethyl) benzenamine
4,4'-methylene dianiline
methyl hydrazine
methyl iodide
methyl methanesulfonate
N-methyl-N'-nitro-N-nitrosoguanidine
4-O-methyl tetradecanoylphorbol-13-acetate
N-(4-methoxy)benzoyloxypiperadine
N-methyl-N'-nitro-N-nitrosoguanidine
metronidazole
mezerein
michler's ketone
mineral oils
mirex
mitomycin C
mustard gas
N
alpha-naphthylamine
beta-naphthylamine
nickel carbonyl
nickel and certain nickel compounds
nickel sulfide roasting, fume and dust
nitrilotriacetic acid
5-nitro-o-anisidine
N-(4-nitro)benzoyloxypiperadine
4-nitrobiphenyl
nitrofen
nitrogen mustard
2-nitropropane
4-nitroquinoline-N-oxide
N-nitrosodimethylamine
N-nitrosodi-n-butylamine
N-nitrosodiethanolamine
N-nitrosodiethylamine
N-nitrosodimethylamine
p-nitrosodiphenylamine
N-nitrosodi-n-propylamine
N-nitroso-n-ethylurea
N-nitroso-n-methylurea
N-nitrosomethylvinylamine
N-nitrosomorpholine
N-nitrosonornicotine
N-nitrosopiperidine
N-nitrosopyrrolidine
N-nitrososarcosine
norethisterone
O
oxymetholone
P
pentachloronitrobenzene
phenactin
phenazopyridine
phenazopyridine hydrochloride
phenolic compounds (certain ones)
phenoxyacetic acid herbicides
N-phenyl-beta-naphthylamine
phenylhydrazine
phenytoin
phorbol-12,13-dibenzoate
phorbol-12,13-didecanoate
polybrominated biphenyls (PBB)

polychlorinated biphenyls (PCB)
procarbazine
procarbazine hydrochloride
progesterone
propane sultone
beta-propiolactone
propyleneimine
propylthiouracil
R
reserpine
12-O-retinoylphorbol-13-acetate
S
saccharin
safrole
selenium sulfide
sodium lauryl sulfate
soots, tars, and mineral oils
sterigmatocystin
streptozotocin
sulfallate
T
teleocidin
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)
1,1,2,2-tetrachloroethane
tetrachloroethylene
2,3,4,5-tetrachloronitrobenzene
2,3,4,6-tetrachloronitrobenzene
2,3,5,6-tetrachloronitrobenzene
12-O-tetradecanoylphorbol-13-acetate
thioactamide
thiourea
thorium dioxide
tobacco extracts and condensates
o-tolidine
o-toluidine
o-toluidine hydrochloride
p-toluidine
toxaphene
trenimone
treosulphan
1,1,3-trichloroethane
2,4,6-trichlorophenol
trichlroethylene
triethylenemelamine
tris(aziridinyl)-p-benzoquinone
tris(aziridinyl)phosphine sulfide
tris(2,3-dibromopropyl)phosphate
tryptophane P1
tryptophane P2
Tween 60
U
uracil mustard
urethane
V
vinyl bromide
vinyl carbamate
vinyl chloride
vinyl cyclohexene dioxide
vinyl fluoride
vinylidene chloride
vinylidene fluoride monomer

[1]This list of chemical carcinogens has been compiled from 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).

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 "known 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, hepatotoxins, 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 chemicals 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.