STATE UNIVERSITY OF NEW YORK

COLLEGE OF TECHNOLOGY

CANTON

LABORATORY

CHEMICAL HYGIENE PROGRAM

In accordance with the OSHA "Occupational exposure to hazardous chemicals in laboratories", 29 CFR 1910.1450, the following Chemical Hygiene Plan has been developed.

Revised July 2019

INTENT

The primary objective of this manual is to protect laboratory workers from exposure to hazardous chemicals and situations that may endanger their health and safety. A conscious effort by all laboratory personnel to follow these guidelines is essential to achieve a safe work environment.

The faculty serve as role models for their technical staff, students and other laboratory support personnel. They must insist that appropriate laboratory procedures be followed at all times.

To ensure a safe work environment, everyone involved in laboratory operations must be safety conscious. Safety becomes part of the work attitude through repeated discussions, meaningful in-service training and the demonstrated commitment of the College administration, faculty, support staff and students. It is in everyone's best interest to carry out laboratory work in accordance with good health and safety practices.

NO EMPLOYEE, STUDENT, OR VISITING SCIENTIST SHALL CONDUCT ANY RESEARCH, INSTRUCTION, OR PROCEDURE IN A MANNER WHICH JEOPARDIZES THE HEALTH OR SAFETY OF ANY PERSON.

The College also has a commitment to protecting the environment. Hence, all chemical waste must be disposed of in accordance with applicable laws and with environmentally sound procedures that minimize their potential harm. When appropriate, every effort shall be made to reduce, reuse, or recycle any chemicals to remove them from the waste stream.

LABORATORY HEALTH AND SAFETY POLICY
AND
CHEMICAL HYGIENE PROGRAM

INDEX

LABORATORY HEALTH AND SAFETY POLICY

I. INTRODUCTION

A. LABORATORY HEALTH AND SAFETY POLICY STATEMENT

It is the policy of the State University of New York College of Technology at Canton (the College) to ensure that all laboratory hazards are identified and information about these hazards is transmitted to employees to provide for their safety and health protection. "Employees" under this policy include custodial and maintenance staff, faculty, instructional support staff, and paid assistants who work in laboratories that utilize hazardous chemicals.

This policy is implemented through the administration of this Laboratory Heath and Safety Policy and Chemical Hygiene Program.

B. AUTHORITY

The Laboratory Health and Safety Policy and Chemical Hygiene Program is authorized by Dr. Zvi Szafran, President of SUNY Canton. It has been reviewed and approved by the Chemical Hygiene Committee.

C. FEDERAL LABORATORY STANDARD

This program was developed and implemented pursuant to 29 CFR 1910.1450, "Occupational Exposures to Hazardous Chemicals in Laboratories, Final Rule", published January 31, 1990. A copy of the regulation is in Appendix A.

D. SCOPE AND APPLICATION

This program applies to laboratories that meet the OSHA definition of "laboratory" published in 29 CFR 1910.1450, Occupational exposure to hazardous chemicals in laboratories (the OSHA "Laboratory Standard", a copy of which is in Appendix A.) ***"Laboratory" means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.*** **The laboratories meeting this definition at the College include chemistry, biology, veterinary science, and automotive technology laboratories. All other laboratories fall under OSHA's Hazard Communication Standard.**

E. CHEMICAL HYGIENE OFFICER

Mr. James Hamilton, Instructional Support Technician, will serve as the Chemical Hygiene Officer. He is qualified by training and experience to provide technical guidance in the development and implementation of the Chemical Hygiene Program.

II. ENSURING LABORATORY SAFETY

A. ALL PERSONS WHO WORK IN CHEMICAL LABORATORIES

1. Employees who work in laboratories where chemicals are handled are expected to:

a) attend a lecture on laboratory safety.

b) follow College wide standard operating procedures and those of the lab in which the person is working.

c) report damaged or malfunctioning equipment to the instructional support staff.

d) report chemical spills or injuries to University Police.

2. All persons should be responsible for correcting, if possible, or reporting to the chemical safety committee, personal behavior that could endanger people, equipment or property.

B. CHEMICAL HYGIENE COMMITTEE

1. Meets at least once a semester.

2. Members include the Chemical Hygiene Officer, laboratory faculty representative(s) and representative(s) of the instructional support technicians.

3. Develops and reviews laboratory health, safety and housekeeping audits.

4. Elements of a health, safety and housekeeping audit:

a. General housekeeping is acceptable.

b. Compressed gas cylinders attached and stored appropriately.

c. Safety shower has been tested at least quarterly.

d. Eyewash is present and has been tested at least weekly while school is in session.

e. Fire extinguisher is present and has been inspected monthly.

f. Acid, base, mercury and oxidant spill kits are located in Cook 205 and are adequately stocked.

g. Chemical fume hoods do not have large items in it that may affect air flow.

h. Chemical fume hoods are inspected annually indicating that it is functioning properly.

i. Safety equipment is not blocked.

j. First aid kits are adequately stocked.

5. Plan and implement general laboratory safety training for employees.

C. CHEMICAL HYGIENE OFFICER

1. Provides technical guidance in the development and implementation of the Chemical Hygiene Program and College-wide SOP's and specific departmental procedures.

2. Chairs the Chemical Safety Committee.

3. Reviews laboratory accident and incident reports and assists University Police in investigations as needed.

4. Participates in health, safety and housekeeping audits.

5. Receives input on health and safety hazards, and actively seeks hazard abatement.

6. Manages the waste disposal program including signing hazardous waste manifests.

D. FACULTY AND/OR INSTRUCTIONAL SUPPORT STAFF

1. Are knowledgeable about the health and safety hazards of the chemicals used in the laboratory and transmit this information to the students; ensure that students handle toxic and hazardous chemicals appropriately.

2. Are responsible for implementing and enforcing health, safety and housekeeping procedures for their laboratory experiments and exercises.

a. Identify standard laboratory procedures for the use of hazardous chemicals, operations and equipment used by their students.

b. Develop procedures for hazards for which there are no published safety procedures.

3. Enforce Standard Operating Procedures in their laboratory. These include applicable College and laboratory specific procedures.

4. Monitor student activity, stopping activities which are or may become hazardous. Students who fail to comply will be subject to disciplinary action as stated in the Student Handbook according to the Code of Student Conduct, Rights and Responsibilities.

5. If a chemical spill kit is used in their laboratory, this information will be relayed to the Instructional Support Staff who will order replacement material(s).

E. STUDENTS

1. Follow all safety procedures. Adopt a "safety first" attitude.

2. Discuss accidents and incidents with instructors, and prepare descriptive reports if needed.

3. Report broken equipment and other laboratory hazards to the instructional support staff or instructor.

F. CUSTODIAL AND MAINTENANCE STAFF

1. Carry out usual cleaning or maintenance activities in laboratories, but in the process will not (and will not be expected to) handle or move chemical containers, sweep or mop up laboratory chemical spills, or touch waste baskets which contain loose chemicals or partially filled chemical containers.

2. Report to the Faculty or Instructional Support Staff chemical spills or chemicals which have been thrown into waste baskets. At night, University Police should be notified. University Police should then notify the Instructional Support Staff or Chemical Hygiene Officer and Environmental Health and Safety.

3. Report to their supervisor concerns about their own health or safety working in specific laboratories. These should be conveyed from their supervisor to the Chemical Hygiene Officer and Environmental Health and Safety.

4. Accidental chemical releases (e.g. accidental breaking of a bottle of chemical) will be immediately reported to Faculty, Instructional Support Staff, University Police, or Chemical Hygiene Officer and Environmental Health and Safety.

5. Attend an annual laboratory health, safety and housekeeping training program.

III. STANDARD OPERATING PROCEDURES

A. INTRODUCTION

The following Standard Operating Procedures (SOPs) apply to personnel in all laboratories. Stricter procedures may be developed by the Chemical Hygiene Committee with assistance from the faculty for specific chemicals, equipment and procedures in various laboratories; these are known as "laboratory specific procedures".

College wide SOPs may change over time to better meet laboratory good work practices and College needs. Suggestions about additions and changes in this program are encouraged; call or write the Chemical Hygiene Officer to provide input.

B. ULTIMATE RESPONSIBILITY FOR LABORATORY SAFETY

A.he ultimate responsibility for personal health and safety in the laboratory rests with the individual; however, it is the policy of SUNY Canton toprovide information about hazardous chemicals, equipment and experiments so that individuals are forewarned about potential laboratory hazards.

2. Instructional Support Staff and Faculty using the laboratories are responsible for overseeing laboratory conditions. Responsibilities include:

a. informing students of the hazards of equipment, procedures and chemicals used in the laboratory; information will be provided orally and/or as written Laboratory Specific Procedures or in course embedded instructions.

b. overseeing the cleanliness and orderliness of the laboratory.

c. providing instructions for the appropriate disposal of laboratory waste materials.

d. contacting appropriate individuals in case of a safety incident or chemical spill.

e. reprimanding or rejecting from laboratories students who repeatedly break laboratory rules.

C. PERSONAL BEHAVIOR IN LABORATORIES

1. Inappropriate personal behavior and irresponsible unauthorized experiments will not be tolerated.

2. Faculty and students should know the hazards of each chemical they handle; safety information will be provided to students and discussed at the beginning of each lab.

3. Faculty and students should know the location and use of first aid kits, fire extinguisher, safety shower, eye wash station, fire blanket, etc. Access to safety equipment must not be blocked.

4. Label chemical storage and hazardous waste containers with generator's initials, chemical contents, hazard and generation date.

5. Don't store food and beverages in refrigerators meant for chemical storage.

6. Smoking is prohibited in public buildings in New York State.

7. Don't eat or drink in laboratories.

8. Clean work areas daily to the standard of the faculty or instructional support staff.

9. The instructional support staff or faculty member will determine appropriate waste disposal procedures prior to generation of hazardous waste and this information will be relayed to students.

10. All hazardous waste must be disposed of in an environmentally ethical manner.

11. Children are not permitted in instructional laboratories except for previously planned for and organized tours and demonstrations.

12. Animals are not permitted in laboratories except for instructional purposes and service animals for the physically handicapped.

D. GENERAL SAFETY PRACTICES

1. Appropriate laboratory attire include shoes which cover the top of the foot (no sandals) and shirt and leg protection. It is recommended that long pants be worn.

2. Wear chemical resistant gloves when appropriate.

- **a. Check gloves for wear and tear before using.**
- **b. Wash them before removal.**
- **c. Discard worn or torn gloves.**

3. Contact lenses are not permitted in laboratories where chemicals are handled.

4. Safety glasses or goggles may be required in some laboratories or on certain days, according to the chemicals in use. Safety glasses are required in the chemistry labs and may be required in the biology and medical labs when chemicals are in use.

5. Do not work in an otherwise unoccupied laboratory building. If this is unavoidable, the employee's supervisor and/or University Police should be notified of arrival and departure.

6. Keep doorways, halls, entrances and stairways clear; remove delivered or discarded goods from entrances at once.

7. Keep floors dry; clean up water spills immediately.

8. Do not suspend or drape extension cords, rope, rubber tubing, etc. in areas and at heights which interfere with normal traffic.

9. Do not lift or move heavy articles without help. Use correct lifting methods and use a hand truck to move them any distance.

10. Close all drawers and keep all obstacles clear of walkways (book bags etc.).

11. Use insulated gloves when handling hot objects.

12. NO MOUTH PIPETTING!! Use a suction bulb or automatic pipette; use rubber tubing and a suction bulb to start a siphon.

E. LABELING

1. Label Requirements

Every chemical received at SUNY Canton is labeled with the following information:

a. the identity of the hazardous chemical

b. the appropriate hazard warnings

c. the name and address of the manufacturer

d. the date received

DO NOT REMOVE OR DEFACE THE ORIGINAL LABEL.

2. Transfer of Chemicals

When hazardous chemicals are transferred from their original containers, the new container must be labeled with:

a. the name of the chemical

b. the appropriate hazard warning

3. Exceptions to Labeling Requirement

a. Portable containers intended for immediate use by the person performing the transfer

b. Laboratory-use-only containers such as test tubes, flasks, beakers, and petri plates

1. Stationary Containers and Vessels may be labeled with signs, placards or other written forms of warning. The alternative method of labeling must provide the same information as a label (identity and primary hazard).

Instructional Support Staff are designated to ensure that all hazardous chemicals used in their laboratories are properly labeled. Instructional Support Staff are also responsible for reviewing the relevant hazards of the chemical and ensuring that the labels are updated.

F. HANDLING CHEMICALS IN THE LABORATORY

The laboratory chemicals found within this college are as varied as the purposes for which they are used. For this reason, general precautions for handling categories of chemicals are more appropriate than specific guidelines for each separate chemical. Nevertheless, all laboratories have available Safety Data Sheets (SDS) for all chemicals used, handled and stored within the work area. They are readily available in the lab to all employees and students.

A. Procurement

1. **Before a substance is received, information on its proper handling, storage and disposal should be known. Request an MSDS when ordering.**

2. **No container will be accepted without a proper identifying label.**

3. **Whenever possible, a less hazardous or toxic chemical should be substituted.**

B. Transport

Transporting hazardous chemicals from one location to another within the College can be safely accomplished when:

1. **Unbreakable containers or glass bottles, protected with bottle carriers, are used for flammable or corrosive liquids.**

2. **The lids for such containers are periodically inspected to ensure their integrity.**

C. Storage

The correct storage of chemicals has become increasingly important to maintain a safe working environment, particularly when the number of chemicals in use increases and their toxicity becomes known.

Problems related to chemical storage can be significantly reduced by following the principles of LIMITING and SEGREGATING.

1. **Toxic substances should be segregated from other chemicals in a well-identified area with local exhaust ventilation.**

2. **Chemicals which are considered highly toxic, carcinogenic, or otherwise hazardous should be placed in an unbreakable secondary container and properly labeled.**

3. **Stored chemicals should be examined at least on an annual basis for deterioration, container integrity, and possible replacement.**

4. **The amount of chemicals stored should be as small as practical.**

5. **Storage in laboratory hoods is prohibited, unless the hood has been designated as a storage area and is not used to conduct laboratory work.**

6. **Do not store chemicals on the floor.**

7. **Avoid exposure of chemicals to heat and direct sunlight.**

8. **An annual chemical inventory review should be conducted with unneeded chemicals given to the Chemical Hygiene Officer for recycling or disposal.**

D. Designated Area

Laboratories working with carcinogens, reproductive toxins, or acutely toxic substances must establish a Designated Area. A Designated Area may be any part of a laboratory, a device such as a laboratory fume hood, or the entire laboratory.

The purpose of the Designated Area is to focus attention on the particularly hazardous substance that is being used and to ensure that the necessary protective measures are observed by all persons in the vicinity.

Designated Areas must be identified by appropriate signs.

E. Approval

Prior approval must be obtained from the Chemical Hygiene Committee before laboratory procedures can be undertaken involving the following:

1. **A newly introduced hazardous chemical substance of moderate, chronic, or high acute toxicity.**

2. **Working with substances of known high chronic toxicity.**

Prior consultation can ensure that appropriate measures are taken to establish safety protocols, minimize exposure, and establish proper waste disposal procedures.

G. HANDLING SPECIFIC TYPES OF CHEMICALS

A description of the hazards of chemicals by hazard class, along with suggested handling procedures is as follows:

FLAMMABLE CHEMICALS: chemicals that may easily ignite or burn. See Appendix A.

1. **Store only one week's worth (or one gallon, whichever is less) of flammable chemical in the laboratory. Keep larger quantities in a flammable storage room or an approved, vented "flammable" storage cabinet.**

2. **Note the location and type of fire fighting equipment available for the particular need. ABC fire extinguishers are available throughout the college.**

3. **Flammable chemicals shall not be used near sparks or open flames.**

4. **Refrigerated flammable chemicals must be stored in FM or UL approved explosion proof or explosion-safe refrigerators.**

CAUSTIC AND CORROSIVE CHEMICALS: Acids and alkalis may cause burns of the skin, mouth, lungs or eyes and irreversible damage to equipment and storage areas.

1. **Transport large bottles of concentrated acids in rubber carriers.**

2. **When handling corrosive chemicals, always wear goggles and a face shield.**

3. **Use chemical resistant gloves and acid aprons when handling corrosive or alkali chemicals. Check gloves for holes before putting them on. Wash exterior of gloves before removing them.**

4. **Never pour water into concentrated acid. When diluting a strong acid, use a heat resistant container that will not break due to the temperature rise which occurs during the mixing process.**

5. **When making a strong caustic solution, use a heat resistant container and provide cooling.**

6. **Never pour concentrated acid or caustic down the sink. Acids and caustics should be neutralized and flushed with copious amounts of water.**

7. **Skin and clothing contamination: immediately use a drench shower if available; otherwise use nearest source of water to flush clothing, removing clothing as needed.**

8. Eye contact: Eyewash stations are located in each laboratory. Keep eyes open and rinse with a gentle stream of running water (preferably at an eye wash station) for at least 15 minutes to clean and cool the eye. Notify laboratory instructor or instructional support staff and seek medical attention immediately by calling University Police at ext. 7777.

9. Skin contact: wash with soap and water.

<u>TOXIC CHEMICALS</u>: Almost any substance in sufficient quantity can be considered toxic. Toxic chemicals are those which damage biological structure and function through exposure or accumulation in tissues. Usually, this involves relatively small amounts of the toxin.

For these purposes, a poison will be defined as a substance which may cause death or serious health effects if relatively small amounts are inhaled, ingested or absorbed by the skin.

1.Wear Personal Protective Equipment when handling toxic chemicals.

2. Store and use small gas cylinders containing toxic gases in a hood; use hood precautions.

3. Do not remove health effect warning tags.

4. Do not remain in the vicinity of a toxic gas release. Leave the area and call University Police at ext. 7777

HANDLING SPECIFIC TOXIC MATERIALS

1. MERCURY: All labs where mercury is used must have a mercury spill clean up kit. Follow the directions in the kit for clean up. All mercury waste shall be delivered to the chemical hygiene officer for disposal.

2. BROMINE AND/OR PHENOL: Prior to handling bromine or phenol, prepare a 50 percent ethyl alcohol/isopropyl alcohol solution to use if skin contact occurs. Use this solution to rinse and pack the burned area. Seek medical attention immediately by contacting University Police at ext. 7777.

<u>REACTIVE AND EXPLOSIVE MATERIALS</u>: Materials that may release large amounts of energy under special circumstances.

1. Disposal of reactive and explosive chemicals is highly regulated. Do not dispose of these materials in the sanitary sewer or garbage. Contact the Chemical Hygiene Officer for assistance.

2. **Examples of highly reactive materials includes: nitric acid, nitrates, permanganates, chromic acid cleaning solutions, peroxides, chlorites, chlorates, perchlorates, and perchloric acid.**

3. **Handle reactive, unstable and explosive chemicals carefully. Follow precautions on the label.**

4. **Do not mix or combine oxidizers such as chlorates, chlorites and perchlorates with sulfuric acid, phosphorous, antimony and cyanides. Heat, shock or friction (e.g. grinding) may set off an explosion.**

5. **If explosive materials must be prepared, prepare the smallest amount practical.**

6. **Ethers react with oxygen in air to form unstable peroxides which may detonate when concentrated by evaporation or distillation; when combined with other compounds; or when heated, shocked or subjected to friction. Ethers must be handled with extreme care. The following are recommended storage procedures.**
   1. **Store in explosion proof refrigerator.**
   2. **Containers should be dated as received and when opened.**
   3. **Open container shelf life of diethyl ether should be 6 months after which time it should be disposed of. Contact the Chemical Hygiene Officer for assistance.**

7. **Isolate reactive chemicals from toxic and flammable materials.**

CARCINOGENS AND TERATOGENS

Carcinogens: Carcinogens are hazardous chemicals capable of increasing the risk of cancer through exposure. Substances designated by the Occupational Safety and Health Administration (29 CFR Part 1910, Sub-part Z) as being a carcinogen require special handling.

Specific authoritative sources such as the Registry of Toxic Effects of Chemical Substances (RTECS), the National Toxicology Program (NTP) Annual Report on Carcinogens, and the International Agency for Research on Cancer (IARC) Monographs serve as primary sources of toxic chemical information.

Teratogens: Teratogens are hazardous chemicals capable of causing an increased risk of birth defects in children of exposed workers.

1. **Reduce your exposure to these chemicals to the lowest possible level through good work habits and common sense. Always wear personal protective equipment (gloves, goggles, aprons) as advised by the MSDS.**

2. **If skin contact occurs, thoroughly wash the area with soap and water.**

H. USE OF CHEMICAL FUME HOODS

1. **Use for operations which use or release toxic chemical vapor or dust, or which have fire or explosion potential.**

2. **Don't use for long-term chemical storage.**

3. **Confirm adequate hood ventilation (flow of 70 - 125 fpm) before starting the experiment. Each hood is equipped with its own flow meter and alarm. Improper air flow will activate the alarm system.**

4. **Keep hood closed or with a 2" opening (according to the building ventilation requirements) except when making adjustments inside the hood.**

5. **Place bulky equipment on platforms inside hood to allow flow of air underneath; this provides for smooth flow of air in the hood.**

6. **Remove unneeded equipment and chemicals to ensure smooth air flow.**

7. **Report malfunctioning hoods to lab instructor or Instructional Support Staff.**

8. **As a rule of thumb: handle chemicals with a PEL (permissible exposure level) of less than 100 ppm in a hood. The following is a list of chemicals used in our labs with a PEL <100 ppm.**

   Chlorine
   Iodine
   Pyridine
   Bromine

I. USE OF SPECIAL LABORATORY EQUIPMENT

1. **Use glassware designed for vacuum procedures. Do not apply a vacuum to glassware with flat surfaces except for desiccators and filter flasks.**

2. **Use a metal safety shield or cloth wrapping when applying a vacuum to a desiccator.**

3. **Wear safety goggles when doing vacuum distillations and freeze-drying; place a safety shield in front of the apparatus.**

4. **Place samples in centrifuge such that proper balance is achieved.**

5. **Centrifuge covers must be closed while spinning. Never open a centrifuge cover until spinning has stopped.**

J. USE OF ELECTRICAL AND MECHANICAL EQUIPMENT

1. When performing electrical work on equipment remove fuses (using fuse puller for cartridge fuses) and tag the switch box. Only the person who tags the switch may remove the tag.

2. Disconnect the power supply to motors before adjusting belts or pulleys.

3. Do not wear loose clothing (unbuttoned shirt sleeves, ties) when working around rotating equipment. Rotating shafts and couplings and exposed belts are hazardous; they should be covered with a guard whenever possible.

4. Confine long hair in a net or pony tail when working with rotating equipment to prevent scalping.

5. Avoid contact with electrical wiring or other fittings; electrical hazards greatly increase when any part of the body is grounded (e.g. in contact with piping or damp floors). Death has been caused by 110 volts to the grounded body.

6. Properly ground portable equipment; pay special attention to grounding when working in or around damp floors or pipes.

7. Examine extension cords and leads before use. Do not use damaged cords (repair cords when necessary). All electrical devices should be grounded or double insulated. Discard two wire extension cords.

8. Unplug electrical cords by grasping and pulling on the plug, not the wire.

K. COMPRESSED GAS CYLINDERS

1. **All compressed gas cylinders must be used and stored vertically either in a cylinder holder or attached to walls or benches. Strap or chain cylinders in place.**

2. **Keep valve protection caps on out-of-service cylinders.**

3. **Do not move a cylinder that has a regulator attached.**

4. **When moving cylinders avoid dragging, rolling and/or sliding them. Use a hand truck for moving cylinders even over short distances.**

5. **Do not heat cylinders higher than 125 ^{0}F (52 ^{0}C). Do not let a flame come into contact with any part of a compressed gas cylinder.**

6. **Do not refill one cylinder from another.**

7. **Use gas cylinders containing toxic gases in a fume hood.**

8. **Close valve, remove regulator, and affix cap when taking a cylinder out of service; if empty, attach an "EMPTY" tag.**

ORDERING NEW AND DISPOSING OF OLD CYLINDERS

1. **Cylinders are delivered directly to the laboratory by the Supplier.**

2. **Cylinder pick-up will take place when deliveries are made.**

3. **The user ensures that cylinders are chained as soon as received; most laboratories will need "in-transit" cylinder storage spaces in the laboratory.**

4. **If the cylinders must be moved more than several feet, a cylinder hand truck must be available.**

L. UNATTENDED USE OF EQUIPMENT OR SERVICES

Unattended use of experimental equipment is prohibited.

M. FIRST AID PRACTICES

1. **EYE CONTACT: immediately rinse the eye with water at eye wash station and continue flushing for 15 minutes. Call University Police at 7777 for assistance.**

2. **SWALLOWING: if possible, determine what the victim swallowed; follow first aid practices if given on the label. Call University Police at 7777 for assistance.**

3. **SKIN CONTACT: flush contaminated area with water; remove contaminated clothing. Wash contaminated area with soap and water; if irritation persists or other symptoms occur, seek medical assistance.**

4. **SUDDEN ILLNESS: call University Police at 7777 for assistance.**

N. PERSONAL INJURY AND ACCIDENTS

1. **Know where first aid kits are located in each laboratory.**

2. **Immediately notify the Instructional Support Staff, a faculty member, or others in the area.**

3. **Call University Police at 7777 and explain the situation; they will call for additional assistance from the fire department, rescue squad, etc.**

4. **In the meantime:**

   a. **Provide first aid if possible.**

   b. **After the victim is taken care of, seek assistance from the Chemical Hygiene officer if necessary to properly clean up any chemical spill.**

   c. **Do not ask custodians to clean up chemical spills.**

5. **All accidents must be reported. Written reports must be prepared for all accidents or incidents that caused (or nearly caused) personal injury or major property damage. Both victims and witnesses may be asked to prepare a report. Formats for accident and incident reports are on the next page. Click on link for a printable version.**

http://www.canton.edu/forms/Accident_Injury_Report_Form.xls

CS-13

Accident / Injury Reporting

SUNY CANTON

1. Date and Time of Accident: Mo: Day: Year: Time:

2. Date of Report: Mo: Day: Year:

3. Did accident involve personal injury: A) Yes B) No

4. Injured: A) Student B) Faculty/Staff C) CA D) Vendor E) Visitor F) Other (specify)

5. Name of office/department where employee is regularly assigned:

6. Sex: A) Female B) Male

7. Date of Birth: Mo: Day: Year:

8. Name of Injured (PRINT Last, First, Middle)

Local Address:

Telephone:

Home Address:

Telephone:

9. Job title (include Student Workers injured while working):

10. Was injured in authorized area: A) Yes B) No C) Unknown

11. Reporter of Accident (Person reporting to you): A) Faculty/Staff B) Injured C) Other (specify)

12. Name of reporter of accident:
PRINT Last, First, Middle:
Local address:
Telephone:

13. General area of occurrence:
A) Residence Hall
B) Dining Hall
C) Campus Center
D) Academic
E) Gym
F) French Hall
G) Maint. Building
H) Road
I) Parking Lot
J) Grounds
K) Other

14. Specific area of occurrence:
Room Number:

15. If physical injury, part of body injured: (ONLY ONE MOST SERIOUS)

A) Abdomen	F) Elbow	K) Hand	P) Lip	U) Teeth	Z) Other, specify
B) Ankle	G) Eye	L) Head	Q) Neck	V) Thigh	
C) Arm	H) Face	M) Hip	R) Nose	W) Toes	
D) Back	I) Finger	N) Knee	S) Shoulder	X) Trunk	
E) Chest	J) Foot	O) Leg	T) Spine	Y) Wrist	

16. Accident: A) Athletic B) Academic C) Job related D) Other

17. Are there witnesses: (List in narrative) A) Yes B) No

18. If Physical Injury, type of injury (SELECT ONE ONLY)

A) Abrasion	F) Concussion	K) Puncture	P) Other, specify
B) Amputation	G) Cut	L) Swelling	
C) Bruise	H) Dislocation	M) Tooth (broken)	
D) Burn	I) Fracture	N) Sprain	
E) Burn (chem)	J) Laceration	O) Strain	

19. Were safeguards provided: A) Yes B) No

20. Were safeguards in use: A) Yes B) No

21. Medical assistance rendered: A) First aid by staff B) Infirmary C) Hospital D) Ambulance E) Other

22. Name and address of hospital:

23. Name and address of physician:

24. Has employee returned to work: A) Yes B) No
If yes, date: Mo: Day: Year:

25. Supervisor notified: A) Yes B) No
Date and Time: Mo: Day: Year: Time:

26. Employee have restricted duties: A) Yes B) No

27. Name of supervisor:

NARRATIVE: (Only give a brief description of who, what, when, where, how, etc.) List witnesses names and addresses:

Report completed by: _____ Title: _____ Date: _____

Rev. 5/14/10

FORWARD TO UNIVERSITY POLICE DEPARTMENT

O. EMERGENCY PREPAREDNESS

1. Know the location of and how to use emergency equipment, such as first aid kits, fire blankets, fire alarm pull stations, eye-wash stations, fire extinguishers, emergency gas shut-off, and safety showers.

2. If you are working with hazardous materials or equipment, plan an emergency response before you start the experiment.

3. Be alert to unsafe conditions in your own work and that of others. Report and/or correct unsafe conditions immediately.

4. In case of fire or explosion, pull the fire alarm. If there is a chance of putting the fire out, use a fire extinguisher; otherwise, leave the building and meet University Police so you can show them where the fire is.

5. Call University Police at 7777 in case of spills or emergencies; they will contact the appropriate emergency response agency.

6. If Bunsen burners are in use during a fire or explosion, activate the emergency gas shut-off button.

P. LABORATORY SECURITY

For the protection of employees, students, equipment, supplies and the public, laboratories must be locked when unoccupied.

Security within the laboratory is also important. Locked storage cabinets are advised for sensitive or expensive supplies and equipment. Locking storage areas or lockers for securing personal property are advised.

Computers and scientific equipment can be the object of theft, vandalism, or damage from fire or utility failure. Appropriate cabinetry designed to protect these items should be considered. Upon request, University Police can assist laboratories with crime prevention surveys and recommendations.

If you observe suspicious persons or activities in your area, contact University Police at 7777 and an officer will be sent to investigate. Report any thefts or other crimes immediately. Information from these reports is used to adjust patrol activities and may prevent further problems.

FOR *ANY* EMERGENCY

INFORM THE

LABORATORY

INSTRUCTOR OR STAFF

AND/OR CALL

UNIVERSITY POLICE

(x7777)

IV. LABORATORY SPECIFIC PROCEDURES (LSP)

Faculty, in conjunction with Instructional Support Staff, develop laboratory specific procedures designed to protect the health of employees and students from hazards not identified as a College-wide SOP.

Laboratory Specific Procedures identify hazardous chemicals, operations and equipment and discuss the nature of the hazard and how to prevent injury. LSP's are developed for experiments which use particularly toxic or reactive chemicals; which generate explosive, flammable or hazardous chemicals; which generate high or low pressure conditions; or which take place in confined spaces (e.g. cold room). A suggested format for LSPs follows on the next page. At this time there are no LSP's being used at the college.

A.

LABORATORY SPECIFIC PROCEDURE
HAZARDOUS CHEMICAL, EQUIPMENT, PROCEDURE OR EXPERIMENT)

NAME OF LABORATORY TO WHICH THIS APPLIES:

NAME OF HAZARDOUS ITEM:

DESCRIPTION OF HAZARD:

SPECIAL INSTRUCTIONS:

RESTRICTIONS ON USE OF ITEM:

PREPARED BY:_____ DATE:_____

V. FIRE PREVENTION, CONTROL AND REPORTING

A. PREVENTING LABORATORY FIRES

1. **Do not use open flames or open electrical heating elements near flammable materials. Use steam baths or heating mantles to heat flammable materials.**

2. **Don't use spark creating equipment (e.g. most switches and electrical outlets) inside hoods because explosive conditions may prevail. Disconnects and switches should be outside of the hood.**

3. **Store highly volatile flammable liquids in refrigerators designed for flammable material storage.**

4. **Attach rubber hoses securely to gas outlets to ensure they do not leak. Check hoses for cracks and leaks. Turn outlets off at source when they are not in use.**

5. **Do not leave gas flames burning unattended.**

6. **If there is a release of flammable vapor or gas do not make or break electrical contacts in the area; if equipment can be turned off from outside of the room, do so.**

B. FIRE-FIGHTING AND RESCUE OPERATIONS

1. **Be sure that the correct type of fire extinguisher is located in each laboratory. Fire extinguisher classification and testing is the responsibility of Environmental Health and Safety.**

2. **Know how to use the fire alarm and extinguisher; turn in a fire alarm if there is <u>any doubt</u> that you may fail to put out the fire. Turn in a fire alarm for any serious emergency such as toxic gas release or an explosion.**

3. **Call Environmental Health and Safety at 386-7631 if you have used an extinguisher. Environmental Health and Safety will see that the extinguisher is replaced with one that is fully charged.**

4. **Use laboratory fire extinguisher only if the building is being evacuated, the University Police have been called, the fire is small and contained, the exit is clear and you can fight the fire with your back to the exit, the proper extinguisher type is available, you can stay low and avoid breathing smoke, and you are trained and confident about using the fire extinguisher.**

5. **If you hear a fire alarm in your building, leave the building--don't look for the fire. Immediately leave. Persons who refuse to abandon a building upon request of the University Police are subject to arrest.**

6. **If a person's clothing catches fire, wrap them in a fire blanket (if available) and roll them on the floor to extinguish flames.**

VI. HANDLING HAZARDOUS WASTE

A. COLLECTION, STORAGE AND DISPOSAL

NOTE: By law, many chemicals can't be discarded in the sink or in garbage cans. The College abides by environmental laws for both legal and ethical reasons. Therefore, don't dispose of a chemical if you don't know the regulatory requirements. If the information below does not answer your question, ask the Chemical Hygiene Officer. If there is any question about correct disposal contact the Chemical Hygiene Officer for instructions.

1. **See if material is listed on Hazardous Chemical list (page 40). If it is, follow the instructions below. If not, contact the Chemical Hygiene Officer for further instructions. Additional information may be obtained from the EPA and OSHA web sites. (www.osha.gov; www.epa.gov)**

2. **Put waste material in a 1 pint to 1 gallon chemical resistant container. Container must be completely sealed except when adding chemical to the container. Do not leave container open with a funnel or other filling device. When about 3/4 full, contact Instructional Support Staff to arrange for removal.**

3. **Attach a completed "HAZARDOUS WASTE" label to the container. Labels are available in each laboratory. Labels may also be obtained from the Chemical Hygiene Officer. Note example on next page. You must keep track of the identity of waste materials. Each time an addition is made to a waste mixture, add to the label what was added, and approximately how much. Dating of the label is not necessary until waste is moved into final storage prior to disposal.**

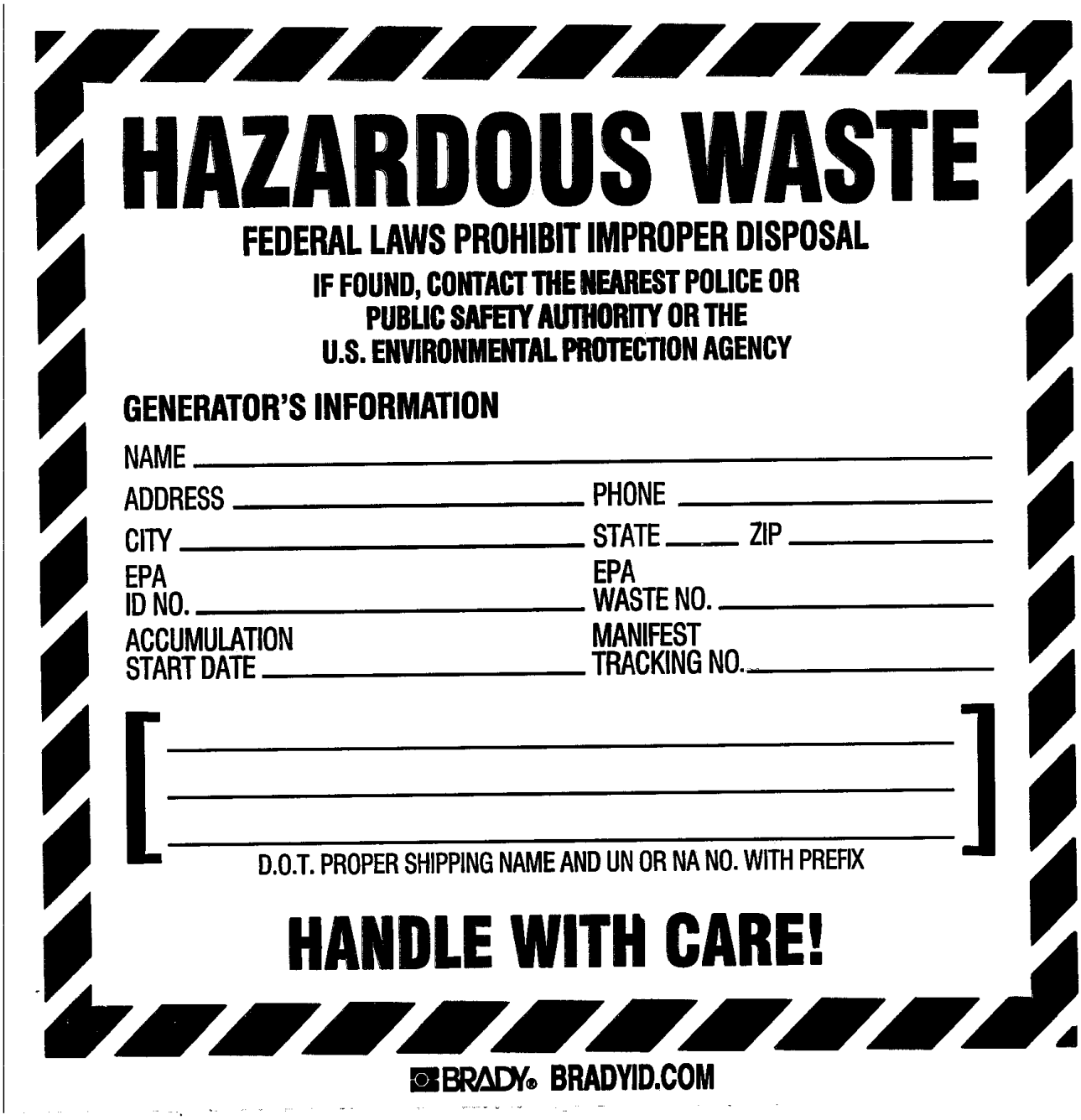
4. **Final storage of hazardous waste is located in the flammable storage vault located behind the chemistry laboratories in Cook Hall. The Automotive Technology Laboratory shall store their waste in Nevaldine Hall South 123.**

5. **When waste is collected and stored in the laboratory, the site is considered a Satellite Accumulation Area and must be clearly labeled as such. It is wise to establish a Satellite Accumulation Area in the laboratory near the point of generation. If a fume hood is utilized, then it may not be used for any other purpose. Satellite waste storage must not exceed 55 gallons and must be under the control of the generator.**

6. **It is not advised to mix wastes.**

7. **If you find unlabeled containers contact the Chemical Hygiene Officer.**

B. HAZARDOUS WASTE DISPOSAL LABEL



C. CHEMICAL SPILL CLEAN UP AND DECONTAMINATION PROCEDURES

1. **In the event of a spill, evaluate the situation. If the spill is too large or dangerous to manage, evacuate the area and contact University Police at 7777.**

2. **When chemical spills occur: FIRST, if necessary, provide first aid and remove contaminated clothing. THEN clean up the spill using personal protective equipment and appropriate spill absorbent materials, if available.**

3. **Certain laboratories have spill clean-up equipment. Know where these materials are stored.**

4. **There are several specific types of spill clean-up materials. Know what material is to be used for the chemicals you handle.**

5. **When a flammable material is spilled, do not trip any switches that could create a spark; do turn off pilot lights and other flames in the area.**

6. **Collect spilled chemical and absorbent material in a plastic bag (it is best to place the plastic bag(s) in a box). Label both the bag and the box with approved hazardous waste tag and store it in an appropriate place. Contact the Chemical Hygiene Officer for proper disposal of the waste.**

7. **Do not ask custodians to clean up chemical spills.**

VII. ADMINISTRATIVE AND ENGINEERING CONTROLS

Engineering controls and safety equipment include chemical fume hoods, laminar flow hoods, walk in hoods, glove boxes, ventilated chemical storage cabinets, fire extinguishers, fire alarms, eye wash stations, showers, fire blankets, etc.. Standardized performance criteria, testing methods, testing frequency and record keeping formats follow.

A. SAFETY EQUIPMENT PERFORMANCE CRITERIA

INSPECTION OF HOODS

1. **All chemical fume hoods have flow detectors that indicate face velocity. The appropriate flow rate for chemical fume hoods is between 70 and 125 fpm; flows beyond that range are not operating properly and must be fixed.**

2. **Some chemical fume hoods have a high flow setting to be used in case of a chemical spill; however, the hood should not be left at this high setting except during spills. (In the case of hoods, more flow is not better.)**

3. **The Environmental Health and Safety department will inspect hood face velocity on a monthly basis and will report all out of range hoods to the Physical Plant.**

4. **An outside contractor certifies fume hoods annually. They will apply a tag to each hood stating flow rate and operating condition. The college's HVAC department performs annualpreventative maintenance on the hoods. The HVAC department has continuous computerized monitoring of all hoods and any failure is recorded immediately. All records are maintained by the HVAC department.**

EYE WASH STATIONS

1. **The Environmental Health and Safety department is in charge of testing eye wash stations on a weekly basis. Barcodes are applied to each eye wash and the date and time of inspections are digitally recorded once completed. Records of testing are maintained by the Environmental Health and Safety department.**

2. **Features looked for in weekly tests are: flow rate ("copious" flow rate of water), dust caps installed, water stays on when hand released from lever.**

SAFETY SHOWERS

1. **The Environmental Health and Safety department are in charge of testing safety showers quarterly. Barcodes are applied to each safety shower and the date and time of inspections are digitally recorded once completed. Records of testing are maintained by Environmental Health and Safety.**

2. **Features looked for in tests are: flow rate ("copious" flow rate of water). At least five gallons of water should be run during the test.**

FIRE EXTINGUISHERS

1. **Environmental Health and Safety department is in charge of checking fire extinguishers on a monthly basis. Barcodes are applied to each fire extinguisher and the date and time of inspections are digitally recorded once completed. Records of testing are maintained by**

Environmental Health and Safety department.

B. LABORATORY SAFETY AUDITS

1. Laboratory Safety Audits are performed biannually by Environmental Health and Safety Department. These audits will be reviewed by the Chemical Hygiene Committee.

2. Records shall be maintained by the Environmental Health and Safety Dept.

3. An example of the Laboratory Safety Audit follows:

VIII. TRAINING

Prior to initial work assignment, "general" laboratory safety training for employees who work in laboratories (including faculty, custodians, maintenance personnel and student workers) is planned and implemented by the Chemical Hygiene Committee. The training program reviews elements of the CHP and also reviews College-wide Standard Operating Procedures and relevant Laboratory Specific Procedures. Additional training will be performed as deemed necessary by the Chemical Safety Committee.

Training covers subjects mandated by 29 CFR 1910.1450, Section f(3) and (4) (see Appendix A).

Attendance logs are maintained by the Chemical Hygiene Officer.

FACULTY AND STAFF TRAINING PROGRAM

TOPICS: BACKGROUND INFORMATION ON THE LABORATORY STANDARD AND REVIEW AND REQUEST FOR COMMENTS ON THE CHEMICAL HYGIENE PLAN

1. **Background and philosophy of the OSHA Laboratory Standard.**
2. **Enforcement of OSHA Standards; agencies that care.**
3. **Elements of the Laboratory Standard.**
4. **Basis of the Chemical Hygiene Plan.**
5. **Overview of Standard Operating Procedures.**
6. **Preparation of Specific Laboratory Procedures.**
7. **Discussion: emergency response.**
8. **Discussion: injury response.**
9. **Discussion: spill clean-up materials: types available and location**
10. **Discussion: providing information sources.**

STUDENT TRAINING PROGRAM

A. Background information about the Laboratory Safety Policy

1. **OSHA Laboratory Standard**
2. **Basis of Safety Policy**

B. Individual responsibility for laboratory safety.

1. **Ultimate responsibility rests with individual.**
2. **Role of custodial staff in laboratory safety.**

C. Review of Laboratory Safety Information

D. Resource materials and people:

1. **SDS's**
2. **Compendia of information**
3. **Computer systems**
4. **Chemical Hygiene Officer's Office**
5. **Instructional Support Staff**
6. **Faculty**

IX. EMPLOYEE EXPOSURE TO HAZARDOUS CHEMICALS

A. OVEREXPOSURE BY INHALATION

Employees shall not be exposed to levels of hazardous chemical in excess of the OSHA Permissible Exposure Limits (PEL's) as specified in 29 CFR Part 1910 Subpart Z.

If there is reason to believe that an employee is routinely exposed to greater than the Action Limit (50 % of the PEL), then:

1. **Exposure level will be measured using acceptable industrial hygiene air monitoring and analytical methods; surveys will be carried out by certified Industrial Hygienists and analyzed by a certified air monitoring laboratory.**

2. **If exposure is greater than the Action Limit, all exposure and medical monitoring provisions of the standard will be met, and steps taken to reduce exposure level to less than the Action Limit.**

B. OVEREXPOSURE BY OTHER ROUTES

Prevention of direct skin contact and ingestion of chemicals is addressed by the following means:

1. **by providing proper personal protective equipment;**

2. **by providing proper handling devices;**

3. **and through training employees in good laboratory practices, including how to properly handle toxic and hazardous chemicals.**

X. MEDICAL CONSULTATIONS , EXAMINATIONS AND RECORD KEEPING

A. EMPLOYEE RIGHTS AND RESPONSIBILITIES

1. **Subsequent to a spill, accident or routine chemical exposure resulting in symptoms of overexposure, employees may require medical consultation to determine if treatment or further examination is necessary.**

2. **Medical examinations will be provided without loss of pay and at reasonable times and places. The College will pay for these services under any of the following conditions:**

a. **If air monitoring data indicate that an employee is exposed to greater than the action limit (½ the Permissible Exposure Limit) if the chemical is regulated by an OSHA health standard which requires medical surveillance.**

b. **If an employee develops signs or symptoms associated with a chemical to which the employee may have been exposed in the laboratory.**

c. **If a spill, leak, explosion or other event results in the likelihood of hazardous exposure.**

3. **The following information will be provided to the physician:**

a. **Qualitative and quantitative information.**
b. **Conditions of exposure.**
c. **Signs and symptoms at exposure and later.**

4. **The physician shall submit to the College this information:**

a. **Medical examination and test results.**
b. **Recommendations for follow-up.**
c. **Medical conditions which place the employee at increased risk due to exposure to laboratory chemicals.**

5. **The physician shall inform the employee (in writing or verbally) of:**

a. **4 (a, b, and c) above.**
b. **Medical conditions discovered in the examination which are unrelated to occupational exposure. (Note that this information is not transmitted to the College.)**

B. RECORD KEEPING

Chemical exposure monitoring and medical records are maintained in accordance with OSHA's Record keeping Standard, 29 CFR 1910.1020.
(www.osha-slc.gov/OshStd_data/1910_1020.html)
See page 24 for accident report to be utilized in the event of an accident.
A copy of the Standard is in the Chemical Hygiene Officer's Office (Cook 204).

XI. HAZARDOUS WASTE CHEMICALS

A. LIST OF HAZARDOUS CHEMICALS

To determine if a chemical is a hazardous waste, it is necessary to ascertain if the chemical in question is either a listed or characteristic hazardous waste. The following includes some of the most common chemicals considered hazardous by the EPA. Information resources pertinent to waste classification are listed on the next page.

1. **Chlorinated hydrocarbons: carbon tetrachloride, chloroform, methylene chloride.**

2. **Aromatic and aliphatic hydrocarbons and their derivatives: benzene, toluene, xylenes, hexanes, hydrocarbon mixtures such as mineral spirits, naphthas, etc.**

3. **Aliphatic and aromatic amines: aniline, p-phenylenediamine, benzidine.**

4. **Alcohols, ketones, aldehydes, ethers and organic acids. (Very small amounts can be poured down the drain and followed by several liters of water; anything more than several milliliters should be collected).**

5. **Amides: acetamide, dimethylformamide, dimethylacetamide.**

6. **Organic and inorganic nitrogen compounds: nitro-, azo- and n-nitroso compounds.**

7. **Non-cured epoxy compounds.**

8. **Carcinogenic materials: see list in Appendix B.**

9. **Monomers of various polymers and plastics, and their decomposition products.**

10. **All heavy metals and phosphorous organic/inorganic compounds: metal dust and fume, mercury, barium salts, chromium salts, chromic acid, cadmium, arsenic, lead, selenium, silver salts bismuth.**

11. **All halogens: chlorine, bromine.**

12. **Poisons such as pesticides, cyanide salts (such as sodium cyanide), and other items labeled "poisonous".**

B. HEALTH AND SAFETY RESOURCES
(located in Cook 204)

NIOSH - OSHA Occupational Health Guidelines for Chemical Hazards.

NIOSH - OSHA Pocket Guide to Chemical Hazards.

Fire Officers Guide to Dangerous Chemicals by Bahme

Prudent Practices for Handling Hazardous Chemicals in laboratories, National Ac

Guide to Hazardous Materials by J. J. Keller

Sigma Aldrich Library of Chemical Safety Data

Prudent Practices for Disposal of Chemicals from Laboratories , National Academy Press.

XII. HAZARD IDENTIFICATION

1. Information about the hazards of specific chemicals is transmitted to employees in the following ways:

a. Labels on shipping containers.

b. Safety Data Sheets. (SDS)

c. Health effect compendia e.g. Sax, Merck, Sigma-Aldrich. A list which includes the location of such holdings is included in Appendix C.

d. The Chemical Hygiene Program contains information about a variety of hazardous materials including proper handling and first aid for certain special hazards.

2. To ensure transmission of hazard information:

a. Labels on shipping containers are not removed or defaced until the container is empty and rinsed.

b. The contents of portable containers are identified on the container. Portable containers include all non-shipping containers such as storage bottles, volumetric flasks, beakers, graduated cylinders, wash bottles, etc.

c. SDSs received are retained;

- **SDS files or binders are located in the laboratory.**
- **SDSs are arranged alphabetically, by chemical name.**

d. SDSs or "caution statements" for all chemicals used and generated in laboratory experiments are located in the laboratory.

- **If an SDS is unavailable, a "caution statement" based on information gathered in a literature search (or phone calls to manufacturers) is prepared.**
- **No employee or student is expected to work with a chemical with unknown toxicity.**

Appendix A

29 CFR 1910.1450 - Occupational Exposure to Hazardous Chemicals in Laboratories

(a) Scope and application.

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

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

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

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

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

1. **This section shall not apply to:**

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

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

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

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

(b) Definitions

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

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee. "Carcinogen" (see"select carcinogen").

"Chemical Hygiene Officer" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

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

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

"Compressed Gas" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 ° F (21.1 ° C); or
(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 ° F (54.4 ° C) regardless of the pressure at 70 ° F (21.1 °C) ; or
(iii) A liquid having a vapor pressure exceeding 40 psi at 100 ° F (37.8 ° C) as determined by ASTM D-323-72.

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

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

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

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

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

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

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

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

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

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

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

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

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTMD 3278-78). Organic peroxides, which undergo auto-accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"Hazardous Chemical" means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoetic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

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

"Laboratory Scale" means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person.

"Laboratory Scale" excludes those workplaces whose function is to produce commercial quantities of materials.

"Laboratory-type hood" means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

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

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

(ii) Multiple chemical procedures or chemicals are used;

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

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

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

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

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

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

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

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

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

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

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

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

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: (A) After inhalation exposure of 6 - 7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3); (B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or (C) After oral dosages of less than 50 mg/kg of body weight per day.

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

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

(c) Permissible Exposure Limits.

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

(d) Employee Exposure Determination

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

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

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

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

(e) Chemical Hygiene Plan

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

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

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

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

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

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

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

(ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

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

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

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

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

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

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

(A) Establishment of a designated area;

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

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

(D) Decontamination procedures.

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

(f) Employee Information and Training.

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

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

3. **Information. Employees shall be informed of:**

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

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

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

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

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

4. **Training**

(i) Employee training shall include:

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

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

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

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

(g) Medical Consultation and Medical Examinations

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

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

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

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

2. All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

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

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

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

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

4. Physician's written opinion.

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

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

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

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

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

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

(h) Hazard Identification

1. With respect to labels and material safety data sheets:

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

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

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

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

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

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

(i) Use of respirators.

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

(j) Recordkeeping.

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

2. The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

(k) Dates

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

2. Start-up dates.

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

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

(l) Appendices

The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

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

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Foreword

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

"Prudent Practices" is cited because of its wide distribution and acceptance and because

of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will

modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices," organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

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

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

Corresponding Sections of the Standard and this Appendix

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

Paragraph	Topic in laboratory standard	Relevant appendix section
(e)(3)(i)	Standard operating procedures for handling toxic chemicals.	C, D, E

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

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A - D. Those recommendations of primary concern to

employees who are actually handling laboratory chemicals are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

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

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

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

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

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

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

B. Chemical Hygiene Responsibilities

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

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

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

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

   (a) Work with administrators and other employees to develop and

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

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

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

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

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

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

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

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

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

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

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

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

6. Laboratory worker, who is responsible for:

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

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

C. The Laboratory Facility

1. Design. The laboratory facility should have:

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

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

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

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

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

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

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

4. Ventilation -

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

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

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

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

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

(f) Performance. Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).

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

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

D. Components of the Chemical Hygiene Plan

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

2. Chemical Procurement, Distribution, and Storage

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

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

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

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

3. Environmental Monitoring

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

4. Housekeeping, Maintenance, and Inspections

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

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

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

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

5. Medical Program

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

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

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

6. Protective Apparel and Equipment

These should include for each laboratory:

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

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

(c) An eyewash fountain (162)

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

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

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

7. Records

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

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

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

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

8. Signs and Labels

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

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

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

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

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

9. Spills and Accidents

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

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

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

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

10. Information and Training Program

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

(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169). Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6). Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

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

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

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

11. Waste Disposal Program.

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

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

(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27). Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

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

(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241). Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or adding them to mixed refuse for landfill burial is unacceptable (14). Hoods should not be used as a means of disposal for volatile chemicals(40, 200). Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

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

1. General Rules

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

(a) Accidents and spills - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172). Ingestion: Encourage the victim to drink large amounts of water (178).

Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33). Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24, 33). See pp. 233-237 for specific clean-up recommendations.

(b) Avoidance of "routine" exposure: Develop and encourage safe habits (23); avoid unnecessary exposure to chemicals by any route (23). Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199). Inspect gloves (157) and test glove boxes (208) before use. Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

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

(d) Eating, smoking, etc.: Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities (23, 24). Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

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

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

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

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

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

(j) Personal housekeeping: Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) Personal protection: Assure that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154). Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159). Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169). Use any other protective and emergency apparel and equipment as appropriate (22, 157-162). Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155). Remove laboratory coats immediately on significant contamination (161).

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

(m) Unattended operations: Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).

(n) Use of hood: Use the hood for operations which might result in release of toxic chemical vapors or dust (198-9). As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm (13). Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200). Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off"(200).

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

(p) Waste disposal: Assure that the plan for each laboratory operation includes plans and training for waste disposal (230). Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24). Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

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

2. Working with Allergens and Embryo toxins

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

(b) Embryo toxins (34-5) (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact. Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made. Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container. Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

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

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

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

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

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

(c) Location: Use and store these substances only in areas of restricted access with special warning signs (40, 229). Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to prevent their discharge with the hood exhaust (40).

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

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

(f) Prevention of spills and accidents: Be prepared for accidents and spills (41). Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39). Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper (40). If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) Waste: Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical version (40). Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

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

Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47). (Procedure A of "Prudent Practices" pp. 47-50).

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

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

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

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

(e) Housekeeping: Use a wet mop or a vacuum cleaner equipped with an HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50).

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

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

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

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

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

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

(l) Waste: Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity

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

(b) Administration of the toxic substance: When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).

(c) Aerosol suppression: Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).

(d) Personal protection: When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).

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

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those that are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6)

2. Electrically powered laboratory apparatus: (179-92)

3. **Fires, explosions: (26, 57-74, 162-64, 174-5, 219-20, 226-7)**

4. **Low temperature procedures: (26, 88)**

5. **Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)**

G. Material Safety Data Sheets

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

- **Acetyl peroxide (105)**
- **Acrolein (106)**
- **Acrylonitrile**
- **Ammonia (anhydrous)(91)**
- **Aniline (109)**
- **Benzene (110)**
- **Benzo[a]pyrene (112)**
- **Bis(chloromethyl) ether (113)**
- **Boron trichloride (91)**
- **Boron trifluoride (92)**
- **Bromine (114)**
- **Tert-butyl hydroperoxide (148)**
- **Carbon disulfide (116)**
- **Carbon monoxide (92)**
- **Carbon tetrachloride (118)**
- ***Chlorine (119)**
- **Chlorine trifluoride (94)**
- **Chloroform (121)**
- **Chloromethane (93)**
- **Diethyl ether (122)**
- **Disopropyl fluorophosphate (41)**
- **Dimethylformamide (123)**
- **Dimethyl sulfate (125)**
- **Dioxane (126)**
- **Ethylene dibromide (128)**
- **Fluorine (95)**
- **Formaldehyde (130)**
- **Hydrazine and salts (132)**
- **Hydrofluoric acid (43)**
- **Hydrogen bromide (98)**
- **Hydrogen chloride (98)**
- **Hydrogen cyanide (133)**
- **Hydrogen sulfide (135)**
- **Mercury and compounds (52)**
- **Methanol (137)**

- **Morpholine (138)**
- **Nickel carbonyl (99)**
- **Nitrobenzene (139)**
- **Nitrogen dioxide (100)**
- **N-nitrosodiethylamine (54)**
- **Peracetic acid (141)**
- **Phenol (142)**
- **Phosgene (143)**
- **Pyridine (144)**
- **Sodium azide (145)**
- **Sodium cyanide (147)**
- **Sulfur dioxide (101)**
- **Trichloroethylene (149)**
- **Vinyl chloride (150)**

29 CFR 1910.1450 App B References (Non-Mandatory)

Appendix B to 1910.1450 - References (Non-Mandatory)

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

(A) Materials for the development of the Chemical Hygiene Plan:

1. **American Chemical Society, Safety in Academic Chemistry Laboratories, 4th edition, 1985.**

2. **Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.**

3. **Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL, 1978.**

4. **Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing Co., NY, 1978.**

5. **Kaufman, James A., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.**

6. **National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.**

7. **National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.**

8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, DC, 1981.

9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, J. Chem. Ed., American Chemical Society, Easlon, PA, 1981.

10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA, 18042, Vol. I, 1967, Vol. II, 1971, Vol. III, 1974.

11. Steere, Norman V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.

12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory, John Wiley ∧ Sons, Inc. New York, 1987.

(B) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211-4438.

2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).

3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.

4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.

5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.

6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).

7. IARC Monographs on the Evaluation of the Carcinogenic Risk of chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).

8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).

9. Occupational Health Guidelines, NIOSH/OSHA. NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.

10. **Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes).**

11. **Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of documents US. Govt. Printing Office, Washington, DC 20402.**

12. **The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).**

13. **Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.**

14. **Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications. Park Ridge, NJ, 1981.**

(C) Information on Ventilation:

1. **American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.**

2. **American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y. 1979.**

3. **Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.**

4. **National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982. Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980. Fire Protection Guide on Hazardous Materials, 7th edition, 1978. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.**

5. **Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF7-1980, 1101 16th Street, NW., Washington, DC 20036.**

(D) Information on Availability of Referenced Material:

1. **American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.**

2. **American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.**

(Approved by the Office of Management and Budget under control number 1218-0131) [55 FR 3327, Jan. 31, 1990]

APPENDIX B

INFORMATION ON HAZARDOUS CHEMICALS BY CLASS

INTRODUCTION

This section contains a description of the physical and/or toxic hazards commonly encountered in laboratory chemicals. For each class some examples are provided. The examples provided are not a complete listing of chemicals that fall within that hazard class.

To use this section, obtain information on specific chemicals of interest (using MSDS's, compendia of information, etc.) to determine which hazard classes apply; then refer to this section for a description of that hazard class.

FLAMMABILITY

Certain physical characteristics are used to describe the flammability characteristics of chemicals. The flash point is the temperature at which there is enough vapor above the liquid to ignite in the presence of a spark, and the auto ignition temperature is the temperature which the material will ignite without a spark source. The boiling point is the temperature at which the vapor pressure above liquid is equal to atmospheric pressure and the vapor pressure is the partial pressure of chemical vapor at a stated temperature, often 25 C. The lower the flash point, lower the autoignition temperature, lower the boiling point, and higher the vapor pressure, the greater the flammability hazard.

Lower and upper explosion or flammability limits are also used to characterize the flammability of chemicals. The LEL (or LFL), lower explosive (flammable) limit, and UEL (or UFL), upper explosive (flammable) limit define the lower and upper ends of the explosive or flammable range. Air and solvent mixtures (expressed as percent solvent vapor) within the flammable range will burn; below the LEL or above the UEL the mixture is too lean (not enough fuel) or too rich (too much fuel), respectively, to burn.

A list of highly flammable materials follows:

acetic anhydride
acetone
iso-amyl alcohol
n-amyl alcohol
n-butyl alcohol
isobutyl alcohol
butyraldehyde
1-chlorobutane
2-chloro-2-methylpropane
cyclopentanone
cyclohexane
diethyl ether
ethyl acetate
ethyl alcohol
n-heptane
n-hexane
kerosene
methyl acetate
methyl alcohol
methyl ethyl ketone
naphthalene
Pentane
2-propanol
n-propyl alcohol
toluene
o-xylene

PYROPHORIC MATERIALS

Pyrophoric materials react with air, or with moisture in air. Typical reactions which occur are oxidation and hydrolysis, and the heat generated by the reactions may ignite the chemical. In some cases these reactions liberate flammable gases which makes ignition a certainty and explosion a real possibility. Examples of pyrophoric chemicals are:

potassium, sodium, lithium.

ODOR THRESHOLD AND WARNING PROPERTIES
(TOXICOLOGY BACKGROUND INFORMATION)

Warning properties include odor, irritation, and color--chemical properties that warn you the chemical is in the area. Chemicals with good warning properties don't sneak up on you; you can smell, see or feel them, so you know to look for the source or leave the area. Chemicals with poor warning properties don't warn you of their presence, so are potentially more dangerous. People often link "strong smell" with "dangerous", and ignore the fact that some dangerous chemicals lack odor (carbon monoxide).

Chemicals with good warning properties can be smelled, felt or seen at safe exposure levels; this table compares a selection of "odor thresholds" with safe 8 hour exposure levels, TLVs. TLV's are developed by the American Committee of Governmental Industrial Hygienists (ACGIH), a standard setting organization.

IRRITATING OR CORROSIVE GASES AND VAPORS

LUNG IRRITATION AND DAMAGE: intense exposure (prolonged exposure to irritants or brief exposure to corrosives) causes lung tissue to swell and seep fluid, a condition called chemical pneumonitis; lungs may be damaged enough to cause death. Methyl isocyanate caused chemical pneumonitis in the Bhopol India tragedy. Chemical pneumonitis survivors may have permanent lung damage with symptoms similar to emphysema and a form of asthma in which airways constrict when exposed to quite low levels of irritating chemicals.

EYE IRRITATION AND DAMAGE: irritating and corrosive gases may cause intense pain and temporary eye damage which can take several weeks to heal. During exposure the eyes are usually tightly shut--which opens the victim up to the hazards of temporary blindness.

Direct eye contact with irritants and corrosive liquids or powders can cause (at best) short term irritation and swelling to (worst case) permanent blindness. Quick and correct actions can reduce symptoms and prevent blindness.

Prevention is the best approach to prevent eye damage; wear goggles and face shield when handling corrosive materials. However, if contact does occur, wash chemical out of eyes immediately and continue rinsing with a gentle stream of water for 15 minutes. If eye irritation persists or if the chemical is particularly toxic or corrosive, the victim should seek medical attention.

SKIN IRRITATION AND DAMAGE: Corrosive chemicals cause severe burns which will form scars unless treated properly. Wash contaminated skin with soap and water (or special solvent in several notable cases--bromine, phenol, hydrogen fluoride) immediately.

Irritating chemicals cause a wide range of skin effects including burns, blisters, redness, itching, dryness, cracks (e.g. between fingers), roughness and a variety of skin problems termed dermatitis (skin inflammation). In general irritant effects are not severe, but are at least, annoying; and at worst, temporarily or permanently debilitating (e.g. when an irritant effect turns into an allergy).

EXAMPLES OF IRRITATING AND CORROSIVE CHEMICALS:

Gases such as ammonia, chlorine, bromine, nitrogen oxides, sulfur oxides, hydrogen chloride, formaldehyde.

Liquids and solids such as strong acids, bases, chlorinated solvents (methylene chloride), organic bases, organic solvents, detergents, metal salts. See list below.

Potassium Dichromate
Potassium Hydroxide
Sodium Hydroxide
Succinic Anhydride
p-Dichlorobenzene
Sodium Dichromate
Chlorosulfonic Acid

SENSITIZERS (ALLERGENS)

Some chemicals cause allergies; an allergy (or sensitivity) is an abnormal response to low exposure levels of chemicals which don't elicit a similar response in the majority of people. The allergic response can be quite serious.

Once an allergy develops it usually does not go away. If the symptoms are serious, the person must not be allowed to work where the chemical is used or generated.

Allergic responses vary from life threatening (anaphylactic "bee sting" type reactions which can cause death by asphyxiation within minutes of exposure); to moderate (dermatitis, severe headache, head or chest cold or flu symptoms); to slight (rash, dry skin, itching nose or eyes).

Chemicals that cause skin sensitivities (by class and several examples of each):

coal tar and its derivatives
benzidine compounds
explosives
insecticides
cutting, linseed
hydroquinone, bichromates, pyrogallol
stearic acid
proteolytic enzymes, B. subtilis
cresol, pyridine, acridine
naphthalene and compounds
sodium nitrate
natural oils
photographic developers
plasticizers
enzymes

ASPHYXIANTS

Animals require a constant supply of oxygen to survive, and asphyxiants reduce or eliminate this supply. Low levels of exposure to asphyxiants (or chronic exposure to less powerful ones) generally cause headaches, fatigue and confusion. High levels (or low levels of very toxic ones) will cause coma and, if the victim is not rescued, death.

Asphyxiants can act quickly. One breath of pure nitrogen causes immediate collapse and unconsciousness--leaving no time to recognize and respond to the danger.

TYPES OF ASPHYXIANTS

CHEMICAL ASPHYXIANTS cause asphyxiation by reacting inside the body; generally small amounts can cause illness or death. For example, hydrogen sulfide interferes with nerve cell function, putting certain nerves to sleep, including olfactory (smell) nerves and the ones necessary for breathing. Moderate exposure levels eliminate our ability to smell--so right at the beginning of exposure we smell the characteristic rotten egg odor--and then it appears to go away. The odor is not gone; the ability to perceive it is gone. At higher concentrations or after prolonged breathing this chemical causes loss of consciousness and loss of the breathing mechanism. Several minutes in this state result in death.

Certain amines, nitrites and carbon monoxide produce asphyxia by reacting with blood hemoglobin, reducing its capacity to carry oxygen.

Chemical asphyxiants include: carbon monoxide, hydrogen cyanide, hydrogen sulfide, arsine, nitrites, amines, nitrobenzene.

SIMPLE ASPHYXIANTS are not toxic, but can cause serious problems in confined spaces. Simple asphyxiants reduce oxygen levels from the usual 21% to lower levels by simple displacement. For example methane may seep into an underground electrical vault and displace most of the air dropping the oxygen concentration to 5%, not enough to survive in.

Asphyxiating conditions can be set up in confined spaces when vessels or pipes are flushed with nitrogen; when CO2 fire extinguishers are used in confined areas; due to generation or leakage of gas from cryogenic or welding processes; due to the formation of rust in closed (or very large) pipes or vessels; and in tanks, in the presence of high levels of microorganisms which use oxygen in metabolic reactions.

Simple Asphyxiants include: methane, helium, nitrogen, carbon dioxide.

CORROSIVE CHEMICAL ASPHYXIATION: breathing certain chemicals can cause severe lung burns resulting in lung damage, swelling and loss of function--thereby affecting the amount of oxygen available to the body (thus meeting the definition of asphyxiation). However this type of "asphyxia" is generally viewed as a corrosive effect rather than true asphyxia.

CENTRAL NERVOUS SYSTEM (CNS) DEPRESSANTS
ANESTHETIC AND NARCOTIC GASES, VAPORS AND LIQUIDS
(MOSTLY SOLVENTS)

Anesthetic or narcotic materials depress the central nervous system (CNS, the brain and spinal cord) causing sleepiness, dizziness, drunk behavior, headache and often nausea and vomiting. Many organic solvents, alcohols, ethers, ketones, esters, etc. are CNS depressants.

CNS effects generally occur within a few minutes of overexposure and may last quite awhile, until the chemical has been detoxified by the liver.

Chlorinated hydrocarbon solvents (methylene chloride, methyl chloroform, carbon tetrachloride, etc.) have a peculiar and dangerous effect at high exposure levels (inhalation or direct skin contact): they cause changes in heart function (similar to a heart attack) which can cause death in minutes. The exposure situation is usually use of these materials in a confined area, where extremely high exposure levels can rapidly develop. Deaths in "glue sniffing" may also be due to this type of heart effect.

One of the most dangerous symptoms of overexposure to CNS depressants is inebriation (drunk behavior) because victims are more likely to make mistakes, to fall or trip, and are less likely to follow or hear instructions or see imminent danger. They are dangerous to themselves and others. Watch for signs of inebriation due to overexposure to chemicals, both in your co-workers and yourself.

Many chemicals (especially solvents) can enter the body through the skin, and entry by this route is often more toxic than by oral or inhalation routes. (Propylamine is ten times as toxic via skin than via mouth). Some areas of skin are more easily penetrated by chemicals than others: the scrotum is very easily penetrated (which makes contaminated slacks particularly hazardous); the scalp and forehead are quite easily penetrated, and the palm of the hand is the least easily penetrated.

POISONS

Certain chemicals are acutely toxic at very low levels and can cause serious, life-threatening damage in amounts readily ingested, inhaled or absorbed through the skin.

Examples of poisons are:

acetic anhydride
arsenical compounds
barium salts
calcium flouride
chloroform
cyanide salts other than ferro- or ferricyanide
iodine
lead compounds
mercury compounds
methanol
nitrobenzene
oxalic acid
potassium hydroxide
potassium iodine
sodium bisulfate
sodium nitrate
silver nitrate
zinc sulfate

SYSTEMIC TOXINS

Systemic toxins damage tissues at sites other than the point of contact. They enter the body through the skin, mouth or lungs, spread via blood, and damage one or more internal organs such as the liver, kidneys, blood forming tissue, reproductive system, brain or nerves.

Systemic damage is usually caused by long term exposure (years) to relatively low levels of chemicals, an exposure pattern often found in industry. Short term exposure to high levels of chemicals (acute exposure) is less likely to cause systemic toxic effects.

We learn about systemic toxicity from human experience (e.g., occupational overexposure) and animal research. Some chemicals have many target organs, some just one. The target organ depends on the material and route and pattern of exposure. It is best to treat systemic toxins as possibly harmful to all organs, since the complete toxicity profile is usually not known.

Examples:

CHEMICALS THAT AFFECT SEVERAL ORGANS: halogenated hydrocarbons (many); phenols (brain and bone marrow/blood forming tissue); ionizing radiation (skin, gut, bone marrow, reproductive organs); methanol, n-hexane, methyl n-butyl ketone (nerves, brain); lead (bone marrow, brain, conceptus); manganese (lungs); cadmium (lungs, testes); mercury (kidneys, brain); arsenic (many organs including blood); phosphorous (bones); selenium (liver); dichloromethane (kidney, liver, brain).

CHEMICALS THAT PRIMARILY AFFECT THE BLOOD: acetonitrile, antimony, arsenic, lead, manganese, mercury, methylchloride, nitrobenzene, nitrophenol, toluene, xylene.

CHEMICALS THAT PRIMARILY AFFECT THE LIVER: antimony, arsenic, cadmium, carbon disulfide, chloroform, cobalt, ethanol, methyl chloride, phenol, phosphorous, thioacetamide.

CARCINOGENS (CANCER CAUSING MATERIALS)

A number of chemicals are known or suspected as causing or helping to cause cancer. A few chemicals are known human carcinogens (such as asbestos and cigarette smoke). Most are known or suspected animal carcinogens. Chemicals known to cause cancer in animals are considered potential human carcinogens.

Current evidence (e.g. for cigarette smoke and asbestos) indicates a 10 to 20 year delay between onset of exposure and onset of cancer; and, for most known human carcinogens, there was a high level, long term exposure pattern. Can long or short term exposure to low levels of asbestos or side stream smoke (or other carcinogens) cause cancer? No one knows. However for regulatory purposes human carcinogens are considered carcinogenic whatever the exposure amount or pattern--thus exposure must by law be kept to a minimum.

Mutagens are chemicals which damage DNA, and DNA damage is believed to play an important role in initiating cancer. Thus mutagens are viewed as "potential suspected animal carcinogens" even in the light of evidence to the contrary.

Examples of known human carcinogens:

arsenic, asbestos

Probable human carcinogens (good animal and equivocal human data).

aflatoxin
formaldehyde
lead and lead compounds
methylene chloride
nickel and certain nickel compounds

REPRODUCTIVE TOXINS AND TERATOGENS

Some chemicals are associated with reproductive damage to mature female or male reproductive system causing reduced fertility or stimulating natural abortions. There are many forms of reproductive damage, including:

abnormal sperm and/or low sperm count
infertility
reduced libido and/or impotence
altered menstrual cycles or no ovulation
spontaneous abortions
damaged eggs
DNA changes in egg or sperm (mutations)

Examples of reproductive system toxins (effects not specified) are:

Anesthetic gases, aniline, arsenic, carbon monoxide, boron, cadmium, formaldehyde, manganese, toluene.

Chemical damage of the conceptus (the developing embryo or fetus) is called TERATOGENESIS, and chemicals causing teratogenic effects are called teratogens.

Examples of teratogens:

ethanol
arsenic
some antibiotics
anticoagulants (e.g. coumarin, wafarin)
chloroform
lead
mercury
methyl ethyl ketone
methylene chloride
selenium
xylene

CHEMICALS THAT DAMAGE THE LUNGS

The damaging effects of inhaled corrosive materials have already been presented, and are not included in this section.

There are other chemicals, not considered corrosive, but still irritating and damaging to delicate lung tissues. In general lung damage is caused by the long term moderate exposure level pattern found in the workplace, though short term high exposure levels have caused severe, permanent damage. Again, in the usual case, the damage occurs over an extended period of time and is not discovered until the victim is debilitated by the damage.

Some examples of lung damaging chemicals are listed below; add to this list materials which are obviously corrosive, such as strong acids and bases.

asbestos
aluminum dust and fume
ammonia
arsenic
chlorine
iron oxide dust and fume
manganese
oxides of nitrogen
silica
sulfur dioxide
talc
tin or tin dust
xylene

APPENDIX C

CHEMICAL INVENTORY LISTS