UIC The University of Illinois at Chicago

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Chemical Hygiene Plan

This document has been revised to better meet the needs of the University at the site of the University of Illinois College of Medicine at Peoria

UNIVERSITY OF ILLINOIS AT COLLEGE OF MEDICINE @ PEORIA
CHEMICAL HYGIENE PLAN

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CHAPTER 1 - INTRODUCTION

1.1 INTRODUCTORY STATEMENT

Through its OSHA Laboratory Standard, Title 29, Code of Federal Regulations, Part 1910.1450, Occupational Safety and Health Administration OSHA) requires a written Chemical Hygiene Plan (hereon referred to as CHP). The Illinois Department of Labor (IDOL) administers these regulations in the State of Illinois. The Standard is "performance oriented"; it consists of guidelines so that each laboratory unit can write standard operating procedures (SOPs) for its own safe operation.

The purposes of the UICOMP are:

- To define work practices and procedures to help ensure the protection of laboratory employees at UICOMP from any health hazards which may be posed by hazardous chemicals.

- To meet OSHA requirements for air concentration limits.
- To set up guidelines for any hazardous but unregulated chemicals.

The complete CHP consists of two portions:

- This document is one portion; and
- The second is detailed laboratory specific safety procedures written by the laboratory supervisor and available to all users in the lab.

The complete plan must be in a clearly labeled three-ring binder and kept available for instruction and reference in the laboratory.

1.1a DEFINITIONS

As defined by OSHA:

- A **laboratory employee** is a paid employee who works in a laboratory and who may be exposed to hazardous chemicals in the course of his or her duties. Students in laboratory classes are not covered, but the same care should be taken to protect them.
- A **laboratory** is a workplace where relatively small quantities of hazardous chemicals are used for non-production purposes.
- A **chemical** is deemed hazardous if there is statistical evidence that exposure to it can cause acute or chronic health effects.

1.2 RESPONSIBILITIES

The division of responsibilities regarding general health and safety is outlined in the UIC Environmental Health and Safety Standards, "Responsibility for Health and Safety" (Ref. 17, pp. ii - v). This section of the manual discusses responsibilities of Administrative Officers, Deans, Directors and Heads of Administrative Units, Supervisors, Employees; and the Environmental Health and Safety Office EHSO).

Administrative Officers shall provide leadership and guidance and make available necessary equipment, services and funding for units within their purview to assist in providing a safe and healthful environment.

Deans, Directors and Heads of Academic and Administrative Units have the primary responsibility for the health and safety of their staff and students. Specific responsibilities regarding the implementation of the CHP include:

- Collaborate with faculty and staff to include laboratory specific guidelines in the UICOMP CHP and to develop strategies to implement the CHP.
- Make budget arrangements for health and safety improvements.

Faculty and Staff supervising laboratories (referred to as laboratory supervisors throughout the CHP) have the following responsibilities for implementing the CHP:

- Complete the parts of the CHP which are specific for their individual laboratory units (Appendix B). Review and revise periodically as appropriate.
- Inform and train employees concerning chemical safety as required in this CHP, Section 1.3.
- Implement and enforce rules and standards concerning health and safety for laboratories under their responsibility.
- Ensure the availability and enforce the use of appropriate personal protective equipment.
- Remain cognizant of chemicals stored and used in their labs, their proper disposal, and the hazards associated with them.

- Conduct internal inspections of labs for health and safety concerns.
- Request assistance from the EHSO as needed.
- Request allocation of funds from superiors for health and safety improvements as needed.

Employee responsibilities regarding implementation of the CHP are:

- Follow **UICOMP Health and Safety Standards** and laboratory rules.
- Report any hazardous conditions to the lab supervisor.
- If you have problems resolving safety issues, contact members of Safety Council.
- Wear or use prescribed protective equipment.
- Refrain from operating any equipment or instrumentation without proper instruction and authorization.
- Remain aware of the hazards of the chemicals in the lab and of methods for handling these hazardous chemicals safely.
- Request and obtain information and training when unsure about how to handle a hazardous chemical or procedure before proceeding.

1.3 TRAINING

Each UICOMP laboratory unit must provide all of its laboratory workers with information and training in proper laboratory safety practices at the time of their initial employment and prior to assignments involving new exposure situations. The laboratory supervisor is responsible for insuring the training is done on a timely basis. Attendance at each session must be documented, together with a description of materials covered. Insert in Appendix B-11.

Initial Training:

When any person begins work in a laboratory, the initial training must include:

- Showing the trainee the location of the CHP for that lab unit in which the trainee will work.
- Briefly reviewing and discussing the CHP and requiring the trainee to read the entire plan within one week.
- Discussing fully the unique and more hazardous materials and physical hazards which may be present in the lab, including safety measures which are required or advisable.
- Showing the location of emergency equipment and reviewing its proper use.
- Discussing signs and symptoms associated with overexposure to hazardous chemicals used in the lab.
- Discussing available reference materials on storage, safe handling and disposal of chemicals found and used in the lab.

Continued Safety Updates:

Regular sessions for refresher information and training should be held by the person responsible for training:

- Review initial training.
- Discuss accidents or potentially hazardous situations which have been experienced as they occur or annually.
- Discuss safety procedures for new materials or operations before implementing any changes.

CHAPTER 2 - GENERAL GUIDELINES

The level of work to be conducted and the number of personnel must be appropriate to the physical facilities and quality of ventilation available in the laboratories. The following general rules must be implemented in each laboratory to minimize hazards in the working environment.

2.1 ATTITUDE

Almost all laboratory chemicals pose some hazard and, as such, exposure to them by any route should be minimized. Exposure can be minimized by the development of good personal chemical hygiene habits.

- Maintain a "safety first" attitude.
- Avoid "horseplay".
- Recognize risks and respect chemicals.
- Assume that substances of unknown toxicity are toxic.
- Assume that a mixture of substances can be more toxic than its most toxic component.

2.2 PLANNING

- Plan all work in advance.
- Anticipate potential problems before they occur.
- Remove unnecessary chemicals and equipment before beginning work, clean up promptly when finished.
- Inspect apparatus before use for proper working condition.
- Never use broken, cracked or chipped glassware. Fire polish broken and chipped glassware.
- Dispose of unusable broken glassware in cardboard boxes designated for broken glassware.
- Use a metal shield, dewars or tape for evacuated glassware to confine glass and chemicals in the event of an implosion.
- Calculate the quantity of each chemical needed before starting work.
- Use the minimum amounts of chemicals necessary to perform any manipulation or operation.
- Do not transfer unused chemicals back into "stock" containers. Transfer them into clean, properly labeled containers for future use or dispose properly.
- Promptly replace caps on opened containers of chemicals.
- Do NOT conduct experiments that release hazardous vapors without proper respiratory equipment or venting.
- Do not work alone when your duties require manipulations or operations with hazardous chemicals. Remain in voice contact with someone else.

If any **unattended (e.g., overnight)** laboratory operations or manipulations are performed:

- Leave appropriate warning and explanatory signs.
- Include proper shut-down procedure next to the experiment.
- Take all necessary precautions for chemical containment in the event of failure of a necessary utility service (e.g., water, electricity).
- Check that the **Laboratory Identification Data** card on the laboratory door is current and includes the names of at least three individuals responsible for the safety of the operation or manipulation and the telephone numbers where they can be contacted after regular working hours in case an emergency situation arises.

Unattended operations include mechanical equipment and instrumentation left in the ON or STANDBY mode, vacuum systems, distillation processes and any other operations which utilize running water.

2.3 INFORMATION

Each laboratory must have safety information available for all laboratory workers in the area where they work.

- The UICOMP CHP (this document) should have Appendices B-1 to B-11 complete and up to date for each operation in the laboratory.
- Know the **chemical and physical hazards** associated with the use of any particular chemical. See Appendix B.
- Read informational and warning labels on all chemicals before using them.
- Understand the content of each chemical's **Material Safety Data Sheet (MSDS)**. An MSDS is provided by the company selling each chemical or product and contains data on the safe use of the product. Exercise care in interpreting MSDSs, because manufacturers who provide MSDSs write conservatively to provide full disclosure but to limit their own liability. The use of these chemicals in small quantities in the laboratory must not be viewed as having the same exposure potential as may exist in manufacturing or production level work. If there are any doubts about the proper use of a chemical, ask a supervisor before beginning work.
- Keep chemicals in original containers to maintain the integrity of the **information on the label**.
- Do not remove or deface labels affixed to containers of chemicals.
- Make no assumptions about the identity of chemicals in unlabeled containers; set such containers safely aside and consult your supervisor as to procedures for analysis.
- Clearly label all reagents with their proper name and Concentration, your name, date of preparation and any pertinent warning information.

2.4 EMERGENCY PREPAREDNESS

Before working with any chemical, plan actions in the event of an accident.

- Check the chemical's MSDS or other sources for advice on how to handle potential exposures or spills.
- Know the location of emergency exits, fire alarms and extinguishers, eye wash stations, emergency showers, spill kits, etc. (Enter locations of emergency equipment in Appendix B-1.)
- Learn how to operate emergency equipment. See Chapter 4 for guidelines on use of emergency equipment.

2.5 PRIOR APPROVAL

Each laboratory supervisor should set conditions under which prior approval must be obtained before certain operations, procedures or activities are implemented. Departments or laboratory units should set approval conditions for mutual understanding and protection. **These should be listed in Appendix B-3.**

2.6 PERSONAL HYGIENE

- Do not taste or smell laboratory chemicals or allow them to come into direct contact with your skin.
- Promptly remove any contaminated clothing.
- Do not eat, drink, smoke or apply cosmetics in a laboratory where hazardous materials are stored or used.
- Do not store food or beverages in a laboratory or laboratory refrigerator which has been exposed to a toxic material.
- Wash your hands after leaving a laboratory.
- Never pipette by mouth.
- Never use lab glassware for drink or food.

2.7. PERSONAL PROTECTION

To protect yourself from exposure to hazardous chemicals, observe good habits and technique and use the appropriate personal protective equipment.

Eye and Face Protection:

See Appendix A-4 for information from the **ANSI Standard** for choice of appropriate eye and face protection for chemical procedures.

- Wear protective safety glasses when working with chemicals or in areas where hazardous chemicals are stored.
- Use face shields and/or explosion shields if the possibility of implosion or explosion exists.

NOTE: Contact lenses can act as a trap for any chemical that may accidentally splash into the eyes. Hydrophylic or "soft" lenses can absorb and entrap hazardous vapors and gradually release them into the eye for an extended period. It is especially important to wear appropriate eye protection, to utilize the fume hood maximally and to alert others in the lab if contact lenses must be worn.

Skin Protection:

Choose appropriate clothing and gloves for work with materials at hand, e.g., latex gloves provide a good grasp and are impermeable to most aqueous solutions, but are degraded rapidly by organic solvents. **Appendix A-5** summarizes the chemical protection characteristics of some common glove materials. Manufacturer catalogs and the MSDS for a particular chemical may have more specific information for use with that chemical.

- Before use, inspect gloves for tears and punctures and discard damaged gloves.
- After use, decontaminate reusable gloves to remove any adhering chemical residue. Discard disposable gloves in a safe manner.
- When wearing gloves, touch only those materials and equipment necessary to perform experimental activities, e.g., avoid touching or handling other items such as door handles or telephones. **NOTE:** Gloves provide protection against exposure to hazardous substances, but they are also potential carriers of the same materials.
- Always wear **sturdy shoes** while in a laboratory; never wear sandals or perforated shoes.
- Wear a laboratory coat, smock or apron.
- Do not wear clothing which exposes large areas of the skin's surface (e.g., jogging shorts or mini-skirts).
- Do not wear oversized/excessively loose clothing. The excess material can contribute to spills or can become entangled in mechanical apparatus.
- Confine long hair.
- Wear no jewelry, especially in work with mechanical apparatus.

2.8 RESPIRATORY PROTECTION AND FUME HOOD USE

Routinely use a **fume hood** when working with flammable chemicals or with volatile or dust-producing toxic chemicals having a TLV (threshold limit value) or PEL (permissible exposure limit) less than 50 ppm or 100 mg/m3 (see Appendix A-6). Because some chemical odor thresholds are above dangerous levels, use a fume hood for working with chemicals which have odor recognition thresholds greater than or nearly equal to their TLVs; common chemicals exhibiting this property include ammonia, carbon tetrachloride, ethylenediamine, formamide, hydrogen sulfide and ethylene chloride.

- Use a fume hood when working with chemicals that create hazardous vapors or dust.

- Confirm that the hood is functioning properly. An exhaust face velocity of about 100 linear feet per minute (LFPM) offers the best removal of fumes in the hood. Significantly greater or lesser velocity can cause conditions in which fumes escape or eddy into the worker's face.
- Attach a piece of tissue to the bottom of the sash as a guide to confirm air flow.
- Because potentially explosive **perchlorates** can form within the ductwork of most fume hoods, perform work involving hot or boiling perchloric acid in a perchloric fume hood. Use it solely for this process.
- Be sure the hood sash is lowered to the height marked on the hood.
- Locate the source of vapor or dust at least 6 inches back from the edge.
- Avoid placing your head within the fume hood.
- Because items stored in the hood can block the vents, do not use fume hoods as storage sites. If hazardous substances must be stored in a hood for a short period of time, post a notice specifying the identity of the hazardous material within the hood, along with instructions that the hood must remain "on".
- For the most efficient exhaust from a laboratory, keep the fume hood on at all times, and lab doors and windows closed.

Prevent routine contamination of the general air supply of a laboratory with hazardous vapors or dusts.

- Report malfunctioning fume hoods to Physical Plant.
- If present engineering controls are unable to contain dangerous vapors and dusts, notify Physical Plant to monitor the air.
- Halt all work which results in the contamination of the laboratory's general air supply until proper modifications are made and approved.
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After repairs and monitoring, if the fume hood is inadequate for maintaining air levels of hazardous chemicals below recommended PELs and if the procedures cannot be reduced in size or modified so that missions are lowered to acceptable levels, then institute the following actions:

- Develop a program of **respiratory protection.**
- Include medical evaluation, fitting, testing, training and sanitation.
- Avoid laboratory situations which require the use of such devices by careful planning.
- Never use a dust mask for protection from vapors because it does not absorb gaseous vapors.

2.9 COMPRESSED GASES

Compressed gases include liquefied petroleum gases and oxygen, nitrogen, anhydrous ammonia, acetylene, nitrous oxide, and fluorocarbon gases.

- Securely fasten compressed gas cylinders in an upright position and in such a manner that they cannot be tipped.
- Do not expose cylinders to temperatures higher than about 50° C. Some rupture devices on cylinders will release at about 65°C. Small cylinders, such as lecture bottles, are not usually fitted with rupture devices and may explode if exposed to high temperatures.
- Never lubricate, modify, force or tamper with cylinder valves.
- Use a soap solution to test all the connections for leaks before use. Teflon tape may be used to seal a loose connection.
- Store flammable gas cylinders away from oxygen cylinders and other oxidants.
- Check the MSDS or other sources for safety procedures for the gas being used.
- Maintain labels. The cylinder decal or label is the only positive way to identify the gas contained within a cylinder. Color codes are not uniform among the manufacturers.
- Do not smoke or use open flames where oxidant or flammable gases are stored.

- When a cylinder is not being used, disconnect and store with the protective cap in place, hand tight.
- Store in a well-protected, well-ventilated, dry location at least 20 feet from highly combustible materials.
- Store in definitely assigned places away from elevators, stairs or hallways.
- Do not keep in unventilated enclosures such as lockers and cupboards.
- To move a compressed gas cylinder:
    - Use a hand truck. Properly secure the cylinder on the truck before beginning the move.
    - Never drag or slide cylinders, even over short distances.
    - Avoid subjecting cylinders to excessive mechanical shocks.

Toxic Gases:

Toxic gases are usually supplied in lecture bottles that are approximately a foot long and have a diameter of about 2 inches. When working with toxic gases, additional precautions are needed:

- When not in use, store them in appropriately sized racks, not just placed on a shelf or stacked.
- Before use, secure them to a stable fixture in the fume hood.
- Do not work with a specialty gas unless you are fully familiar with its proper handling procedures and its toxic or corrosive effects.
- When opening the valve on a cylinder containing an irritating or toxic gas, stand on the upwind side of the cylinder with the valve pointed downwind.
- Warn those working nearby in case of a possible leak.

2.10 CHEMICAL HANDLING AND STORAGE

- Handle all chemicals with respect.
- Use bottle carriers or other packaging and/or carts when transporting chemicals in glass containers room to room or building to building.
- Mix chemicals slowly and with stirring; add the more concentrated chemical to the solvent or more dilute solution.
- Test peroxide-forming chemicals (Appendix A-8) before every use involving heat and/or evaporation (See ref. 12, p 64).
- Dispose of deteriorated chemicals promptly.
- Store only compatible chemicals in close proximity to each other. Compatible chemicals are those which, when accidentally mixed, will not release heat or toxic gases or cause pressure build-up. See (Appendix A-1).
- Maintain a current inventory of all hazardous chemicals, listed by hazard class. Attach to Appendix B.
- When chemicals must be stored on wooden shelving, ensure that the shelving is fire-protected by coats of intuminescent paint or similar flame shield.
- Ensure that 5-gallon and larger containers are bonded and grounded when transferring flammable liquids.

CHAPTER 3 - SPECIFIC GUIDELINES

The following guidelines must be followed when working with the specific classes of chemicals. Special precautions and procedures for handling each laboratory chemical must be attached as Appendix B-10. Work with any chemical must be performed in compliance with the "UIC Environmental Health and Safety Standards" (ref. 17) and the American Chemical Society (ACS) guidelines, "Safety in Academic Chemistry Laboratories" (ref. 16). (Single free copies may be obtained by calling the ACS at (202) 872-4363).

3.1 RADIOACTIVE MATERIALS

Authorization to use radioactive materials must be obtained in advance from the Radiation Safety Committee. The following requirements must be satisfied:

- Investigators who would like to obtain an authorization to use radioactive material should obtain a copy of the UIC Radiation Safety Manual, radiation safety data sheets for the radionuclides they would like to use, and application forms.
- A health physicist will evaluate the completed application with the applicant and will review the radiation safety procedures that must be followed to ensure compliance with safety rules established by the Illinois Department of Nuclear Safety, the UIC Radiation Safety Committee. A written authorization document will be issued that specifies the authorized project personnel, authorized radionuclides and possession limits, authorized use locations, and other conditions of the authorization.
- Before a new person may be allowed to use radioactive material under an existing authorization, the individual must submit the appropriate application form. Only personnel who are specifically listed on the most recent radionuclide project authorization documents may use radioactive materials.
- All personnel who use radioactive materials must attend the UICOMP Radiation Safety Training.

3.2 IRRITANTS AND SENSITIZERS

Irritants are chemicals which are not corrosive but cause reversible inflammatory effects on living tissues at the site of contact. Sensitizers cause allergic reactions in normal tissue after repeated exposure. When working with irritants and sensitizers:

- Keep contact to a minimum.
- Consult and follow the recommendations contained in the appropriate MSDS for specific precautions.
- Wear appropriate gloves and/or a dust mask, as recommended by manufacturer.

3.3 CORROSIVE CHEMICALS

Corrosive chemicals cause visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. All of the hydrogen halides are serious respiratory irritants. Alkali metal hydroxides and aqueous solutions of ammonia are extremely destructive to both the skin and eye tissues. Aqueous solutions having a pH of less than 2.5 or more than 12 are considered corrosive. List these in Appendix B-4.

- Wear goggles, gloves and apron or lab coat when working with corrosives in quantities larger than 50ml.
- Store liquid corrosives below eye level.
- Store acids separate from bases and according to compatibility. **Note:** Acetic acid is an organic acid and a reducing agent; whereas chromic acid, nitric acid, perchloric acid and potassium permanganate are oxidizing agents and hence are likely to react with the acetic acid.
- Use spill trays under the containers.
- Never add water to a concentrated acid. Always add acid to water.
- Refrain from rubbing eyes until fingers are thoroughly decontaminated.

3.4 FLAMMABLE CHEMICALS

The flammability of a chemical is determined by its flash point, the lowest temperature at which an ignition source can cause the vapor above it to ignite under controlled conditions. Those with flash points below 100°F (37.8°C), except any mixture having components with flash points of 100°F or higher, the total of

which make up 99% or more of the total volume of the mixture ("3" or "4" in the red section of the fire diamond see Appendix A-3)), are considered flammable. Liquids with flash points at or above 100°F are considered "combustible".

- When working with flammable chemicals:
- Keep in covered containers when not actually in use.
- Keep all sources of ignition, high heat and combustion remote from storage and dispensing areas. Always keep most organic solvents away from inadvertent contact with oxidizers.
- Dispense all solvents within a fume hood.
- Draw or transfer into other containers by means of a pump, safety can or self-closing valve.
- Do not use Nalgene carboys. Safety cans with self-closing faucet, pressure relief cap and flame arrester must be used for storing quantities greater than 1 gallon. Polyethylene safety cans with these features are available in various sizes.
- Do not use the floor for storage.
- Store and use in the smallest amounts possible so that any spill can be cleaned up before it can cause a large fire. See Appendix A-7 for recommended maximum allowable sizes of containers.
- Provide a means to dispose of leakage or spills.
- Do not exceed ten gallons in regular cabinets in any laboratory.
- Store quantities greater than 10 gallons in an approved flammable materials safety cabinet.

All flammable chemicals should be listed, and the list attached to the CHP as Appendix B-5.

Approved Flammable Storage Rooms:

Store flammable solvents in amounts greater than those allowed in laboratories in approved flammable storage rooms. Among the requirements are door sills designed to prevent the flow of liquid from the room, no floor drains, and automatic fire suppression systems. The UIC Office of Capital Programs can make recommendations for such construction.

3.5 HIGHLY REACTIVE CHEMICALS

Unstable (reactive) chemicals are those which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense or will become self-reactive under conditions of shocks, pressure or temperature. Compounds containing the following functional groups tend to be sensitive to heat and shock: acetylide, diazo, nitroso, peroxide, azide, halamine, ozonide.
Compounds containing nitro groups may be highly reactive, especially if other substituents such as halogens are present. Treat the following groups with respect, especially at higher temperatures: perchlorates, nitrates, chlorites, chlorates, bromates, iodates.
Special handling procedures for highly reactive chemicals:

- Consult guidelines in the appropriate references or MSDSs before using chemicals exhibiting these properties.
- Bring into the laboratory only as required and then in the smallest possible quantities.
- Segregate from other materials in storage.
- Do not mix even small quantities with other chemicals without prior approval of the lab supervisor.
- Wear safety glasses, a lab coat, appropriate gloves (i.e., yellow electrical lineman's gloves), and use a shield.

A list of potentially explosive or water-reactive chemicals which the laboratory workers may encounter should be attached as Appendix B-6.

3.6 REPRODUCTIVE TOXINS, CARCINOGENS AND ACUTELY TOXIC CHEMICALS

Parameters for judging the toxicity include LD50 (from tests on animals to determine the lethal dosage) and permissible exposure limits (PELs) which define concentrations in air considered safe for most people.
PELs include time-weighted averages (TWAs) or threshold limit values (TLVs) of allowable concentration for an 8-hour workday as well as short term exposure limits (STELs). They are expressed in ppm (parts of vapor or gas per million parts of air by volume at room temperature and atmospheric pressure) or mg/m3 (milligrams of particulate per cubic meter of air). TLVs, have been determined by the ACGIH (American Council of Governmental Industrial Hygienists). The lower the value, the more hazardous the material.

Definitions:

Reproductive toxins include mutagens, embryotoxins, teratogens and substances which can cause birth defects. Examples of common reproductive toxins include formamide and lead compounds. A more complete listing of teratogenic agents can be found in Appendix A-10. An inventory of reproductive toxins should be attached to the CHP as Appendix B-7.

Carcinogens are those chemicals which have been evaluated and listed as a carcinogen or potential carcinogen by the National Toxicology Program in the latest edition of the Annual Report on Carcinogens, or chemicals regulated as such by OSHA. See Appendix A-9 for a listing from the Annual Report. An inventory list of carcinogens must be attached to the CHP as Appendix B-8.

Acutely toxic chemicals are those chemicals which have the possibility of lethal effects in a single exposure or can cause target organ damage, and have LD50s of less than 50mg/kg. Common chemicals which are classified as being either moderately chronic or acutely toxic include iiso-propylfluorophosphate and hydrogen cyanide. A list of acutely toxic chemicals which are in the laboratory must be attached to the CHP as Appendix B-9.

Safety Guidelines:

A minimum set of guidelines that should be followed when working with reproductive toxins, carcinogens, acutely toxic chemicals and **experimental chemicals with unknown toxicity** are listed below. The lab supervisor should ensure that these and other necessary precautions are taken when working with these substances.

- Use of these chemicals must be approved by a supervisor before beginning any manipulation/operation.
- All work must be performed in a functioning fume hood, biological safety cabinet, ventilated glove box, sealed system or other system designed to minimize exposure to these substances. The exhaust air from the ventilation system may require scrubbing before being released into the atmosphere.
- Designate the work area by posting signs: "DANGER, (specific agent), AUTHORIZED PERSONNEL ONLY" or comparable warning sign.
- If the fume hood does not have a sill, all work should be performed inside containment devices (trays lined with disposable absorbent material) to prevent accidental spills from spreading to the exterior of the fume hood.
- The ventilation efficiency of the designated hazard area and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances must be periodically evaluated at intervals determined by the laboratory supervisor (ref. 16, p. 46). The interval for evaluating systems may vary from weekly to biannually depending upon the frequency of usage, quantities employed and level of hazard.
- Gloves and other appropriate protective apparel must be worn when working with these chemicals.

- Hands, arms, face and neck must be washed after working with these toxic substances.
- The quantities used and stored in the laboratory and their concentrations in solution or mixtures must be minimized.
- Decontaminate and clean the work area at appropriate intervals. Follow a procedure approved by the lab supervisor. The interval may be as short as one day or as long as six months depending upon the frequency of usage and level of hazard.
- All contaminated wastes must be collected and disposed of in a timely and appropriate manner as outlined in the EHSO's waste disposal guide. For special disposal information call EHSO. If possible, treat wastes by suitable, generally acceptable chemical procedures to lessen or eliminate their toxicity (refs. 7 and 11).
- When not in use, these chemicals should be stored in a limited access area and within protective containment devices.
- Female employees of childbearing age should be especially cautious when working with reproductive toxins.
- Volatile substances should be kept cool and contained.
- Dispersible solids should be kept in closed containers, used in places with minimum air currents, and suitable contact materials should be used to avoid static charge buildup.
- Compressed gas cylinders which contain acutely toxic chemicals such as arsine and nitrogen dioxide must be kept in ventilated gas cabinets.
- Ensure control of gases by using piping, valves and containers which can withstand pressure buildup.
- Detection equipment may be required in laboratories where chemicals (especially poisonous gases) with a high degree of acute toxicity are utilized.
- 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.
- Employees must comply with the recommendations contained in the National Institutes of Health (NIH) publication entitled *NIH Guidelines for the Laboratory Use of Chemical Carcinogens*.

3.7 INFECTIOUS AGENTS

Proper laboratory procedures to follow when working with infectious or potentially infectious agents are not within the scope of this CHP. Prudent practices to follow when working with such agents are contained in the joint Centers for Disease Control - NIH publication entitled *Biosafety in Microbiological and Biomedical Laboratories*. This publication, No. (NIH) 88-8395, is available through the U.S. Department of Health and Human Services, PUBLIC HEALTH SERVICE, National Institute of Health, Bethesda, MD 20892.

CHAPTER 4 - EMERGENCY RESPONSE INFORMATION

4.1 Health Risks

When faculty or staff are injured on campus,

- Have minor injuries treated at the Ambulatory Center during normal working hours.
- At all other times, report to the Emergency Room at SFMC.
- If a chemical injury, bring the MSDS to the Emergency Room at SFMC.
- When trauma is life threatening or an ambulance is required, call Security to arrange for emergency assistance and transportation.
- All accidents, no matter how minor, must be promptly reported to the lab supervisor and to Human Resources.

In the event of an emergency, the guidelines listed below should be followed. In all instances the advice and/or orders given by trained emergency-responding personnel (physicians, nurses, paramedics, fire-fighters, police officers) must be followed.

Contact of Chemicals with the Eyes:

- Take victim immediately to the nearest eyewash station.
- Flush the eyes for at least 15 minutes.
- Eyelids must be held open with the eyeballs continuously rotating for optimum flushing.
- Immediately after, seek medical attention and evaluation by medical personnel in Ambulatory Center or SFMC Emergency Room.

Ingestion of Chemicals:

- Drink large volumes of water.
- Call the Poison Control Hotline at 1-800-942-5969 for advice on first aid.
- Do not induce vomiting unless specifically instructed to do so.
- Promptly seek medical attention.

Contact of Chemicals with the Skin over a large part of body:

- Help the injured person to the safety shower, and flush skin exposed to the chemical for at least 15 minutes.
- Remove all layers of contaminated clothing, shoes and jewelry.
- If clothing or jewelry adheres to a chemically-burned area of skin; do not pull it away.
- Seek medical attention.

Inhalation of Chemical Vapors or Smoke:

- Relocate to an area of fresh uncontaminated air.
- Remember: hot gases rise, but most chemical vapors are heavier than air.
- Seek medical attention.

Signs and Symptoms of Overexposure to Hazardous Chemicals:

The large number of potentially hazardous chemicals precludes an exhaustive list of the symptoms of overexposure.
Certain signs and symptoms associated with chemical overexposure are also associated with conditions arising independent of contact with any chemical. Thus, the presence of a given sign or symptom need not indicate overexposure to a particular chemical. Conversely, the absence of a particular sign or symptom may not be meaningful since individuals react differently to toxins. Accurate diagnosis of pathological effects, and determination as to whether these effects are associated with overexposure to a particular chemical, must be left to trained medical personnel.

- Consult the MSDS for signs and symptoms of overexposure before working with a compound.
- Any deviation from an individual's normal state of health, especially in those instances in which an employee suspects or knows of chemical overexposure, must be reported immediately to a supervisor or attending physician.

4.2 FIRES

In case of fire, follow the acronym **R A C E**:

RESCUE anyone in immediate danger of the fire.

ACTIVATE alarm. (Call 9-911 & then Wayne Holly @ 8520).

CONFINE the fire by closing windows and doors to the fire.

EVACUATE to an area of refuge or EXTINGUISH fire only if you have been trained and if the fire is small.

- Class A extinguishers (water-filled) on ordinary combustibles such as paper, cloth and plastics.
- Class BC (identified by the large horn and producing carbon dioxide gas) for flammable liquid fires or charged electrical equipment.
- ABC (dry powder) extinguishers for all three types of fires.

Be sure you have a safe escape route, with your back to the exit, in case you are unsuccessful in fighting the fire.

Four steps to correctly use any type of fire extinguisher follow the acronym **P A S S:**

PULL the safety pin out, release a lock latch or press a puncture lever.

AIM the extinguisher nozzle, horn or hose low at the base of the fire's leading edge.

SQUEEZE or press the extinguisher's handle to release the extinguishing agent.

SWEEP the extinguisher from side to side, progressing from the leading edge of the fire toward the fire center, until the fire is extinguished. Extinguishing techniques may vary; read the directions on the extinguisher.

If you have any doubts about your ability to extinguish the fire:

- Leave the scene.
- To inhibit the spread of the fire and to diminish smoke, close and latch doors.
- Never use elevators.
- Before opening any doors, feel the door's surface with the back of your hand to be sure that the fire hasn't spread to the room or corridor you wish to enter.
- If smoke is a problem, place a wet cloth over the mouth and nose and stay as low to the floor as possible.
- Keep in mind that hot gases rise, but most chemicals vapors are heavier than air.

Clothing on Fire:

- STOP moving and call for help.
- DROP to the ground.
- ROLL to smother the flames and to keep flames from the face and hair.

Then:

- Cool mildly burned areas with clean water.
- Promptly seek medical attention.

4.3 CHEMICAL SPILLS

In the event of a chemical spill, employee safety is the primary concern.

- Notify co-workers and a supervisor of any large chemical spill before beginning any clean-up.
- Check the MSDS.
- Follow the plan your lab has developed for emergency action.
- Wear appropriate personal protective equipment during the actual clean-up procedure.
- If you have any questions about the proper procedure for clean-up, don't hesitate to call EHSO.
- If the spill poses an immediate health or safety hazard which cannot be controlled:
    - **Evacuate** the laboratory.
    - **Contact Physical Plant, Wayne Holly @ 8520.**

Appendix B-1 should contain the location of the nearest spill kit in your lab or department. As a general guideline:

- Neutralize acid spills and absorb them with sodium bicarbonate.
- Use vinegar or monobasic sodium phosphate to neutralize and absorb spills of bases.
- Use activated charcoal, vermiculite or kitty litter to absorb spilled solvents.

After liquids have been absorbed:

- Place the chemical and the absorbent material into double plastic bags.
- Seal, label and store the bags in a functioning fume hood. In consultation with Physical Plant, make arrangements for the proper disposal of the chemical waste.

CHAPTER 5 - MEDICAL CONSULTATION

In the event of suspected or actual accidental overexposure to a hazardous chemical in the course of performing duties related to the job, UICOMP will provide medical consultation and treatment. Such treatment will be under the supervision of the medical staff if available, during working hours or SFMC after working hours.

The physician should be provided with the following information:

- Identity of the chemical, including MSDS.
- Conditions relating to the exposure.
- Quantitative exposure data.
- Description of the signs and symptoms the employee is experiencing.

In any case in which medical care is sought for chemical exposure, Supervisors first report of Injury should be completed and forwarded to Human Resources.

CHAPTER 6 - HAZARDOUS CHEMICAL WASTE

Chemical wastes are regulated by the U.S. Environmental Protection Agency (EPA) as "hazardous" if they are on the EPA lists of hazardous wastes or if they possess the following properties:

- Ignitability (e.g. flash point below 140 deg. F).
- Corrosivity (pH below 2.5 or above 12).
- Reactivity (e.g. cyanides, sulfides, active metals and metal hydrides).
- Toxic Characteristic Leaching Procedure (TCLP) waste (including many heavy metals, pesticides and some chlorinated compounds).

6.1 MINIMIZATION

It is important to avoid disposal of unused chemicals as waste and to reduce the quantities requiring expensive processing or other waste disposal. Chemicals should be removed as hazardous waste only after all other disposal options have been exhausted.

Have written guidelines for purchasing practices and sharing:

- Purify aged reagents instead of buying new.
- Substitute a less hazardous reagent.
- Reduce the scale of experiments by use of microscale labware.

- Develop a policy for reduction of hazardous wastes. Include:
  - Recovery and reuse of reagents and solvents.
  - Laboratory destruction of by-products to less hazardous substances. Some examples of laboratory destruction are:
    1. The chemical decomposition of malodorous mercaptans,
    2. Hydrolysis of hydride reducing agents, and
    3. Neutralization of acids and bases.

6.2 WASTE DISPOSAL PROCEDURES

A general policy concerning chemical waste may be found in UICOMP *Environmental Health and Safety Standards* (ref. 17), Sections 2-6-0 and 2-6-1. In summary, these Standards state that all persons producing chemical waste have a legal and moral responsibility to use environmentally sound chemical waste disposal procedures. The disposal procedure chosen must be based on chemical hazard, safety, governmental regulation and cost.

The EHSO provides a chemical surplus removal service to laboratories generating small quantities of hazardous chemical waste. The term "surplus" is used instead of "waste" since EHSO redistributes some chemicals in good condition to other chemical users at UIC. Laboratories generating hazardous chemical surplus should contact EHSO for more information regarding this service. The EHSO is also responsible for keeping records of all disposal to outside contractors for those labs which choose to dispose of large quantities directly. There is no charge for small quantities, but labs with large quantities may be required to pay disposal costs. Approximate disposal costs in 1991 were: $7.00/gallon for solvents; for other chemicals the cost ranges from $25.00 to $250.00 per bottle. Contact Wayne Holly at 8520 for information.

Many chemicals are non-hazardous and may, in small amounts, be safely and legally poured down the drain or disposed of in the normal trash. Even hazardous materials, in small amounts, such as the residue in an empty bottle, may be diluted and flushed down the drain. Whenever possible, hazardous chemicals must be rendered non-hazardous as a final step in an experiment.

APPENDIXES

APPENDIX A-1
LIST OF REFERENCES

1. American National Standard Practice for Occupational and Educational Eye and Face Protection, ANSI Z87.1-1989, American Society of Safety Engineers, Des Plaines, IL 1989.
2. Handbook of Reactive Chemical Hazards. L. Bretherick, Butterworth-Heinemann, Stoneham, MA 1990.

3. Catalog of Teratogenic Agents, Sixth Edition. Shepard, T. Johns Hopkins University Press, Baltimore 1989.
4. Code of Federal Regulations (CFR) Title 29. U.S. Government Printing Office, Washington DC, 1988.
5. (The) Condensed Chemical Dictionary. Van Nostrand Reinhold, New York, Eleventh Edition, 1989.
6. CRC Handbook of Laboratory Safety, Third Edition. CRC Press, Inc. Boca Raton, FL, 1990.
7. Destruction of Hazardous Chemicals in the Laboratory. Lunn, G. and Sansone, E.B. Wiley-Interscience, New York, 1990.
8. Fifth Annual Report on Carcinogens, Summary 1989 (or later). U.S. Department of Health and Human Services, National Toxicology Program 89-239.
9. Merck Index. Merck & Co., Inc., Rahway NJ, Eleventh Edition, 1989 or latest edition.
10. National Fire Protection Association (NFPA). Standard 30, Container and Portable Tank Storage, 1987 ed.; and Standard 45, Fire Protection for Laboratories Using Chemicals, 1986.
11. Prudent Practices for Disposal of Chemicals from Laboratories. National Research Council. National Academy Press, Washington DC, 1983.
12. Prudent Practices for Handling Chemicals in Laboratories. National Research Council. National Academy Press, Washington DC, 1981.
13. Registry of Toxic Effects of Chemical Substances. (RTECS) U.S. Department of Health and Human Services, Superintendent of Documents, Washington DC, 1989 plus supplements.
14. Safe Laboratories: Principles and Practices for Design and Remodeling. Ashbrook, P. C. and Renfrew, M. M. Lewis Publishers, Inc. Chelsea, MI, 1991.
15. Safe Storage of Laboratory Chemicals. Editor Pipitone, Wiley-Interscience, New York, 1991.
16. Safety in Academic Chemistry Laboratories. American Chemical Society, Washington DC, 1990. (Single free copies may be obtained by a written request to the American Chemical Society, 1155 16th Street NW, Washington DC 20036 or telephone request at (202) 872-4363.)
17. UIC Environmental Health and Safety Standards. University of Illinois at Chicago, 1986.

APPENDIX A-2

UIC ENVIRONMENTAL HEALTH AND SAFETY STANDARDS (Partial Listing)*

1-1-0 Fume Hoods
1-1-1 Chemical Fume Hoods
1-1-2 Ductless Portable Fume Hoods
1-3-0 Air-Quality Sampling for Contaminants
2-2-0 Incompatible Materials
2-3-0 Hazardous Material Storage
2-4-1 Perchloric Acid Handling
2-4-2 Solvent Handling
2-4-3 Peroxide-forming Chemical Handling
2-4-4 Picric Acid Handling
2-4-5 Mercury Handling
2-4-6 Anesthetic Gases Handling
2-4-9 Formaldehyde Handling
2-5-0 Chemical Mishaps and Spills
2-6-1 Chemical Waste/Surplus Disposal
2-6-2 Biohazardous (Infectious) Waste Disposal
2-6-3 Sharps Disposal
2-6-4 Needles and Syringes Disposal
2-6-5 Aerosol Can Disposal
3-2-5 Laboratory Hazard Identification

3-2-6 Transfer of Laboratory Space
3-2-0 Personal Protective Equipment
3-3-1 Eye Protection
3-6-0 Compressed Gas Cylinders
3-7-0 Working Alone
4-2-0 Means of Egress
4-3-0 Flammable Storage
4-5-0 Laboratory-Safe Refrigerators, Freezers, and Cooling Equipment
5-1-0 Fire Emergency CHPs
5-3-0 Occupational Injuries and Illnesses
5-4-0 Emergency Medical Attention

- Copies of these individual sections may be obtained from the Health and Safety Section, EHSO (6-7233).

APPENDIX A-3

INFORMATIONAL CONTENT OF NFPA FIRE DIAMONDS

An NFPA hazard rating fire diamond is a visual warning system containing material-specific information pertaining to a chemical's degree of health hazard, flammability, and reactivity - as they relate to a fire condition. It can also contain information about any special hazards a chemical may exhibit and which are useful to know in case of a fire.

Accepted numerical codes for information in each of the fire diamond's positions are as follows:

Health Hazard (blue)
0 = Ordinary combustible hazards in a fire
1 = Slightly hazardous
2 = Hazardous - use fume hood or breathing apparatus
3 = Extremely Dangerous - use full protective clothing
4 = Deadly - too dangerous to enter vapor or liquid

Flammability (red) - Number 3 and 4 indicates fire hazard, thus the guidelines in section 2.9 need to be followed.
0 = Will not burn
1 = Will ignite if preheated
2 = Will ignite if moderately heated
3 = Will ignite at most ambient conditions
4 = Burns readily at ambient conditions

Reactivity and Instability (yellow) - This position contains information related to the energy released if the chemical is mixed, decomposed, or burned. The numerical codes for this information are:
0 = Stable and not reactive with water
1 = Unstable if heated - use normal precautions
2 = Violent and heat may detonate
3 = Shock and heat may detonate
4 = May Detonate
Flammability---
Special Hazard (White) (Red)

---Reactivity
OXY = Oxidizer (Yellow)

ACID = Acid Health Hazard---
ALKALI = Alkali (Blue)
COR = Corrosive ---Special Hazard
W = Use no water (White)

APPENDIX A-4

ANSI EYE PROTECTION STANDARD

Reprinted from American National Standards Practice for Occupational and Educational Eye and Face Protection, ANSI Z87.1-1989, approved by the American National Standards Institute on February 2, 1989 and published by the American Society of Safety Engineers as the Secretariat of the Standards project.

APPENDIX A-5

PROTECTION CHARACTERISTIC PROPERTIES OF GLOVE MATERIALS

MATERIAL	PROPERTIES
CPE (chlorinated polyethylene)	Increased resistance to oil, ozone, heat, and chemicals and low permeability to gases.
Natural Rubber (latex)	Resists acids, alkalies, salts and, ketones.
Neoprene	Resists oil, acids, caustics, alcohols, and solvents.
Nitrile	Superior puncture and abrasion resistance in addition to chemical resistance similar to neoprene.
PVA (polyvinyl alcohol)	Resists halogenated hydrocarbons, some aromatic hydrocarbons and ketones. Not recommended for alcohols or aqueous matrix solutions.
PVC (polyvinyl chloride or vinyl)	Resists acids and alcohols but not petroleum products.
Viton	Resists oils, fuels, lubricants, most mineral acids, hydraulic fluids and aliphatic, and aromatic hydrocarbons.

APPENDIX A-6
PERMISSIBLE EXPOSURE LIMITS (PELs)
OF SOME COMMON LABORATORY CHEMICALS

Expressed in TWAs (8-hour time weighted averages) and STELs (short term exposure limits)

SUBSTANCE	TWA		STEL	
	ppm[a]	mg/m^3 [b]	ppma	mg/m3 b
Acetaldehyde	100	180	150	270
Acetic Acid	10	25	-	-
Acetone	750	1800	1000	2400
Acetonitrile	40	70	60	105

Acrylic Acid	10	30	-	-
Ammonium Chloride fume	-	-	10 -	20
n-Amyl Acetate	100	650	-	-
Arsenic, organic compounds	-	0.5	-	-
tert-Butyl alcohol	100	300	150	450
Butyl mercaptan	0.5	1.5	-	-
Carbon disulfide	4	12	12	36
Carbon monoxide	35	40	-	-
Carbon tetrachloride	2	12.6	-	-
Chlorobenzene	75	350	-	-
Chloroform	2	9.78	-	-
Cyanogen	10	20	-	-
Cyclohexane	300	1050	-	-
Cyclohexylamine	10	40	-	-
1,1-Dichloroethane	100	400	-	-
Dimethylformamide	10	30	-	-
Dimethyl sulfate	0.1	0.5	-	-
Dinitrotoluene	-	1.5	-	-
Ethanolamine	3	8	6	15
Ethyl acetate	400	1400	-	-
Ethyl alcohol	1000	1900	-	-
Ethyl ether	400	1200	500	1500
Furfural	2	8	-	-
Heptane	400	1600	500	2000
n-Hexane	50	180	-	-
Hydrogen peroxide	1	1.4	-	-
Hydrogen sulfide	10	14	15	21
Isoamyl alcohol	100	360	125	450
Isobutyl alcohol	50	150	-	-
Isopropyl ether	500	2100	-	-
Isopropyl glycidyl ether	50	240	75	360
Mercury (organo) alkyl compounds	-	-	0.01	0.03
Methacrylic acid	20	70	-	-
Methyl acrylate	10	35	-	-
Methyl alcohol	200	260	250	325
Methylamine	10	12	-	-
Methyl n-amyl ketone	100	465	-	-
Methyl 2-cyanoacrylate	2	8	4	16
Methyl Chloroform (1,1,1-Trichloroethane)	350	1900	450	2450
Methyl formate	100	250	150	375

Methyl iodide	2	10	-	-
Methyl isocyanate	0.02	0.05	-	-
Methyl methacrylate	100	410	-	-
Naphthalene	10	50	15	75
Nitric acid	2	5	4	10
Nitrobenzene	1	5	-	-
Octane	300	1450	375	1800
Oil mist, mineral	-	5	-	-
Oxalic acid	-	1	-	2
Paraffin wax fume	-	2	-	-
Pentachlorophenol	-	0.5	-	-
Pentane	600	1800	750	2250
Phenol	5	19	-	-
Phenyl glycidyl ether (PGE)	1	6	-	-
Phosgene (Carbonyl chloride)	0.1	0.4	-	-
Phosphoric acid	-	1	-	3
Phosphorus (yellow)	-	0.1	-	-
n-Propyl alcohol	200	500	250	625
Propylene glycol monomethylether	100	360	150	540
Pyridine	5	15	-	-
Sodium bisulfite	-	5	-	-
Stoddard solvent	100	525	-	-
Tetrahydrofuran	200	590	250	735
Toluene	100	375	150	560
o-Toluidine	5	22	-	-
Trichloroacetic acid	1	7	-	-
Triethylamine	10	40	15	60
Xylenes	100	435	150	655

[a] Parts of vapor or gas per million parts of contaminated air by volume at 25 deg C and 760 torr.

[b] Approximate milligrams of substance per cubic meter of air.

STEL Duration is for 15 minutes, unless otherwise noted.

Taken from Title 29 Code of Federal Regulations Part 1910.l000, "Air Contaminants - Permissible Exposure Limits", U.S. Department of Labor, Occupational Safety and Health Administration, 1989.

APPENDIX A-7
MAXIMUM ALLOWABLE SIZE OF CONTAINERS
For Fire Hazard Chemicals

Container Type*	Class IA1	Class IB2	Class IC3	Class II4	Class III5
Glass	1 pt**	1 qt**	1 gal	1 gal	5 gal
Metal (other than DOT drums) or Approved Plastic	1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	1 gal	5 gal	5 gal	5 gal	5 gal
Polyethylene DOT Spec. 34, or as autorized by DOT Exemption	1 gal	5 gal	5 gal	60 gal	60 gal
Metal Drum (DOT Spec.)		5 gal	5 gal	60 gal	60 gal
Metal Drum (DOT spec.) in approved storage rm.	60 gal	60 gal	60 gal	60 gal	60 gal

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

** Glass containers as large as one gallon may be used if the required purity would be adversely affected by storage in a metal or an approved plastic container, or if the liquid would cause excessive corrosion or degradation of a metal or approved plastic container.

*** N/A = Not Allowed

1 Liquids having flash points below 73 deg F (22.8 deg C) and having a boiling point below 100 deg F (37.8 deg C).

2 Flash point below 73 deg F, boiling point above 100 deg F.

3 Flash point above 73 deg F and below 100 deg F.

4 Flash point above 100 deg F and below 140 deg F (60 deg C)

5 Flash points at or above 140 deg F.

This table is taken from the UIC Environmental Health and Safety Standard 4-3-0, 1988, adapted from NFPA 30, Flammable and Combustible Liquids Code except for allowable quantities of flammable liquids in metal DOT drums.

APPENDIX A-8
ORGANIC PEROXIDES AND PEROXIDE FORMERS

Organic peroxides are a special class of compounds which pose unusual stability problems. These peroxides are among the most hazardous chemicals normally handled in chemical laboratories and in manufacturing. As a class, organic peroxides are low-power explosives. They are hazardous because of their extreme sensitivity to shock, sparks or other forms of accidental ignition. Many peroxides that are routinely handled in laboratories are more sensitive to shock than primary explosives such as TNT. Peroxides have a specific half-life, or rate of decomposition, under any given set of conditions. A low rate of decomposition may autoaccelerate into a violent explosion, especially in bulk quantities of peroxides. They are sensitive to heat, friction, impact, and light as well as to strong oxidizing and reducing agents. All organic peroxides are extremely flammable, and fires involving bulk quantities of peroxides should be approached with extreme caution. A peroxide present as a contaminating reagent in a solvent can change the course of a planned reaction.

Compounds of the following types are known to form peroxides:

- Aldehydes
- Ethers, especially cyclic ethers, and ethers derived from primary and secondary alcohols. It is especially important to label the containers of ethyl or isopropyl ether with the date they are opened, so that the contents of the container can be destroyed by the user within three months. Ethers must never be distilled unless known to be free of peroxides.
- Compounds containing benzylic hydrogen atoms. Such compounds are especially susceptible to peroxide formation if the hydrogens are on tertiary carbon atoms, e.g., cumene (isopropyl benzene).
- Compounds containing the allylic (CH2=CHCH2-) structure, including most alkenes.
- Ketones, especially cyclic ketones.
- Vinyl and vinylidene compounds, e.g., vinyl acetate and vinylidene chloride.

Specific examples of chemicals that can form dangerous concentrations of peroxides with exposure to air are cyclohexene, cyclooctene, decalin (decahydronaphthalene), p-dioxane, ethyl ether, isopropyl ether, tetrahydrofuran (THF), tetralin (tetrahydronaphthalene).

Several acceptable colorimetric tests for peroxides in ethers are available. A test for peroxides should only be attempted if it is clear that no danger will result from moving or opening the container. Solids observed in the liquid or around the cap can indicate dangerous peroxide buildup. Store peroxides away from heat and light in closed vessels, preferably in the container furnished by the supplier.
The following precautions should be followed when handling organic peroxides and hydroperoxides:

- Study and follow all precautions specified by the manufacturer of the peroxy substance before using it.
- Store the peroxides at the minimum safe temperatures to minimize the rate of decomposition. CAUTION: Do not refrigerate liquid or solutions of peroxides at or below the temperature at which the peroxide freezes or precipitates. Peroxides in these forms are extra sensitive to shock and heat.
- Limit the quantity of peroxide handled to the minimum amount required. Don't return unused peroxide to the stock container
- Clean up all spills immediately by recommended procedures. The first step is usually to dilute or disperse the peroxide with an inert substance.
- Reduce the sensitivity of most peroxides to shock and heat by dilution with inert solvents such as aliphatic hydrocarbons (e.g., mineral oil) but NEVER with acetone or other ketones.
- Avoid using solutions of peroxides in volatile solvents when it is possible that the solvent will vaporize and thereby increase peroxide concentration.
- Never use a metal spatula with organic peroxides. Contamination by metals can cause explosive decomposition. Use ceramic or plastic spatulas instead.
- Do not permit smoking, open flames, sparking equipment or any source of intense heat near peroxides.
- Avoid friction, grinding, and all forms of impact, especially with solid organic peroxides. NEVER use glass containers with screw cap lids or glass stoppers. Instead, use plastic (e.g., polyethylene) bottles and sealers.
- Because peroxy compounds are generally irritants, avoid ingestion, inhalation, and skin contact. Treat any areas of contact as burns and get medical attention.

APPENDIX A-9
CARCINOGENS

Substances or Groups of Substances, and Medical Treatments that are Known to be Carcinogenic:*

- 4-Aminobiphenyl
- Analgesic Mixtures Containing Phenacetin
- Arsenic & Certain Arsenic Compounds
- Asbestos
- Azathioprine
- Benzene
- Benzidine
- Bis(chloromethyl)ether
- Tech. Grade Chloromethyl Methyl Ether
- 1,4-Butanediol Dimethylsulfonate (Myleran)
- Chlorambucil
- Chromium and Certain Cr Compounds
- Conjugated Estrogens
- Cyclophosphamide
- Diethylstilbestrol
- Melphalan
- Methoxsalen w/UV A Therapy (PUVA)
- Mustard Gas
- 2-Naphthylamine
- Thorium Dioxide
- Vinyl Chloride

*For the purpose of this report, "known carcinogens" are defined as those substances for which the evidence from human studies indicates that there is a causal relationship between exposure to the substance and human cancer.

Substances or Groups of Substances, and Medical Treatments that may Reasonably be Anticipated to be Carcinogens**

- 2-Acetylaminofluorene
- Acrylonitrile
- Adriamycin
- Aflatoxins
- 2-Aminoanthraquinone
- o-Aminoazotoluene
- 1-Amino-2-methylanthraquinone
- Amitrole
- o-Anisidine Hydrochloride
- Benzotrichloride
- Beryllium and Certain Be Compounds
- Bischloroethyl Nitrosourea
- 1,3-Butadiene
- Cadmium & certain Cd compounds
- Carbon tetrachloride
- Chlorendic Acid
- Chlorinated Paraffins (C12, 60% Cl)
- 1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
- Chloroform
- 3-Chloro-2-methylpropene

- 4-Chloro-o-phenylenediamine
- C.I. Basic Red 9 Monohydrochloride
- p-Cresidine
- Cupferron
- Dacarbazine
- DDT
- 2,4-Diaminoanisole Sulfate
- 2,4-Diaminotoluene
- *1,2-Dibromo-3-chloropropane
- 1,2-Dibromoethane (EDB)
- 1,4-Dichlorobenzene
- 3,3'-Dichlorobenzidine
- 3,3'-Dichlorobenzidine Dihydrochloride
- 1,2-Dichloroethane
- Dichloromethane (Methylene Chloride)
- 1,3-Dichloropropene (Technical Grade)
- Diepoxybutane
- Di(2-ethylhexyl)phthalate
- Diethyl Sulfate

** For the purpose of this Report, substances "which may reasonably be anticipated to be carcinogens" are defined as those for which there is a limited evidence of carcinogenicity in humans or sufficient evidence of carcinogenicity in experimental animals.

May Reasonably Be Anticipated To Be Carcinogens

- Benz(a)anthracene
- Benzo(b)fluoranthene
- Benzo(j)fluoranthene
- Benzo(k)fluoranthene
- Benzo(a)pyrene
- Dibenz(a,h)acridine
- Dibenz(a,j)acridine
- Dibenz(a,h)anthracene
- 7H-Dibenzo(c,g)carbazole
- Dibenzo(a,e)pyrene
- Dibenzo(a,h)pyrene
- Dibenzo(a,i)pyrene
- Dibenzo(a,l)pyrene
- Diglycidyl Resorcinol Ether
- 3,3'-Dimethoxybenzidine
- 4-Dimethylaminoazobenzene
- 3,3'-Dimethylbenzidine
- Dimethylcarbamoyl Chloride
- 1,1-Dimethylhydrazine
- Dimethyl Sulfate
- Dimethylvinyl Chloride
- 1,4-Dioxane
- Direct Black 38
- Direct Blue 6
- Epichlorohydrin

- Estrogens (Not Conjugated): Estradiol-17 Beta
- Estrogens (Not Conjugated): Estrone
- Estrogens (Not Conjugated): Ethinylestradiol
- Estrogens (Not Conjugated): Mestranol
- Ethyl Acrylate
- Ethylene Oxide
- Ethylene Thiourea
- Formaldehyde (Gas)
- Hexachlorobenzene
- Hexamethylphosphoramide
- Hydrazine & Hydrazine Sulfate
- Hydrazobenzene
- Iron Dextran Complex
- Kepone (Chlordecone)
- Lead Acetate & Lead Phosphate
- Lindane & Other Hexachlorocyclohexane Isomers
- 2-Methylaziridine (Propyleneimine)
- 4,4'-Methylenebis(2-chloroaniline (MBOCA)
- 4,4'-Methylenebis(N,N-dimethyl)benzenamine
- 4,4'-Methylenedianiline & its Dihydrochloride
- Metronidazole
- Michler's Ketone
- Mirex
- Nickel and Certain Nickel Compounds
- Nitrilotriacetic Acid
- 5-Nitro-o-anisidine
- Nitrofen
- Nitrogen Mustard Hydrochloride
- 2-Nitropropane
- N-Nitrosodi-n-butylamine
- N-Nitrosodiethanolamine
- N-Nitrosodiethylamine
- N-Nitrosodimethylamine
- p-Nitrosodiphenylamine
- N-Nitrosodi-n-propylamine
- N-Nitroso-N-ethylurea
- N-Nitroso-N-methylurea
- N-Nitrosomethylvinylamine
- N-Nitrosomorpholine
- N-Nitrosonornicotine
- N-Nitrosopiperidine
- N-Nitrosopyrrolidine
- N-Nitrososarcosine
- Norethisterone
- 4,4'-Oxydianiline
- Oxymetholone
- Phenacetin
- Phenazopyridine Hydrochloride
- Phenoxybenzamine Hydrochloride
- Phenytoin
- Polybrominated Biphenyls

- Polychlorinated Biphenyls
- Polycyclic Aromatic Hydrocarbons:
- Indeno(1,2,3-cd)pyrene
- 5-Methylchrysene
- Procarbazine Hydrochloride
- Progesterone
- 1,3-Propane Sultone
- Beta-Propiolactone
- Propylene Oxide
- Propylthiouracil
- Reserpine
- Saccharin
- Safrole
- Selenium Sulfide
- Streptozotocin
- Sulfallate
- 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)
- Tetrachloroethylene (Perchloroethylene)
- Thioacetamide
- Thiourea
- Toluene Diisocyanate
- o-Toluidine and o-Toluidine Hydrochloride
- Toxaphene
- 2,4,6-Trichlorophenol
- Tris(1-aziridinyl)phosphine Sulfide
- Tris(2,3-dibromopropyl)phosphate
- Urethane

This list is taken from the FIFTH ANNUAL REPORT ON CARCINOGENS SUMMARY 1989, U.S. Department of Health and Human Services, Public Health Service, Prepared for the National Institute of Environmental Health Sciences, Research Triangle Park, NC, by Technical Resources, Inc., Rockville, MD.

APPENDIX A-10
TERATOGENIC AGENTS IN HUMAN BEINGS

RADIATION

- Atomic weapons
- Radioiodine
- Therapeutic
-

INFECTIONS

- Cytomegalovirus (CMV)
- Herpes virus hominis ? I and II
- Parvovirus B-19 (Erythema infectiosum)
- Rubella virus
- Syphilis
- Toxoplasmosis
- Venezuelan equine encephalitis virus
-

DRUGS & ENVIRONMENTALCHEMICALS

- Aminopterin & methylaminopterin
- Androgenic hormones
- Busulfan Chlorobiphenyls
- Coumarin anticoagulants
- Cyclophosphamide
- Diethylstilbestrol
- Diphenylhydantoin and trimethadione
- Etretinate
- Lithium
- Mercury, organic
- Methimazole & scalpdefects
- Penicillamine
- 13-cis-Retinoic acid (Iso-tretinoinand Accutane)
- Tetracyclines
- Thalidomide
- Trimethadione
- Valproic Acid

MATERNAL METABOLIC IMBALANCE

- Alcoholism
- Cretinism, endemic
- Diabetes
- Folic acid deficiency (following
- gastric by-pass surgery)
- Hyperthermia
- Phenylketonuria
- Rheumatic disease & congenital heart block
- Virilizing tumors

POSSIBLE TERATOGENS

- ?Binge drinking
- ?Carbamazepine
- ?Cigarette smoking
- ?Cocaine
- ?Disulfiram
- ?Folic acid deficiency
- ?High Vitamin A
- ?Lead
- ?Primidone
- ?Streptomycin
- ?Toluene abuse
- ?Varicella virus
- ?Zinc deficiency

UNLIKELY TERATOGENS

- Agent Orange

- Anesthetics
- Aspartame
- Aspirin (in 2nd half of pregnancy may increase cerebral hemorrhage during delivery)
- Bendectin (antinauseants)
- Birth control pills
- Illicit drugs (marijuana, LSD)
- Metronidazole
- Oral contraceptives
- Rubella vaccine
- Spermicides
- Video display screens

This list is reprinted from the CATALOG OF TERATOGENIC AGENTS, 6th ed. Thomas H. Shepard, M.D., Johns Hopkins University Press, Baltimore, 1989.

APPENDIX A-11
INCOMPATIBLE CHEMICALS

Chemical	**Keep Out of Contact With**
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali and alkaline earth	Water, carbon tetrachloride or other chlorinated hydrometals (such as powdered carbons, carbon dioxide, halogens aluminum or magnesium, lithium, sodium, potassium)
Ammonia (anhydrous)	Mercury (in manometers, for example), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids
Bromine	See chlorine
Calcium Oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid and chromium	Acetic acid, naphthalene, camphor, glycerol, alcohol, trioxide flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens

Fluorine	All other chemicals
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalies, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Potassium chlorate
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium com pounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing agents

ADDITIONAL APPENDIXES TO BE ADDED BY INDIVIDUAL LABORATORY UNITS

The following appendixes, which are to be completed by individual laboratory units, can be obtained in Adobe Acrobat format by clicking here.

B-1 Emergency Equipment Locations
B-2 MSDSs for Hazardous Chemicals in the Lab
B-3 Conditions for Prior Approval
B-4 Inventory of Corrosive Chemicals
B-5 List of Fire Hazard Liquids, Gases and Solids
B-6 Inventory of Highly Reactive Chemicals
B-7 Inventory of Reproductive Toxins
B-8 Inventory of Carcinogens
B-9 Inventory of Acutely Toxic Chemicals
B-10 Standard Operating Procedures for Handling Hazardous Chemicals in the Lab
B-11 Records of Training, Accidents, Monitoring, and Medical Surveillance

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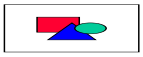

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