CHEMICAL HYGIENE PLAN AND SAFETY REGULATIONS FOR

THE DEPARTMENT OE CHEMISTRY

THE UNIVERSITY OF KANSAS

Lawrence, Kansas

Approved, April 13, 1978
Modified by the Departmental CHSE, Spring 1996
Modified by the Departmental CHSE, Fall 2005

EMERGENCY (AMBULANCE, FIRE, POLICE) 911

CAMPUS POLICE (NON-EMERGENCY CALLS) 4-5900

WATKINS MEMORIAL HOSPITAL 8-749-6100

POISON CONTROL CENTER 8-1-800-332-6633

CHEMISTRY STOREROOM 4-3488 (transportation arrangement to Watkins Hospital Emergency Room)

CHEMISTRY BUSINESS OFFICE 4-4271 OR 4-3547

ENVIRONMENTAL HEALTH AND SAFETY 4-4089

24 HOUR EHS EMERGENCY ON-CALL PAGER 838-7421

EHS WEBSTIE WWW.EHS.KU.EDU

Susan Teague – 2010 Malott – 864-3547, cell 785-766-7311 or steague@ku.edu

File location: o:Safety/Chem Hygiene Plan

ADMINISTRATIVE RESPONSIBILITIES

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

EHS. The Office of Environmental Health and Safety (EHS) has specific responsibility for developing and implementing programs for environmental health and safety at the University of Kansas, and seeing that these programs are adapted and implemented at the departmental level.

Department of Chemistry. The Department of Chemistry is responsible for the adaptation and implementation of a Chemical Hygiene Plan and Safety Regulations (CHPSR) for all laboratories under its administrative control. The Chairperson of the Department of Chemistry shall designate a member of the Chemical Hygiene and Safety Committee (CHSC) to serve as the Departmental Chemical Hygiene Officer (CHO). The Departmental CHO will assist any laboratory supervisor in adapting the Department's Chemical Hygiene Plan to the specific needs of individual laboratories, will be responsible for implementing the Departmental CHPSR, and will serve as a liaison to the EHS.

Laboratory Supervisors. The immediate supervisor of laboratory students or employees is responsible for adapting and implementing the Departmental CHPSR to specific laboratories, implementing the policies and procedures of the Departmental CHPSR, enforcing safe practices, providing any specialized safety training that may be needed, reporting hazardous conditions to the CHSC or EHS, and maintaining any required records to demonstrate compliance with the CHPSR.

Employees. Employees are responsible for observing all appropriate practices mandated by the Departmental CHPSR as well as other safety practices, for attending designated training sessions, and for reporting hazardous conditions to the Laboratory Supervisor, CHSC, or EHS.

The following Chemical Hygiene Plan and Safety Regulations for the Department of Chemistry are designed to protect students, employees, and faculty from accidental injury or exposure in the laboratory. Their success depends upon the enthusiastic cooperation of all persons concerned. Selected portions of these regulations have been combined with minor modifications to form the "Safety Regulations for Courses Numbered Below 700" (attached) detailed knowledge of which is required before undergraduate students are permitted to begin experimental work.

Willful non-compliance with any of the following regulations is a serious offense that will result in disciplinary action.

Special thanks to Emery Sobottka for providing copies of the Chemical Hygiene Plan developed for Iowa State University.

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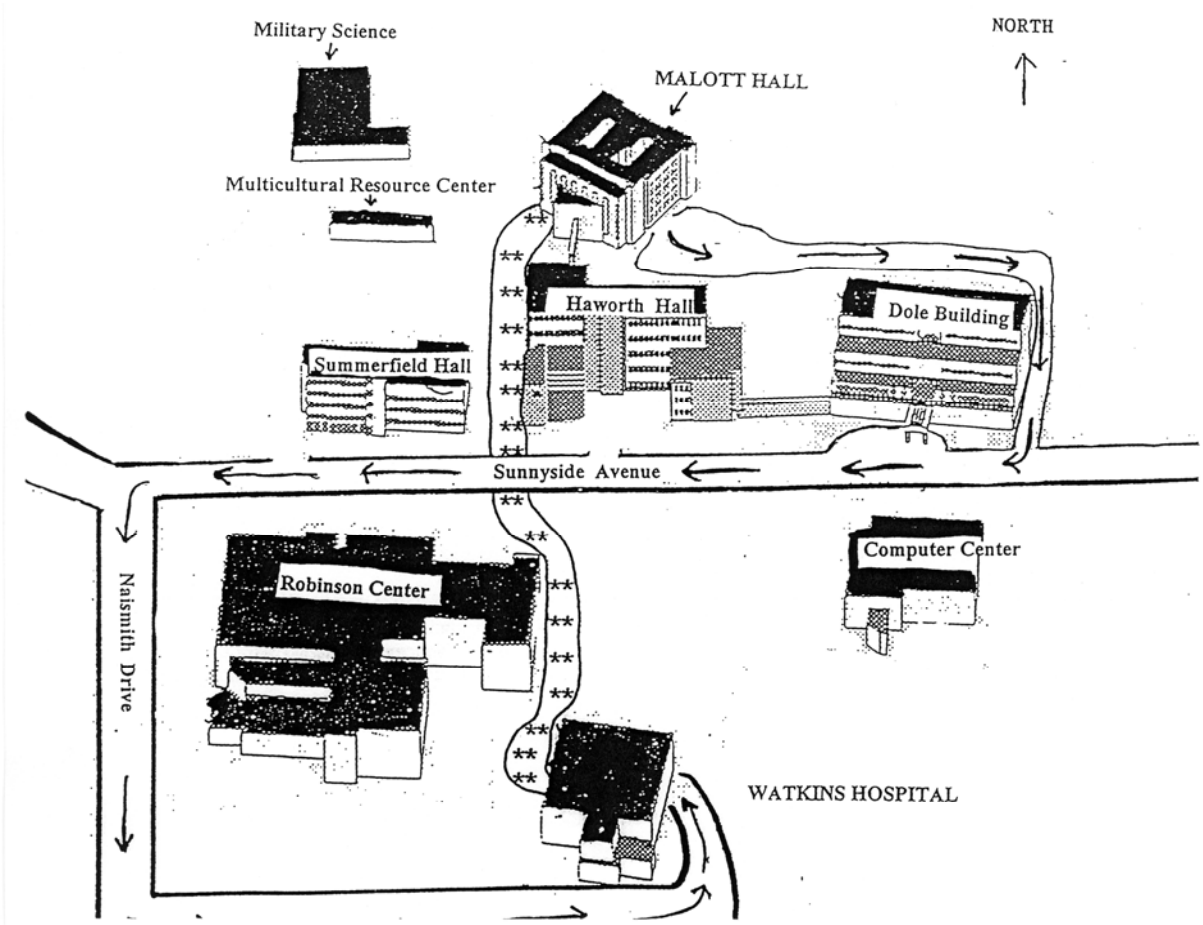
WATKINS HOSPITAL

864-9500

→ DRIVING ROUTE
***** WALKING PATH -

WATKINS HOURS DURING SEMESTERS
Monday - Friday 8:00 a.m. to 8:00 p.m.
Saturday 8:00 a.m. to 4:00 p.m.
Sunday 12:30 p.m. to 4:30 p.m.
.
WATKINS HOURS FOR BREAKS AND HOLIDAYS
8:00 a.m. to 4:30 p.m.

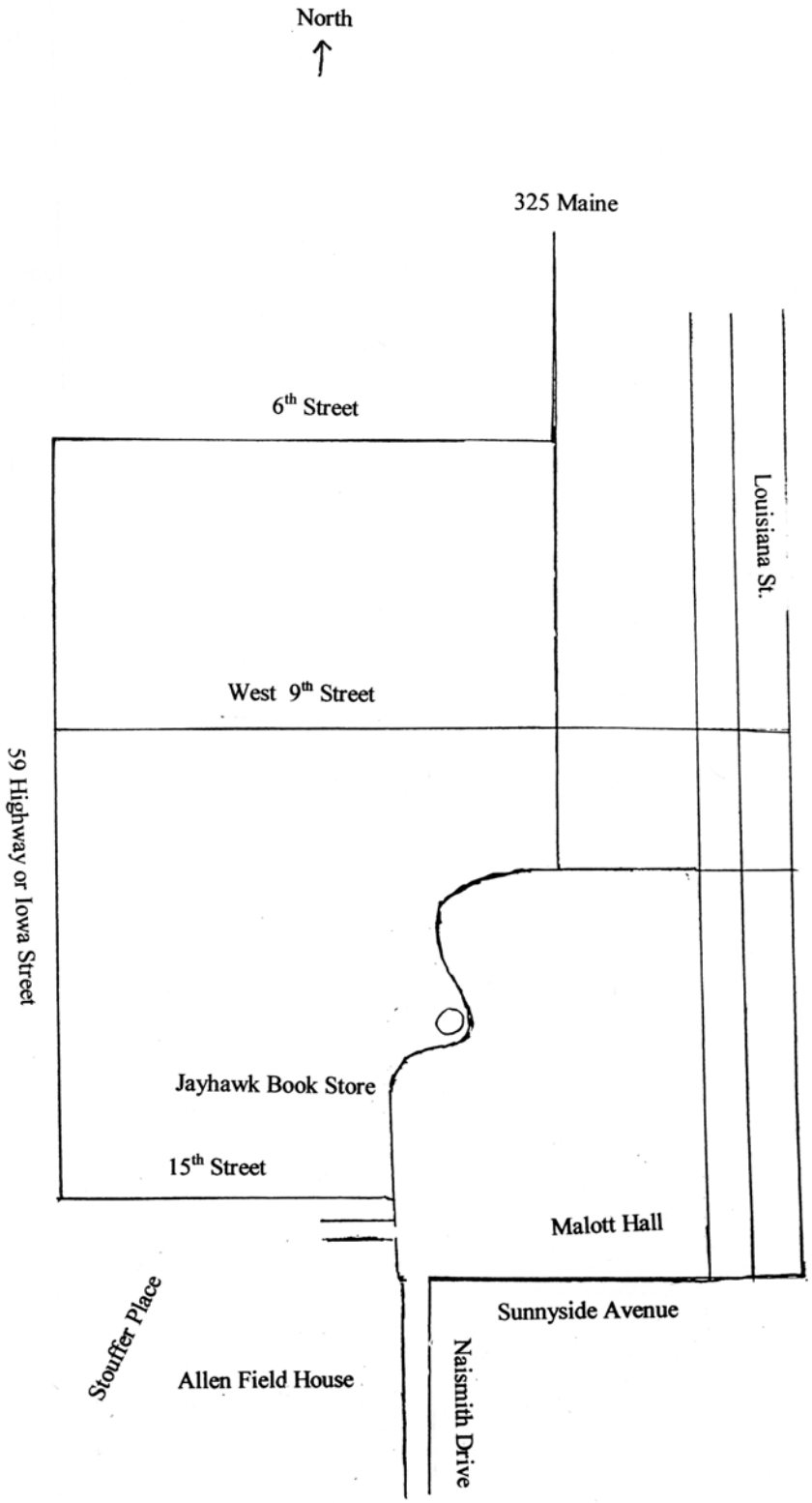


LAWRENCE MEMORIAL HOSPITAL
325 Maine

840-3114

Occupation Health and Safety Desk

All employees (including GTA's and GRA's) who are injured in lab, must be seen at LMH. Upon returning to work, you must fill out an accident form in room 2010 Malott.



I. Emergency Response Procedures

A. Initial Action and First Aid (Do not move an injured person unless such movement is necessary to prevent further injury).

PERSON ON FIRE OR SPLASHED WITH CORROSIVE CHEMICAL: In the event that any individual has been splashed with a burning solvent or corrosive chemical or has any clothing on fire, the affected area must be doused quickly with running water to avoid serious injury. This action must be performed immediately by the person(s) closest to the victim. Unless only a small area (such as the hand) is affected, a safety shower should be used. Remove any clothing that has been contaminated with chemicals. Do not use neutralizing chemicals, creams, lotions, ointments, or salves. (See Section I.B.)

CORROSIVE SUBSTANCE IN EYE: Get the injured person to the nearest eye wash as quickly as possible and irrigate the eye with plenty of water for 10-15 minutes.

After an initial few minutes of irrigation have the person remove any contact lenses and then continue to irrigate the eye. The injured person should be encouraged to keep his/her eyes open as much as possible during the irrigation which may require that he/she hold the eye lid. Finally, place a loose (no pressure) clean bandage or cloth over the eye. (See Section I.B.)

SEVERE BLEEDING: Elevate the injury above the heart and apply a clean pad or cloth directly to the wound with firm pressure. (See Section I.B.)

ELECTRIC SHOCK: Shut off current or cautiously remove contact from victim with an insulating material.

BREATHING (AND HEART) STOPPED: *If you are certified in CPR*, administer rescue breathing (and CPR) until ambulance or physician arrives. (See Section I.B.)

INGESTION OF CHEMICALS: Encourage the victim to drink large amounts of water. Call an ambulance (DiaI 911). Determine as much as possible about what was ingested and call the Poison Control Center (KUMC Poison Control Center 8-1-800-332-6633).

MINOR CUTS AND PUNCTURES: Encourage bleeding, wash with running water, and wrap in a clean towel until proper treatment can be secured. (See Section I.B.)

B. <u>Additional Medical Aid</u> (undergraduate students only)

In the event of a minor injury in a regularly scheduled undergraduate laboratory the Teaching Assistant must contact the storekeeper in the nearest dispensing storeroom. The storekeeper will then arrange for transportation to Watkins Hospital. In the event that transportation is not available (after 4:00 pm on weekdays and on Saturday morning), have another Teaching Assistant watch the section temporarily and walk the injured person to the emergency room of Watkins Hospital. Try to have someone call ahead to the emergency room at the hospital (4-9500), and alert them that someone is coming, and indicate as much information about the nature of the injury as possible, including what chemicals may have been involved.

If a person is injured in any other laboratory or shop during normal business hours (Mon-Fri, 8:00 a.m.-4:00 p.m.) or was incurred outside of the normal business hours, walk the injured person to the emergency room of Watkins Hospital. Emergency action and first aid described in Section I.A. should be carried out before the person goes to the hospital, not in lieu of his/her going to the hospital.

If an individual is injured so seriously that he/she cannot be driven or walked to the hospital, then an ambulance should be called by dialing (911).

C. Reporting: Accidents and Injuries

For every accident or injury (minor or major) fill out a Departmental Accident Report Form (available in any storeroom or in the Chemistry Business Office (Room 2010 and submit it to the Chemistry Business Manager as soon as possible. Employees (e.g., faculty, research assistants, postdoctoral research associates, teaching assistants, university support staff, and student hourly assistants) must also fill out and submit an Accident Report Form (1101-A, Chemistry Business Office) to the Chemistry Business Office within 24 hours of an accident. Employees are required to go to Lawrence Memorial Hospital, Occupational Health Department for treatment

In the event that a student in a regularly scheduled undergraduate laboratory is injured, the accident report should be initiated by the Teaching Assistant. In any advanced laboratory course or research laboratory, the person who is injured should initiate the accident report if that is possible. Otherwise the report should be filed by the Instructor or Research Advisor of that student.

A *serious injury* is defined as one for which there is a reasonable expectation that the injured person will not be able to resume normal activities the same day and/or will have to receive treatment for an extended period of time and/or will have to be hospitalized and/or will experience prolonged effects from the injury.

In the event of a serious injury (as defined above) and after the emergency actions described in Sections I.A. and I.B. have been taken, the area where the accident occurred must be *untouched* and one of the following individuals should be summoned immediately: The Chairperson of the Department, the Associate Chairperson of the Department, or the Business Manager. If none of these individuals can be located, the laboratory room must be cleared of all persons and locked until one of the three aforementioned individuals arrives. The research director or faculty instructor, as appropriate, should be notified.

D. Building Alarm - Emergency Response Plan for Malott Hall

All of Malott Hall must be evacuated in a timely but orderly fashion through the nearest safe outside exit. Stairways must be used (never elevators). Students in laboratory and lecture courses are advised to take all their personal belongings with them. Laboratory instructors must be prepared to instruct their students about what to do; in general, all reagent flows and heat sources must be shut off and any radiation sources must be secured. Research and storeroom personnel should exercise good judgment in leaving their facilities in a safe and stable condition. *Everyone should assume that once the building is evacuated, reentry might not occur for an extended period and that power to the building might be interrupted.*

Individuals from each department who have been designated previously will meet in front of the east loading dock of Malott Hall in order to serve as resource people for the Fire Department, Hazardous Material Personnel, Campus Police, and the Environmental Health and Safety personnel of the campus.

Any individual (student, faculty member, or other employee) who has specific knowledge of the incident that resulted in the alarm being sounded should go as quickly as possible to the front of the east loading dock to Malott Hall and relay that information to the person in charge. Persons (including those who might have responsibility for the incident) who provide vital information in a timely manner will **not** be subject to disciplinary action, while failure to do so might result in disciplinary action. Such information could avoid building evacuation or at least greatly reduce the time required before the building can be reentered. (Information can be given anonymously by telephone to the EHS at 4-4089.)

You may enter the building only when the alarm stops and security personnel have officially opened the building for occupancy.

E. Chemical Spills

Minor Spills The following general procedures must be observed by laboratory personnel for minor spills of chemicals.

- Notify EHS if you require additional assistance or information.
- Attend to any persons who may have been contaminated.
- Notify people in the immediate area about the spill.
- Evacuate all non-essential personnel from the immediate vicinity of the spill.
- If the spilled material is flammable, turn off all ignition and heat sources.
- Avoid breathing vapors of the spilled material; if necessary use a respirator.
- Maintain or establish exhaust ventilation with hoods if it is safe to do so, or open windows.
- Secure supplies to effect the cleanup.
- During clean up, wear gloves and protective clothing as needed to prevent contamination.
- Dispose of collected material in accordance with proper waste disposal procedures (see Section IV and contact 4-4089)

Mercury Spills. Mercury must be used and handled with care because it is a subtle toxin with cumulative effects not easily reversed. Metallic mercury can be absorbed into the body by inhalation, ingestion, or skin contact. Mercury must only be used in well-ventilated areas and with containers that could catch any spill. The following procedures should help assure a safe environment if a spill occurs.

- Notify people in the area of the spill, mark that area with chalk, and restrict traffic that could track the mercury to other locations.
- Wear plastic disposable gloves.
- Small pools and globules of mercury should be pushed together and picked up with an appropriate suction device or cellophane tape. An alternative is to amalgamate the mercury with zinc dust and carefully sweep up the amalgam with a plastic dust pan. Droplets in floor crevices can be converted to mercuric sulfide by dusting with sulfur.
- Place any recovered but dirty mercury into a small tightly sealed heavy-walled polyethylene bottle and take it to the Chemical Storeroom (BOO7) for commercial recycling.
- Rags, gloves, shoe covers, and other clean up materials should be sealed in a plastic bag for pick up by the personnel from EHS.

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

- Contact EHS to have the area checked.

Leaking cylinders Small leaking cylinders of toxic and/or corrosive gas should be placed in a laboratory hood and allowed to vent into an appropriate chemical neutralizer. Contact EHS for assistance.

II. Standard Operating Procedures for Chemicals

A. Procurement

- Plan experiments carefully and obtain data concerning possible hazardous properties and special handling requirements of the required chemicals (See Section V, Sources of Information).

- Estimate the amounts of each chemical needed and purchase the smallest possible lot. Keep in mind that the eventual cost of hazardous waste disposal often far exceeds the purchase price for the chemical.

- Purchase only those chemicals for which your laboratory facility has adequate ventilation.

- Notify the Chemical Storeroom of any unusual handling requirements.

- Before chemicals arrive, identify a safe and appropriate storage area in the laboratory.

- When the chemicals arrive in the Chemical Storeroom (B007), personnel in that facility will check the contents of the shipping container, forward the Material Safety Data Sheet (MSDS) forms to the EHS, and notify you.

B. Transportation

- Do not accept any chemical that is not properly labeled.

- All liquids in amounts greater than or equal to 500 ml, 500 g, or 1 pt in glass containers may not be removed from the chemical storeroom (B007 Malott) unless the bottle is in a suitable safety carrier or on a cart with sides that will contain the liquid should breakage occur. (Styrofoam containers in 1- and 4-L sizes can be obtained at no cost from the chemical storeroom or for a small charge to those outside the Chemistry Department.)

- Large cylinders of gases (greater than size 4B) must always be transported by means of a cylinder cart and with the cylinder cap in place.

C. Storage and Labeling

- Storage areas should be dry, well ventilated, and have secure shelving. If shelving is adjacent to an aisle, shelves should be equipped with lips to prevent bottles from being accidentally brushed off by a person walking past.

- All containers of stored chemicals (pure compounds, mixtures, or reaction products) must be labeled carefully. Labels on research samples must contain information about the nature and/or

origin of the sample, the date, and the name of the responsible individual; if possible, include specific chemical names(s); these labels must be solidly attached and covered with clear plastic tape in order to keep them readable. Labels on all stored chemicals must be checked regularly and replaced as necessary. *Keep in mind that there is no legal way to dispose of a bottle of an unknown chemical.*

- Store incompatible chemicals separately by hazard class (e.g., flammable liquids, corrosive acids, corrosive bases, oxidizers, reducing agents) Contact EHS for assistance.

- Flammable or combustible solvents in containers greater than one liter should be stored in vented, fire resistant cabinets whenever possible. Otherwise small quantities of such solvents should be stored on or near the floor and away from exits. Use metal cans unless solvent purity demands a glass container, and store only the amount of solvent required for the specific needs of the laboratory.

- Use only Department-modified or explosion-proof freezers and refrigerators to store flammable liquids.

- Secure gas cylinders away from heat sources.

- Whenever possible, store highly reactive or corrosive liquids in a spill container.

- Indicate the date of purchase and the date of opening of any peroxide-forming chemicals. Six months after such a container is opened, it should be disposed of as a hazardous waste or tested by a method such as that listed in Appendix II and treated to remove the peroxides if the test is positive.

- Excessive quantities of chemicals should not be allowed to accumulate. Contact EHS for disposal.

D. <u>Handling Chemicals - Hazard Communication</u>

Because many chemicals have toxic properties, all chemicals should be handled with care and with special efforts to keep such substances from hands, face, clothing, and shoes.

Many substances can be absorbed through the skin or through inhalation, while others can enter the mouth or eye from contaminated hands. Many chemicals are more readily absorbed through the skin when they are dissolved in organic solvents than when they are handled as pure compounds.

In order to follow safe practices with respect to the handling of chemicals, it is essential that prior to the initiation of any experimental work every student and faculty member be aware of available information on the toxic or other hazardous properties of any chemicals that will be used. Sources of information include the MSDS (on file in EHS (4-4089) as well as other listings in Section V which are kept in the Chemistry Office (Room 2010). Laboratories are encouraged to maintain accurate inventories of all chemicals and reagents.

Scheduled Laboratory Courses. In all scheduled laboratory courses it shall be the responsibility of the instructor to see that all students in the course are aware of hazardous properties (related to either toxicity or chemical reactivity) and safe handling procedures for chemicals used in that course.

Research. Although the faculty research director has the responsibility for seeing that students under his/her direction are aware of the potential hazards of chemicals and apparatus and the safe

handling procedures for both, the individual researcher is expected to take the initiative to determine the hazardous properties of chemicals before any experimental work is started.

E Flammable and Combustible Chemical Hazards

- Unless you have specific knowledge to the contrary, all organic liquids should be treated as flammable or combustible and handled with great care.

- Flammable or combustible materials must **never** be heated with a flame or burner. Because hot plates are usually equipped with thermostats that can spark and ignite a vapor, they must not be used to heat flammable or combustible materials in an open container. Appropriate sources of heat for such materials include steam baths, electrically heated oil baths, heating mantles (electrically heated jackets around the container), and infrared lamps. If an infrared lamp is used (except for microscale experiments) it should not be placed in a vertical upward orientation because of the possibility that liquid might spill onto the glass bulb and ignite.

- Solvent vapors must never be allowed to escape into the laboratory, but should either be condensed or exhausted by means of a hood.

F. Explosive Chemical Hazards

Compounds containing functional groups listed in Appendix I may be capable of detonation. (The fact that a compound has been reported to have been prepared without incident is not adequate evidence that it is safe.) Unless specific permission of the research director is obtained, the following precautions must be followed.

- The scale of any experiment involving the compound as a reactant or product must be restricted to **two grams** or less.

- Such compounds shall only be heated with a carefully controlled water or oil bath and shall **not** be mixed or ground in the dry state.

- **All operations** involving the compound must be carried out behind a safety shield with the operator wearing a face shield and a long-sleeve laboratory coat, with protective gloves as an option. Corresponding care must be observed in the storage of such compounds as well.

- Such reactions shall never be carried out without at least one other person in the laboratory who is aware of the experiment.

- Any person using such compounds must refer to the C.R.C. "Handbook of Reactive Chemical Hazards", I. Sax, "Dangerous Properties of Industrial Materials", and the "Fire Protection Guide on Hazardous Materials" for further information (listed under the specific compound or class of compounds). These volumes are available in the Business Office (Room 2010).

For additional related information regarding specific chemical incompatibilities, potentially explosive combinations, and peroxide-forming chemicals, see Appendix IV.

G. Corrosive Chemical Hazards

Corrosive chemicals include many acids and bases capable of causing burn-like damage to tissue (skin, eyes, mucous membrane, lung).

Examples: concentrated mineral acids (e.g., hydrochloric, nitric, sulfuric, glacial acetic), various hydroxides (e.g., sodium or potassium hydroxide), phenol, bromine.

Observe the following precautions when materials such as these are handled.

- Wear eye protection and rubber gloves. A face shield, rubber apron, and rubber boots may also be appropriate if quantities of these materials to be handled are large.

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

- An eyewash and safety shower must be readily available in any areas where corrosives are handled or stored. In the event of skin or eye contact with corrosives, immediately flush the affected area with water for 10-15 min., remove affected clothing, and immediately seek medical help. (Do not use neutralizing solutions; they can cause additional harm.)

H. Reactive Chemical Hazards

Chemical substances which have the potential to react rapidly so as to release relatively large amounts of energy or dangerous by-products (e.g., a toxic gas) are termed reactives. Several groups of such substances are listed below with some simple precautions to be followed when handling them. Refer to Appendix IV, List A for information on specific chemical incompatibilities and List B for potentially explosive combinations.

- **Pyrophorics** (can undergo spontaneous combustion)

Examples: Some finely divided metals such as Raney nickel, aluminum, magnesium, zinc, white phosphorus.

Precautions: Store and use these materials in an inert atmosphere (e.g., glove bag, dry box, Schlenk apparatus)

- **Oxidizers** (can react vigorously with organic materials or reducing agents)

Examples: Perchloric, chromic, and fuming nitric acids, nitrates, nitrites, permanganates, persulfates, dichromates.

Precautions: Use minimal amounts. Store these materials away from organic compounds, reducing agents, and flammable materials

- **Peroxidizables** (react with oxygen to form potentially explosive peroxides)

Examples: diethyl ether (ethyl ether), diisopropyl ether (isopropyl ether), tetrahydrofuran, dioxane. (See Appendix IV, List C for more information.)

Precautions: A test such as that described in Appendix II should be used to check for the presence of peroxides before peroxidizables which have been stored for six months or more are handled. If bottles of liquid ethers contain visible crystalline material, **do not touch these containers**. Put up a warning sign and notify the EHS as soon as possible. Refer to Section II. C for special instructions concerning labeling and storage of peroxidizable materials.

- **Water Reactives** (react violently with water to produce a flammable or toxic gas or other hazardous condition)

Examples: lithium aluminum hydride, sodium hydride, sodium, potassium, aliphatic acid chlorides, carbides.

Precautions: Store and handle these materials away from water sources and in well-ventilated areas (to help disperse flammable or toxic gases if there is an accident). Have dry sand or a Type D fire extinguisher available for emergencies.

I. Hazards from Carcinogens. Reproductive Toxins, and Acutely Toxic Chemicals

Chemicals covered by these procedures can be found in Appendix III, List A (EPA acute hazardous wastes); Appendix V, List A (Occupational Safety and Health Administration, National Toxicology Program, and International Agency for Research on Cancer combined list of carcinogens), Appendix V, List B (Reproductive Toxins); and Appendix V, List C (Chemicals reasonably anticipated to be Carcinogens).

In accordance with recommendations of The American Chemical Society, quantities less than 10 milligrams are exempt from the following special procedures.

- Establish a designated area for the use of these materials (e.g., a hood, lab bench, or glove box)
- Use containment devices and protective equipment as recommended in the MSDS.
- Establish a procedure for the safe removal of contaminated waste.
- Develop appropriate procedures for decontamination and use them on designated areas as needed and when the work is over.
- Only personnel trained to work with these chemicals should perform the work and always within designated areas with minimum quantities.

J. Use of Hoods and Safety Shields

Any reaction in which toxic or flammable gases (vapors) are involved or which involves obnoxious materials of any kind should be done in a hood. Hoods should not be used for storage of chemicals unless the hood is designated (and clearly marked) for that purpose only. Eye protection must be worn even when hoods are used. Standing safety shields are recommended for all operations in which solvents and reagents are heated or placed under vacuum, and are required for any reaction in which there is a potential for explosion (see Part F above). Eye protection must be worn even when safety shields are used.

III. Specific Safe Laboratory Practices and Conduct

Safe Apparel

A. Clothing

Clothes worn in the laboratory should cover as much of the body area as possible. Shorts worn without a protective full-length laboratory coat are prohibited. Women who prefer dresses to slacks or long pants are encouraged to wear a long laboratory coat for additional protection. Shoes should cover the

entire foot. Sandals are prohibited. Persons with long hair or beards should recognize that these constitute a fire hazard and should be especially careful.

B. Eye Protection

Approved protective devices are required by all persons in each of the following types of rooms.

Undergraduate Laboratories. Approved monogoggles (with shielded vents) are required in the laboratories associated with CHEM 125, 184, 188, 517, 625, 627, 635, 647 and 649 except when no experimental work is in progress anywhere in the laboratory.

Wet Laboratories. Approved eye protection is required at all times except when no experimental work is in progress. Monogoggles (with shielded vents) or face shields worn over approved safety glasses with side shields are required of every person in the laboratory whenever anyone in that laboratory is participating in activities involving caustic or explosive chemicals or hot liquids or solids or other hazardous materials.

Instrument Rooms. Approved safety glasses are required except when no experimental work is in progress.

Storerooms. Approved goggles or face shields are required when handling hazardous chemicals.

Shops. Approved eye protection for the particular hazard involved is required at all times. In addition, other safety devices will be worn as required by the specific situation.

Contact lenses constitute a particular hazard because foreign substances or corrosive chemicals can be trapped between the lens and the eye. Persons wearing them are encouraged to get prescription safety glasses rather than to use plain lens safety glasses with the contact lenses (under circumstances for which approved safety glasses are designated as adequate protection.)

Approved plain lens safety glasses, goggles and face shields are stocked in Room B007. They may be checked out by faculty members, graduate students and employees. They are to be charged to research funds if available or to the Department otherwise. Goggles which meet the State law are monogoggles with shielded vents. Approved monogoggles can be purchased at most of the stores that sell textbooks.

Prescription safety glasses are ordered through Room 2010. The Department or research funds will pay for the purchase of one pair of prescription safety glasses for graduate students and classified employees but not for the medical costs. Faculty members must pay for both purchase and medical costs. Blank prescription forms may be obtained in Room 2010 to be filled out by an eye doctor.

A copy of the Kansas Statute on eye protection is available in the Office of the Business Manager (Room 2010).

C. Safety Equipment

Become familiar with the location and operation of the nearest fire extinguisher, safety shower, eye wash and fire blanket relative to any laboratory in which you are located. Know the location of power switches and circuit breakers.

Whenever a fire extinguisher is used in a regularly scheduled undergraduate laboratory, it must be reported as soon as possible to the storeroom keeper assigned to that laboratory. Whenever a fire extinguisher is used in any other laboratory it must be taken to the storekeeper in Room BOO7 at the earliest opportunity so that it can be replaced.

Conduct in the Laboratory

D. Behavior

Throwing of objects, running, pushing, practical joking, or any other horseplay will not be tolerated in any laboratory.

E. Foods and Beverages

Because of the possibility of chemicals getting into the mouth or lungs through contamination, food preparation, eating, and drinking, are prohibited in all undergraduate and research laboratories. Food and beverages are allowed in designated office areas only. Food and beverages must never be kept in refrigerators used to store chemicals, and refrigerators used to store food must be marked "For Food Only". A beaker or other piece of laboratory glassware must never be used as a drinking glass.

F. Housekeeping

Laboratory benches and other facilities should be kept clean, neat, and uncluttered at all times. Drawers and cabinets should be closed; aisles and exits should be kept free of obstructions. Spilled chemicals and broken glassware should be cleaned up carefully and without delay. The floor should be kept free of slipping hazards, such as spilled ice, stirring rods, stoppers, pencils, etc.

G Smoking

Smoking is not allowed in any university building.

H. Working Arrangements

Students are not allowed to work with potentially hazardous laboratory operations in the undergraduate laboratories unless there is a Teaching Assistant on duty in that laboratory. When graduate, postdoctoral, and advanced undergraduate students do potentially hazardous laboratory work, they should notify at least one other person who will remain within sight or sound during the working period.

Glass and Sharp Hazards

I. Broken Glass and Sharp Objects

University Regulations require that all sharp objects, such as broken glassware and hypodermic needles, be disposed of in an approved container. This container is a plastic bag inside of a cardboard box and is available in two sizes in the Chemistry Stockroom (Room BOO7). Seal the full box prior to disposal. Each lab is responsible for removing the glass disposal box to the dumpster. (See also Section IV.B.1.)

J. Frozen Stoppers and Stopcocks

All ground glass surfaces should be lubricated lightly with stopcock grease. In the event that a stopper, stopcock, or joint becomes frozen it usually can be loosened as follows: (1) Remove all liquids, dry the apparatus, and allow it to cool; (2) heat the outer joint quickly (20-30 sec.) and evenly (rotate it) in the flame of a burner; pull apart before inner joint warms. If the procedure fails, take the apparatus to the glassblower.

K. Glass Tubing

The following precautions should be taken when a glass tube, rod or thermometer is being inserted through the hole in the cork or rubber stopper: (1) be certain that the hole in the stopper is not too small; (2) glass tubes should always be fire polished; (3) lubricate the glass and stopper with glycerin (glycerol), silicone oil or stopcock grease; (4) protect your hand with a cloth towel or rag; (5) grasp the tubing near to the end being inserted; (6) twist the tube through the hole with firm, steady pressure but do not force it.

L. Inspection of Glassware

Before assembly of glassware it should be checked carefully for flaws such as cracks or chips. Apparatus clamped to a support rack should be clamped firmly but without putting strain on any glassware. Apparatus should be clamped sufficiently far above the bench that a cold bath could be used to quickly moderate a reaction that has become too vigorous. Before starting any reaction check all glass joints, stoppers, hose connections, and the alignment of stirring motors.

Apparatus and Procedure Hazards

M. Addition of Reagents

Always add reagents slowly; never "dump" them in. Be especially careful with a potentially exothermic reaction that fails to start. Further addition of reagents could result in an uncontrollable reaction. Never add any solid to a liquid that is near its boiling point.

N. Cold Traps and Cryogenic Hazards

Contact with cryogenic materials (e.g., dry ice and various liquefied gases) can cause severe burns. Even brief skin contact with liquid nitrogen (bp -195 °C) can cause tissue damage similar to thermal burns, while prolonged contact can cause blood clots that have potentially serious consequences.

- Wear goggles (or preferably a face shield) and gloves when handling dry ice, cold baths, or cryogenic liquids such as liquid nitrogen. Gloves should be loose enough to toss off quickly. A potholder may be a desirable alternative.

- Work in a well ventilated area.

- Because of the danger of asphyxiation, avoid lowering your head into a dry ice chest.

- To avoid hazards from implosions, Dewars used for cold traps or to transport liquefied gases should be taped on the outside or enclosed in a metal container.

- Liquid nitrogen should not be used to cool vessels on a vacuum line open to the atmosphere, because oxygen can condense from the atmosphere within the vessel. If the line is then closed, an extreme pressure buildup can occur when the liquid nitrogen coolant evaporates or the cold trap is removed.

- Liquid nitrogen should not be used to cool a flammable material in air because atmospheric oxygen can condense to produce an explosion hazard. Dewars used for liquid nitrogen should be clean (free from any flammable residue).

- Transfer of liquefied gases from one container to another should not be attempted the first time without supervision.

O. Gas Cylinders

Large compressed gas cylinders must always be supported by straps or chains attached to a sturdy object such as a laboratory bench or wall. Such cylinders must never be moved without the cylinder cap in place to protect the valve stem from being accidentally broken. The main cylinder valve must always be closed (and any reduction valve bled) when a cylinder is not in use. Valves should never be forced. Never bleed a cylinder empty, but leave a slight positive pressure to keep out contaminants. Oil, or grease on the high-pressure side of the regulator on an oxygen cylinder may cause an explosion. Gas regulators should only be modified or repaired by qualified shop personnel.

Large cylinders must always be transported into or out of laboratory rooms by means of a cylinder cart. (The use of a cart does not preclude the need to have the cylinder cap in place.)

P. Leaving the Laboratory

Reactions left overnight or unattended are prime sources for fires, floods, and explosions. Special care should be exercised in checking water lines, power stirrers, electric heating sources, pumps, and condensers to insure that connections are tight, equipment is secure, flow rates are appropriate, moving parts are lubricated, etc., before the equipment is left unattended.

Fill out the approved form (available in the Business Office, Room 2010) indicating information about the reaction and how you can be contacted in case a problem arises during the night. Attach the form in a prominent location near the apparatus.

Q. Oil Baths

Dow Corning 550 silicone oil is recommended in small baths (it is expensive) because it is not combustible. Other oils must be used with great caution because overheating could result in a fire. Serious burns can also result from the splattering of hot oil caused by water falling into the bath, sinking, and evaporating with explosive force. Thus special caution should be observed when one uses this kind of heating source. Temperatures must be controlled carefully and the oil must not become contaminated with water.

R. Pipeting

Liquids must never be drawn into a pipet by mouth. Always use the rubber bulbs that are available.

S. Refrigerators

Although refrigerators for storage of chemicals are equipped with externally mounted thermostats to minimize the possibility of explosions, all chemicals stored in these units should be tightly sealed. In addition, every container must be labeled with the name of the compound or source of the material being stored, the name of the experimenter, and the date. Refrigerators must be marked "**Chemical Storage Only**".

In the event that a beeping alarm sounds to indicate that the refrigeration unit has failed, all chemicals must be transferred to another refrigerator as soon as possible and with great caution. A face shield and gloves are recommended for this procedure. A spare refrigerator on wheels is available for loan from the Maintenance Shop (Room BOO5). Refrigerators should be defrosted regularly to avoid the formation of excessive amounts of ice.

T. Spraying or Splattering of Chemicals

Heated containers such as flasks or test tubes must never be pointed toward another person. Similar precautions should be taken with any apparatus such as a separatory funnel which might spill or spray a corrosive or toxic material onto another individual.

Radiation and Related Hazards

U. High Magnetic Fields

The following precautions apply especially to rooms containing high-field NMR instruments. Persons with cardiac pacemakers or metallic implants (e.g., wound clips) must not enter these areas. Within approximately 10 ft. of high-field magnetic, the field could represent a life-threatening risk for these persons.

Ferromagnetic objects (iron or steel) must not be brought within 10 ft. of these magnets. Strong attractive forces could result in the object striking the magnet and either causing damage to the instrument or injuring anyone in the way.

If one of these super-cooled magnets suddenly releases large quantities of nitrogen or helium gas (a "quench"), all persons should exit the room because of the risk of asphyxiation. Wait until the cold gases dissipate before you reenter the area.

V. Laser Radiation

Because the human retina is irreplaceable, it is especially critical to take the following appropriate precautions in laboratories where research with lasers is being done.

- Proper eye protection must be available in every laser lab and must be used any time work with lasers is being done.
- Never look directly into a laser beam under any circumstances.
- Be extremely careful about stray beam reflections which may come from objects on or off of the laser table.
- Keep all laser beams on the laser table and block them with appropriate materials.
- When the red warning light outside the laser lab is on, follow the directions listed at the door, i.e., knock at the door and wait for a response. If there is no response, do not enter the lab.

W. Radioactive Isotopes

For information pertaining to the purchase or handling of radioactive materials, contact the Radiation Safety Service at 4-4089.

IV. Hazardous Waste Management

A. Introduction and Background

Hazardous chemicals and hazardous materials must be handled and disposed of properly to protect human health, safety and the environment from harm. A vast majority of the materials and chemicals being used within the Chemistry Department laboratories present some type of hazard

(corrosivity, flammability, reactivity, and/or toxicity) and will require special procedures to be followed for their disposal. Those chemicals that require disposal as a hazardous waste must be disposed of in accordance with the University's Hazardous Chemicals and Hazardous Materials Waste Management Program as developed and administered by the KU Department of Environment, Health & Safety.

The KU EHS Dept. is responsible for collecting unwanted, spent, used, excess or surplus hazardous chemicals/materials from departments; performing materials evaluations as to potential reuse elsewhere on campus and making these chemicals available through redistribution. Materials which do not have any potential reuse are evaluated to determine if they meet the definition of a hazardous waste. If they do, then EHS packages, labels, and transports the identified wastes to the KU Hazardous Waste Accumulation Facility for temporary storage pending pickup and off-site disposal by a contracted Hazardous Waste Treatment, Storage & Disposal Facility.

In order for the University to be in compliance with all applicable federal and state regulations, every employee or student using hazardous chemicals/materials must be aware of this program and its implications, and must follow the prescribed procedures. Non-compliance with the KU Hazardous Chemical and Hazardous Materials Waste Management Program by faculty, staff, and/or students constitutes a violation of University Policy punishable by established disciplinary procedures, and could be construed as a violation of state and/or federal laws punishable by fines and/or prison. For more information please visit the EHS website at www.ehs.ku.edu.

B. Waste Disposal Basics

In order to prevent this publication from becoming unnecessarily lengthy, the University's Hazardous Chemicals and Hazardous Materials Waste Management Program is not included in its entirety within this Chemistry Department Safety Manual. A copy of the actual KU Hazardous Chemicals and Hazardous Materials Waste Management Program is available within each laboratory and through the supervising faculty. Additional copies may also be obtained from the EHS Dept or on their website www.ehs.ku.edu . The following waste disposal basics are provided:

- Each user of hazardous chemicals/materials is responsible for reviewing the University's Hazardous Chemicals and Hazardous Materials Waste Management Program and becoming familiar with its requirements.

- Each user of hazardous chemicals/materials is responsible for determining whether their chemicals/materials may be disposed as Non-Hazardous Materials, prohibited from disposal into the sanitary sewer system, or need to be collected for removal and special disposal by the KU EHS Dept.

- Follow the hazard identification procedures identified in Section 2 of the University's Hazardous Chemicals and Hazardous Materials Waste Management Program in order to determine proper disposal methods. Contact the EHS Dept. if you have questions.

- Collect all spent, used, excess or unwanted chemicals/materials into compatible containers and label (in English) each container as to specific chemical content and volume. Keep containers closed at all times, except when filling. Segregate different or incompatible chemicals into separate containers. Follow the collection procedures identified within Section 3 of the University's Hazardous Chemicals and Hazardous Materials Waste Management Program. Contact the EHS Dept. if you have questions.

- ❖ Contact EHS Dept. (864-2853 or their website) to arrange for removal and disposal of spent, used, excess or unwanted chemicals/materials. Follow the pickup & removal procedures identified within Section 4 of the University's Hazardous Chemicals and Hazardous Materials Waste Management Program.

- ❖ If you are working with biohazard materials, follow the biohazard waste management procedures identified in Section 5 of the University's Hazardous Chemicals and Hazardous Materials Waste Management Program. Contact the EHS Dept. if you have questions.

- ❖ Practice Pollution Prevention, Waste Minimization and Reduction. Chemical reuse, redistribution, source reduction, material substitution, procedure modifications, inventory management, reclamation, recycling, EHS approved waste reduction procedures are all viable techniques further detailed in Section 6 of the University's Hazardous Chemicals and Hazardous Materials Waste Management Program. Contact the EHS Dept. if you have questions or would like further pollution prevention assistance.

V. Sources of Information

The following references are among those found in the Business Managers Office, Room 2010B, and which have a substantial amount of information on safety, data on toxicity, other hazardous properties, and disposal of chemicals.

1. Material Safety Data Sheets (MSDS); contains information on synonyms, structure, physical properties, toxicity and hazards, and special handling conditions; available from a variety of sources including chemical manufacturers and suppliers; many are on file in the EHS office (140A Burt Hall, 4-4089 and their website).

2. "Prudent Practices for Handling Hazardous Chemicals in the Laboratory," Committee on Hazardous Substances in the Laboratory, NRC, National Academy Press, 1981; an excellent safety manual for the research chemist.

3. "Dangerous Properties of Industrial Materials," N. Irving Sax, Van Nostrand Reinhold Co.; a valuable reference to the hazardous properties of numerous chemicals.

4. "Fire Protection Guide on Hazardous Materials," National Fire Protection Association; contains useful information on fire, explosion, and toxic hazards of numerous chemicals as well as on hazardous reactions between chemicals.

5. "Handbook of Reactive Chemical Hazards," L. Bretherick, Chemical Rubber Co.; a comprehensive treatment of hazardous chemicals and reactions in the laboratory.

6. "Registry of Toxic Effects of Chemical Substances," National Institute for Occupational Safety and Health; current toxicity data including carcinogenicity.

7. "Guide for Safety in the Chemical Laboratory," Manufacturing Chemists Association, Van Nostrand Reinhold Co.; contains a broad spectrum of safe practices as well as information on waste disposal and hazardous properties of chemicals.

8. "The Merck Index," Merck and Co.; contains some useful information on physiological or toxic effects of chemicals.

9. "Matheson Coleman and Bell Chemical Reference Manual," Vol. 2, Matheson, Coleman, and Bell Annual Editions; useful information on the disposal of organic and inorganic compounds by class of compound.

10. "The Aldrich Catalog Handbook of Organic and Biochemicals," Aldrich Chemical Co., Annual Editions; each of several thousand organic compounds is referenced to a specific appropriate waste disposal procedure.

11. "Safety in Academic Chemistry Laboratories," American Chemical Society Committee on Safety; a pamphlet on safe laboratory practices directed at the academic community.

12. "Prudent Practices for Disposal of Chemicals from Laboratories," Committee on Hazardous Substances in the Laboratory, NRC, National Academy Press, 1983; an excellent guide to hazardous waste management for research and teaching laboratories.

13. "Sigma-Aldrich Library of Regulatory and Safety Data," Sigma-Aldrich Co., Vols. I-III; a wealth of information on hazardous properties and regulatory data for over 20,000 chemical substances.

VI. Safety Inspections

One or more members of the staff of the Department will be assigned the responsibility of making unannounced inspections during the Fall and the Spring semesters of safety and related equipment, including fire blankets, first-aid cabinets, eye washes, fire extinguishers, gas masks, refrigerators, solvent cabinets, safety signs, safety showers, and hoods. Records of these inspections will be kept by the Business Manager.

At the same time, all laboratories will be inspected for any unsafe conditions. The inspector will complete a Safety Inspection Form which will be submitted to the Business Manager who will file the original and send a copy to the faculty member(s) responsible for safety in the rooms that were inspected. The responsible faculty member(s) will be required to respond in writing within one week to the Business Manager with specific information of how and when unsafe conditions have been (will be) corrected.

VII. Training and Records

A. Undergraduate Laboratory Courses

In all undergraduate laboratories having regularly scheduled hours, students will not be allowed to begin experimental work until they have passed with a grade of 100% a written examination on "Safety Regulations for Undergraduate Laboratories Numbered Below 700." The signed and dated examination paper will be kept by the Business Manager for five years. Instructors in undergraduate laboratories shall discuss the safety rules with the students at the beginning of the semester, shall see that the corrected and signed safety examinations are forwarded to the Business Manager, shall see that Teaching Assistants are fully aware of the more extensive CHPSR of the Department of Chemistry, and shall be responsible for the enforcement of safety regulations throughout the semester.

B. Advanced Courses and Research

Instructors in advanced courses and faculty and staff directing research by undergraduate, graduate or postdoctoral students or technicians are responsible for seeing that each researcher has a copy of the CHPSR of the Department and that they understand the rules and regulations before any experimental work is undertaken. Each researcher is required to attend appropriate safety and chemical hygiene training sessions as outlined in Part C.

C. Safety and Chemical Hygiene Training

The CHSC will be responsible for running an orientation program on the CHPSR for all entering personnel each year prior to the beginning of the Fall Semester and the Summer Session. All graduate students and faculty who have not been through this program will be expected to attend. Records of attendance will be kept by the Business Manager. A short training session relevant to safety in the undergraduate laboratories will be held at the beginning of the Spring semester for any graduate teaching assistants who enter the program at that time. Additional training and refresher seminars on various specific topics associated with chemical hygiene and safety will be scheduled each semester. Attendance at these sessions is mandatory and records will be kept.

Training will include the following topics:

- Content of the Departmental CHPSR
- Standard operating procedures with regard to chemicals.
- Emergency procedures.
- Proper Use of fire extinguishers
- Methods or observations that may be used to detect the presence or release of a hazardous chemical.
- Hazardous properties of chemicals; the MSDS and other sources of information.
- Safe laboratory procedures which limit exposure to hazardous chemicals.
- Hazardous waste disposal.

Any person (faculty, unclassified staff, classified staff, research assistant, teaching assistant, or postdoctoral) who fails to attend two Chemical Hygiene or Safety Training Sessions within a twelve (12) month period, and who has not already submitted an explanation, will receive a written inquiry. The individual will have seven (7) working days in which to respond with an explanation and a signed agreement to attend the next session. **Willful disregard** of the Department's Chemical Hygiene and Safety Regulations will be dealt with by the Chair of the Department.

D. Accident Reports

See Section I. C. of these Regulations for additional details.

E. Safety Records

It will be the responsibility of the Business Manager to maintain records of accident reports, safety inspection reports and responses, student safety examinations, safety bulletins and notices, literature on safety, data on chemical hazards, and attendance records for chemical hygiene and safety meetings. These records must be kept for a minimum period of three years.

VIII. Exposure Assessment/Medical Exams

A. Exposure Assessment

- If there is any reason to believe that overexposure to a chemical has occurred or might occur, it is the responsibility of the laboratory supervisor to contact the EHS to initiate environmental monitoring.

- If the initial monitoring indicates a problem, the EHS will make recommendations for corrective actions or alternative procedures. Each laboratory supervisor is responsible for seeing that the recommended actions are followed. Additional monitoring will be done to ensure that the corrective actions are effective.

- The employee must be notified in writing (by his/her supervisor) of the outcome of any laboratory environmental monitoring in a timely manor.

B. Medical Exams

- Any employee (faculty, professional staff, classified staff, or student) who believes that he/she has been exposed to any chemical hazard should go to the emergency room of Lawrence Memorial Hospital for an examination, must fill out workman's compensation forms (available in the Business Office, Room 2010B), submit it to the same office as soon as possible, and should notify the appropriate Laboratory Supervisor and the EHS (4-4089).
- Any student (not employed) who believes that he/she has been exposed to any chemical hazard should go to the emergency room of Watkins Hospital for an examination, must fill out an accident report form and submit it to the business office (Room 2010) as soon as possible, and should notify the appropriate Laboratory Supervisor.

APPENDIX I

SELECTED FUNCTIONAL GROUPS WITH THE POTENTIAL FOR EXPLOSION

(Reprinted from Reference 4 in Section VI)

ACETYLENIC COMPOUNDS
METAL ACTYLIDES
HALOACETYLENE DERIVATIVES
D IAZIRINES
DIAZO COMPOUNDS
NITROSO COMPOUNDS
NITROALKANES, *C*-NITRO AND POLYNITROARYL COMPOUNDS
POLYNITROALKYLCOMPOUNDS
ACYL OR ALKYL NITRATES
1,2-EPOXIDES
METAL FULMINATES OR *aci*-NITRO SALTS
FLUORODINITROMETHYL COMPOUNDS
N-MET AL DERIVATIVES
NITROSO COMPOUNDS
N-NITRO COMPOUNDS
AZO COMPOUNDS
ARENEDIAZOATES
ARENEDIAZO ARYL SULPHIDES
BIS-ARENEDIAZO OXIDES
BIS-ARENEDIAZO SULPHIDES
TRIAZENES
HIGH-NITROGEN COMPOUNDS TETRAZOLES
ALKYLHYDROPEROXIDES, PEROXY ACIDS
PEROXIDES (CYCLIC, DIACYL, DIALKYL),
PEROXYESTERS OZONIDES
METAL PEROXIDES, PEROXOACID SALTS
PEROXOACIDS
AMMINECHR0MIUMPER0XO COMPLEXES
AZIDES (ACYL, HALOGEN, NON-METAL, ORGANIC)
ARENEDIAZONIUM0LATES
DIAZONIUM SULFIDES AND
DERIVATIVES, 'XANTHATES'
HYDRAZINIUM SALTS,
OXOSALTS OF NITROGENOUS BASES
HYDROXYLAMMONIUM SALTS
DIAZONIUM CARBOXYLATES or SALTS
AMMINEMET AL OXOSAL TS
HALO-ARYLMETALS
HALOGEN AZlDES
N-HALOGEN COMPOUNDS
N-HAOLIMIDES
DIFLUOROAMINO COMPOUNDS
N,N,N- TRIFLUOROALKYLAMIDINES
ALKYLPERCHLORATES
CHLORITE SALTS
HALOGEN OXIDES

HYPOHALITES
PERCHLORIC ACID
PERCIHLORYL COMPOUNDS

APPENDIX II

DETECTION AND DESTRUCTION OF PEROXIDES IN ETHER SOLVENTS

For a simple qualitative test, one adds 1 ml of the ether to be tested to a freshly prepared solution of 100 mg of sodium or potassium iodide in 1 ml of glacial acetic acid. A yellow color indicates a low concentration of peroxide in the sample; a brown color indicates a high concentration. Procedures for the destruction of these peroxides include passing the solvent (400 ml) through a column (2 cm x 30 cm) containing about 80g of basic activated alumina. Larger amounts of water insoluble ethers (such as diethyl ether) can be treated with derrous sulfate solution. One liter of ether should be shaken (separatory funnel) with a solution of 6g of $FeSO4 \cdot 7HzO$ and 6 ml of concentrated sulfuric acid in 11 ml of water. Be certain to retest the ether after treatment.