

College of Science and Engineering

Chemical Hygiene Plan

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by

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NOTE: Until further notice, forms contained in the appendix will serve as guidelines, rather than the actual form(s) to be used.

FORWARD

On January 31, 1990, the Occupational Safety and Health Administration (OSHA) promulgated a final rule for occupational exposure to hazardous chemicals in laboratories. Included in the standard, which became effective on May 1, 1990, is a requirement for all employers covered by the standard to develop and carry out the provisions of a Chemical Hygiene Plan (CHP). The standard requires that at St. Cloud State University the CHP must be developed and implemented by January 31, 1991.

Our CHP is defined as a written program which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace. Components of the CHP include standard operating procedures for safety and health, criteria for the implementation of control measures, measures to ensure proper operation of engineering controls, provisions for training and information dissemination, permitting requirements, provisions for medical consultation, designation of responsible personnel, and identification of particularly hazardous substances.

This plan is the Chemical Hygiene Plan developed for science laboratories located within our campus. This CHP is maintained and readily available to all laboratory employees at SCSU. All laboratory personnel must know and follow the procedures outlined in this plan. All operations performed in the laboratories must be planned and executed in accordance with the enclosed procedures. In addition, each employee is expected to develop safe personal chemical hygiene habits aimed at the reduction of chemical exposures to themselves and coworkers.

This document was developed to comply with paragraph (e) of the referenced OSHA 1910.1450 standard. College of Science and Engineering Chemical Hygiene Officer (CHO) will maintain the facilities and procedures employed in the laboratory compatible with current knowledge and regulations in laboratory safety. This CHP will be reviewed, evaluated, and updated at least annually and is readily available to employees, their representatives, and representative of the Assistant Secretary of Labor for OSHA.

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1.0 Standard Operating Procedures for Laboratory Chemicals

1.1 Chemical Procurement

- 1.1.1 The decision to procure a chemical is a commitment to handle and use the chemical properly from initial receipt to ultimate disposal.
- 1.1.2 Requests for procurement of new (not previously ordered) chemicals shall be submitted to the Chemical Hygiene Officer for approval. The form entitled, "New Chemical Purchasing Request," Appendix C to this plan, should be considered for this purpose. All involved personnel prior to the procurement of the chemical should know information on proper handling, storage, and disposal. Chemicals utilized in the laboratory shall be those which are appropriate for the ventilation system.
- 1.1.3 All chemicals shall be received in a central location. Personnel who receive chemical shipments should be knowledgeable of the proper procedures for receipt. Chemical containers shall NOT be accepted without accompanying labels, material safety data sheets, and packaging in accordance with all appropriate regulations. All chemical shipments should be dated when received and opened.

1.2 Chemical Storage

- 1.2.1 Received chemicals should be immediately moved to the designated storage area. Large glass containers should be placed in carrying containers or shipping containers during transportation.
- 1.2.2 The storage area shall be well-illuminated, with all storage maintained below eye level. Large bottles, greater than 10 L

(with the exception of distilled water carboys) should be stored no more than four feet from the ground.

- 1.2.3 Our goal is to segregate chemicals by hazard classification and compatibility in a well-identified area with local exhaust ventilation where necessary.
- 1.2.4 Mineral acids should be separated from flammable and combustible materials. Separation is defined by NFPA 49 as storage within the same fire area but separated by as much space as practical or by intervening storage from incompatible materials.
- 1.2.5 Acid-resistant trays should be placed under bottles of mineral acids.
- 1.2.6 Acid-sensitive materials such as cyanides and sulfides should be separated from acids or protected from contact with acids.
- 1.2.7 Highly toxic chemicals or other chemicals whose containers have been opened should be stored in unbreakable secondary containers. See Appendix K for a list.
- 1.2.8 The stockroom area should not be used as a preparation or repackaging area except where appropriate.
- 1.2.9 The storage area shall be accessible during normal working hours. The chemistry storage area is under the supervision of Mike Moore and Jeff Stobb. The biology storage area is under the supervision of Steve Thrune.
- 1.2.10 When hazardous chemicals, see Appendix K, are taken from the main storage area, they should be placed in an outside container or bucket.
- 1.2.11 Storage of chemicals at the lab bench or other work areas should be limited to those amounts necessary for one operation or laboratory session. The container size should be the minimum convenient. The amounts of chemicals at the lab bench should be as small as practical. Chemicals in the workplace should not be exposed to sunlight or heat.

1.2.12 Stored chemicals should be examined at least annually by the Chemical Hygiene Officer, or designee, for replacement, deterioration, and container integrity. The inspection should determine whether any corrosion, deterioration, or damage has occurred to the storage facility as a result of leaking chemicals.

1.2.13 Periodic inventories of chemicals as directed outside the storage area should be conducted by the Chemical Hygiene Officer, or designee. Unneeded items should be properly discarded or returned to the storage area.

1.3 Chemical Handling

Each laboratory employee with the training, education and resources provided by supervision, shall develop and implement work habits consistent with this CHP to minimize personal and coworker exposure to the chemicals in the laboratory. Based on the realization that all chemicals inherently present hazards in certain conditions, exposure to all chemicals should be minimized. General precautions which shall be followed for the handling and use of all chemicals are:

- 1.3.1 Skin contact with all non-household chemicals should be avoided.
- 1.3.2 All employees should wash all areas of exposed skin prior to leaving the laboratory.
- 1.3.3 Mouth suction pipeting or starting a siphon is prohibited.
- 1.3.4 Eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present shall be avoided. Hands shall be thoroughly washed prior to performing these activities.
- 1.3.5 Storage, handling and consumption of food or beverages shall not occur in chemical storage areas, refrigerators, glassware, or utensils also used for laboratory operations.
- 1.3.6 Risk determination shall be conservative in nature.
- 1.3.7 Any chemical mixture shall be assumed to be as toxic as its most toxic component.
- 1.3.8 Substances of unknown toxicity should be assumed to be toxic.

- 1.3.9 Laboratory employees should be familiar with the symptoms of exposure for the chemicals with which they work and the precautions necessary to prevent exposure.
- 1.3.10 The intent and procedures of this Chemical Hygiene Plan shall be continuously adhered to.
- 1.3.11 In all cases of chemical exposure, neither the Permissible Exposure Limits (PELs) of OSHA or the Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH) shall be exceeded. For more information on the PELs, please visit the OSHA website at <http://www.osha.gov/SLTC/pel/index.html>. For more information on TLVs, please visit the ACGIH website at <http://www.acgih.org>.
- 1.3.12 The engineering controls and safety equipment in the laboratory should be utilized and inspected in accordance with Appendix A of this plan.
- 1.3.13 Specific precautions based on the toxicological characteristics, see Appendix K, of individual chemicals should be implemented as deemed necessary by the Chemical Hygiene Officer (see 7.2). These special precautions are listed in section 8.0

1.4 Laboratory Equipment and Glassware

Each employee should keep the work area clean and uncluttered. All chemicals and equipment should be properly labeled in accordance with Section 1.7. At the completion of each workday or operation, the work area should be thoroughly cleaned and all equipment properly cleaned and stored.

In addition, the following procedures should apply to the use of laboratory equipment.

- 1.4.1 All laboratory equipment should be considered only for its intended purpose.
- 1.4.2 All glassware will be handled and stored with care to minimize breakage; all broken glassware will be disposed of in the broken glass container.

- 1.4.3 All evacuated glass apparatus should be shielded to contain chemicals and glass fragments should implosion occur.
 - 1.4.4 Labels must be attached to all chemical containers, identifying the contents and related hazards.
 - 1.4.5 All waste containers must be identified as “hazardous waste” or “non-hazardous waste” (place labels on containers).
 - 1.4.6 All laboratory safety equipment should be inspected on a periodic basis, as specified in Appendix A and repaired as necessary.
- 1.5 Personal Protective Equipment
- 1.5.1 Safety glasses meeting ANSI Z87.1 are required for employees and visitors to the laboratory and will be worn at appropriate times when in the laboratory. Contact lenses are discouraged in the laboratory.
 - 1.5.2 Chemical goggles must be worn during chemical transfer and handling operations as procedures dictate. If extra protection is needed, a full-face shield should be added.
 - 1.5.3 Sandals, perforated shoes and bare feet are prohibited in chemical laboratories. Safety shoes, per ANSI 47 are required where employees routinely lift heavy objects.
 - 1.5.4 Lab coats are encouraged to be worn in the laboratory.
 - 1.5.5 Appropriate chemical-resistant gloves based on the table in Appendix B should be worn at appropriate times when there may be skin contact with chemicals. Used gloves should be inspected and washed prior to re-use. Damaged or deteriorated gloves will be immediately replaced. Gloves should be washed prior to removal from the hands.
 - 1.5.6 Thermal-resistant gloves should be worn for all operations involving the handling of heated materials and exothermic reaction vessels. Thermal-resistant gloves shall be non-asbestos and should be replaced when damaged or deteriorated.

1.5.7 Respirator use should comply with the OSHA Respiratory Protection Standard, 29 CFR 1910.134, and the SCSU Respiratory Program (See Safety Administrator).

1.6 Personal Work Practices

1.6.1. Laboratory supervision must ensure that each employee knows and follows the rules and procedures established in this plan.

1.6.2. All employees should remain vigilant to unsafe practices and conditions in the laboratory and must immediately report such practices and/or conditions to the laboratory supervisor. The supervisor must correct unsafe practices and or conditions promptly.

1.6.3. Long hair and loose-fitting clothing should be confined close to the body to avoid being caught in moving machine/equipment parts.

1.6.4. Use only those chemicals appropriate for the ventilation system.

1.6.5. Avoid unnecessary exposure to all chemicals by any route.

1.6.6. Do not smell or taste any chemicals.

1.6.7. Encourage safe work practices in coworkers by setting the proper example. Horseplay is strictly forbidden.

1.6.8. Seek information and advice from knowledgeable persons, standards, and codes about the hazards present in the laboratory. Plan operations, equipment, and protective measures accordingly.

1.6.9. Use engineering controls in accordance with Section 3.0.

1.6.10 Inspect personal protective equipment prior to use, and wear appropriate protective equipment as procedures dictate and when necessary to avoid exposure.

1.7 Labeling

1.7.1 All containers in the laboratory must be labeled. This includes chemical containers and waste containers. The label shall be informative and durable, and at a minimum will

identify contents and indication of hazard. Source, date of acquisition, storage location should also be included.

- 1.7.2 Portable containers should be labeled by the individual using the container.
- 1.7.3 Exemptions for labeling requirements should be made for chemical transfers from a labeled container into a container which is only for the immediate use of the employee who performed the transfer.
- 1.7.4 The labeling program will be periodically inspected under the direction of the Chemical Hygiene Officer. The form entitled, "Chemical Hazard Audit Checklist," Appendix D to this plan should be considered for this purpose.

2.0 Criteria for Implementation of Control Measures

2.1 Air Sampling

- 2.1.1 Air sampling for evaluating employee exposure to chemical substances should be conducted periodically or as specified by specific codes or regulations.
- 2.1.2 Upon addition of new chemicals or changes in control procedures, additional air sampling will be considered to determine the exposures. Conduct air sampling if there is reason to believe that exposure levels for regulated substances that require sampling routinely exceed the action level, or the PEL. Air sampling should be implemented when usage of highly toxic substances exceeds three times per week.
- 2.1.3 The results of air sampling studies performed in the laboratory are maintained and recorded similar to the form shown in Appendix E of this plan.

2.2 Housekeeping

- 2.2.1 Each laboratory employee is directly responsible for the cleanliness of his or her workspace, and jointly responsible for common areas of the laboratory. Laboratory management shall insist on the maintenance of housekeeping standards.

2.2.2 The following procedures apply to the housekeeping standards of the laboratory.

- 2.2.2.1 All spills on lab benches or floors must be immediately cleaned and properly disposed of. Non-routine spills, a spill which occurs outside the scope of the normal course of assigned work, will necessitate the implementation of the Emergency Action Plan per OSHA 1910.38 and 1910.120.
- 2.2.2.2 The lab benches should be kept clear of equipment and chemicals except those necessary for the work currently being performed.
- 2.2.2.3 The work area should be cleaned at the end of each operation and each shift.
- 2.2.2.4 All apparatus should be thoroughly cleaned and returned to storage upon completion of usage.
- 2.2.2.5 All floors, aisles, exits, stock room emergency door, fire extinguishing equipment, eyewashes, showers, electrical disconnects, and other emergency equipment must remain unobstructed.
- 2.2.2.6 All labels should face front.
- 2.2.2.7 Chemical containers should be clean, properly labeled, and returned to storage upon completion of usage.
- 2.2.2.8 All chemical waste will be disposed of in accordance with the waste disposal plan.

2.3 Safety and Emergency Equipment

- 2.3.1 Telephone numbers of emergency personnel, supervisors and other workers as deemed appropriate should be posted.
- 2.3.2 All laboratory personnel, including instructors, student workers, graduate students, and research assistants, should be trained in the proper use of fire extinguishers when hired and biannually thereafter. Set up fire extinguisher training with Bud Boeder, 320-293-6811. Prior to the procurement of new (not previously ordered) chemicals, the Chemical

Hygiene Officer should verify (as directed) that existing extinguishers and other emergency equipment are appropriate for such chemicals.

2.3.3 All employees who might be exposed to chemical splashes should be instructed as to the location and proper usage of emergency showers and eyewashes. The eyewash and emergency shower should be inspected monthly. These inspections shall be performed as directed by the Chemical Hygiene Officer. These inspections should be in accordance with ANSI Z358.1 and manufacturer's specifications. Records shall be maintained.

2.3.4 Location signs for safety and emergency equipment should be posted.

3.0 Engineering Controls

3.1 Intent

The engineering controls installed in the laboratory are intended to minimize employee exposure to chemical and physical hazards in the workplace. These controls must be maintained in proper working order for this goal to be realized.

3.2 Modification

No modification of engineering controls will occur unless testing indicates that worker protection will continue to be adequate.

3.3 Improper Functions

Improper function of engineering controls must be reported to the Chemical Hygiene Officer immediately. The system must be taken out of service until proper repairs have been executed.

3.4 Usage

All employees must follow proper work practices when using the engineering controls.

3.4.1 Local Exhaust Ventilation

3.4.1.1 Openings of hoods should be placed as close as possible to sources of the air contaminant.

- 3.4.1.2 Clean the window on the face of the hood prior to usage.
- 3.4.1.3 Hood fans must operate when hoods are being used.
- 3.4.1.4 After using hoods, operate the fan for an additional period of time sufficient to clear residual contaminants from the ductwork.
- 3.4.1.5 The ventilation system should be inspected periodically. The duct velocity should be maintained per manufacturer's recommended specifications. A record of each inspection should be maintained and available to the Chemical Hygiene Officer.

3.4.2 Laboratory Hoods

The laboratory hoods must be utilized for all chemical procedures which might result in release of hazardous chemical vapors or dust. As a general rule, the hood should be considered for all chemical procedures involving substances which are appreciably volatile and have a permissible exposure limit (PEL) less than 50 ppm. The following work practice should apply to the use of hoods:

- 3.4.2.1. Confirm adequate hood ventilation performance prior to opening chemical containers inside the hood. An inward flow of air can be confirmed by holding a piece of paper at the face of the hood and observing the movement of the paper.
- 3.4.2.2. Keep the sash of the hood closed at all times except when adjustments within the hood are being made. At these times, maintain the sash height as low as possible.
- 3.4.2.3. Storage of chemicals and equipment inside the hood must be kept to a minimum as per 1.2.11.
- 3.4.2.4. Minimize interference with the inward flow of air into the hood.
- 3.4.2.5. Leave the hood operating when it is not in active use if hazardous chemicals are contained inside the hood.

- 3.4.2.6. The hood tail velocity should be inspected periodically. The hood face velocity should be maintained between 75 and 125 feet per minute. A record of each inspection should be maintained under the direction of the Chemical Hygiene Officer.
- 3.4.2.7. The hood should not be used as a means of disposal for volatile chemicals.

3.4.3 Glove Boxes and Isolation Rooms

Consideration should be given for exhaust air from a glove box isolation room to pass through scrubbers or other treatment before release into the regular exhaust system.

3.4.4 Storage Cabinets

Storage cabinets for flammable and hazardous chemicals should be ventilated as needed.

- 3.4.4.1 No more than three flammable cabinets may be placed in a row in any one location.
- 3.4.4.2 No storage is allowed on top of the flammable cabinets.

4.0 Employee Information and Training

4.1 Hazard Information

All employees will be apprised of the hazards presented by the chemicals in use in the laboratory. Each employee should receive training at the time of initial assignment to the laboratory, prior to assignments involving new exposure situations.

4.2 Forms

The forms in Appendices F-H entitled "New Employee Chemical Hygiene Training and Training Checklist," and "New Chemical Training Checklist" should be considered for these purposes.

4.3 Training

This training must include methods of detecting the presence of hazardous chemicals, physical and health hazards to the chemicals in the laboratory, and measures employees can take to protect themselves from these hazards. The training shall present the details of the Chemical Hygiene Plan and should include:

- 4.3.1 The contents of the OSHA laboratory standard and its appendices, see Appendix L;
- 4.3.2 The location and availability of the Chemical Hygiene Plan;
- 4.3.3 The permissible exposure limits for OSHA regulated substances or recommended exposure values for other hazardous chemicals not regulated by OSHA which are present in the laboratory.
- 4.3.4 Signs and symptoms associated with exposure to the chemicals present in the laboratory, refer to the Departmental Material Safety Data Sheet.
- 4.3.5 Location and availability of reference material on chemical hygiene;
- 4.3.6 Training should be conducted by SCSU's Chemical Hygiene Officer. A copy of the training outline is included in the SCSU CHP compliance manual. For questions see Safety Administrator.

5.0 Prior Approval of Laboratory Activities

5.1 Permit System

A permit system should be considered for laboratory activities which present specific, foreseeable hazards to the employees. These activities include off-hours work, sole occupancy of building, hazardous operations and unattended operations. The permit entitled "Chemical Hygiene Permit," is included in Appendix 1 to this plan and should be evaluated as a guide prior to the performance of these activities.

5.1.1 Off-Hours Work Procedures

Laboratory personnel are not normally permitted to work after hours in the lab, except when permitted by special arrangements.

5.1.2 Sole Occupancy

At no time should work be performed in the laboratory when the only person in the building is the laboratory person performing the work. Under unusual conditions, crosschecks, periodic security guard checks, closed circuit television, or other measures may be taken when permitted.

5.1.3 Hazardous Work

All hazardous operations are to be performed during a time when at least two personnel are present in the laboratory. At no time should a laboratory person, while working alone in the laboratory, perform work which is considered hazardous. The determination of hazardous operations shall be made by the laboratory supervisor as permitted.

5.1.4 Unattended Operations

When laboratory operations are performed which will be unattended by laboratory personnel (continuous operations, overnight reactions, etc.), the following procedures will be employed:

- 5.1.4.1 The permit system should be utilized as a guideline.
- 5.1.4.2 The laboratory supervisor will review work procedures to ensure for the safe completion of the operation.
- 5.1.4.3 An appropriate sign will be posted at entrances to the laboratory.
- 5.1.4.4 Precautions should be made for the interruption of utility services during the unattended operation (loss of water pressure, electricity, etc.).
- 5.1.4.5 The person responsible for the operation will return to the laboratory at the conclusion of the operation to assist in the dismantling of the apparatus.

6.0 Medical Consultations and Examinations

- 6.1 An opportunity to receive medical attention is available to all employees who work with hazardous chemicals in the laboratory. The opportunity for medical attention will be made available to employees under the following circumstances:

- 6.1.1 Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory,
 - 6.1.2 Medical surveillance programs should be established where exposure monitoring reveals an exposure level above the action level for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, and/or,
 - 6.1.3 Whenever an event takes place in the laboratory such as a spill, leak, explosion, or other occurrence resulting in the likelihood of hazardous exposure, the employee is provided an opportunity for medical consultation for the purpose of determining the need for medical examination.
- 6.2 These medical consultations and examinations should be provided without cost to the employees, without loss of pay and at a reasonable time and place.
 - 6.3 These medical consultations and examinations should be administered by or under the direct supervision of a licensed physician. A current list of available physicians is often maintained by Human Resources. Employees seeking the opportunity of medical consultation should request the list from Human Resources. (Midwest Occupational Medicine, St. Cloud).

7.0 Chemical Hygiene Responsibilities

- 7.1 Dean for the College of Science and Engineering (COSE), has the ultimate responsibility for chemical hygiene throughout each COSE science laboratory, and with assistance of other program administrators, will provide continuous support for chemical hygiene.

Chemistry, Biology, Physics, Environmental and Technological Studies, Aviation, Mechanical and Manufacturing Engineering and Earth & Atmospheric Sciences departmental chair personnel are responsible for the chemical hygiene/safety within their respective departments.

Faculty members are, in turn, responsible for day-to-day laboratory safety in their respective laboratories and research areas.

- 7.2 Chemical Hygiene Officer

The Chemical Hygiene Officer Shall:

- 7.2.1 Work with administration and other employees to develop and implement appropriate chemical hygiene policies and practices.
- 7.2.2 Monitor procurement and use of chemicals in the lab, including determining that facilities and training levels are adequate for the chemicals in use.
- 7.2.3 Perform regular, formal chemical hygiene and housekeeping inspections, in conjunction with the SCSU Safety Administrator, including inspection of emergency equipment.
- 7.2.4 Help department technicians develop precautions and adequate facilities.
- 7.2.5 Maintain current knowledge, in conjunction with the SCSU Safety Administrator, concerning the legal requirements of regulated substances in the laboratory.
- 7.2.6 Review and improve the Chemical Hygiene Plan on an annual basis.
- 7.2.7 Maintain overall responsibility for the laboratory operation.
- 7.2.8 Ensure that workers know and follow the chemical hygiene rules.
- 7.2.9 Determine the proper level of personal protective equipment, ensure that such protective equipment is available and in working order.
- 7.2.10 Ensure that appropriate training has been provided to employees.
- 7.2.11 Monitor the waste disposal program.

7.3 Laboratory Workers

The laboratory workers/students are individually responsible for:

- 7.3.1 Planning and conducting each laboratory operation in accordance with the Chemical Hygiene plan.
- 7.3.2 Developing good personal chemical hygiene habits.

7.3.3 Dispose of chemicals within 180 days.

8.0 Special Precautions

When laboratory procedures change to require the use of additional classifications of chemicals (allergens, embryotoxins, teratogens, carcinogens, etc.), additional special precautions should be implemented as deemed necessary by the Chemical Hygiene Officer. It is the responsibility of those working with a chemical to determine if it falls into one or more of these classifications. Please check the chemical's MSDS sheet for this information. MSDS sheets can be found at <http://www.msds.com>. The permit system should be utilized as a guide for all special activities. All questions regarding the use of the permit system should be addressed to the Chemical Hygiene Officer.

8.1 Working with Allergens and Embryotoxins (Special Precautions)

Examples of allergens are diazomethane, isocyanates, and bichromates. Examples of embryotoxins are organomercurials, lead compounds, and formamide.

- 8.1.1 Suitable gloves to prevent hand contact must be worn when exposed to allergens or substances of unknown allergen activity.
- 8.1.2 Women of child-bearing age will handle embryotoxins only in a hood with confirmed satisfactory performance and will use protective equipment to prevent skin contact as prescribed by the supervisor and Chemical Hygiene Officer.
- 8.1.3 Embryotoxins will be stored in adequately ventilated areas in unbreakable secondary containers.
- 8.1.4 The supervisor and Chemical Hygiene Officer will be notified of spills and other exposure incidents based upon the toxicity of the material. A physician will be consulted when appropriate.

8.2 Working with Chemicals of Moderate Chronic to High Acute Toxicity (Special Precautions).

Examples of these are diisopropylfluorophosphate, hydrofluoric acid, and hydrogen cyanide.

- 8.2.1 Areas where these chemicals are stored and used are of restricted access and special warning signs have been considered.
 - 8.2.2 A special hood with a minimum face velocity of 100 linear feet per minute or other containment device will be used. Released vapors should not discharge with the hood exhaust, but rather should be trapped.
 - 8.2.3 Gloves and long sleeves should be used. Hands and arms must be washed immediately after working with these chemicals.
 - 8.2.4 Two people should always be present during the work with these chemicals.
- 8.3 Working with Chemicals of High Chronic Toxicity (Special Precautions)

Examples of these are dimethylmercury and nickel carbonyl, benzo-a-pyrene, N-nitrosodiethylamine, and other human carcinogens or substances with high carcinogenic potency in animals.

- 8.3.1 All transfer and work with these substances should be in a designated area; a restricted access hood, glove box or portion of lab.
- 8.3.2 Approval of the supervisor will be obtained before use.
- 8.3.3 Vacuum pumps should have scrubbers or high efficiency particulate absolute (HEPA) filters.
- 8.3.4 Any contaminated equipment or glassware should be decontaminated in the hood before removing them from the designated area.
- 8.3.5 For powders, a wet mop or vacuum with a HEPA filter will be used for cleanup.
- 8.3.6 The designated area will be marked with warning and restricted access signs.
- 8.3.7 Containers should be stored in a ventilated, limited access area in labeled, unbreakable, chemically resistant, secondary containers.

8.4 Working with Animals and Chemicals of High Chronic Toxicity (Special Precautions)

- 8.4.1 For large-scale studies, special facilities with restricted access will be provided.
- 8.4.2 The substance should be administered by injection when possible rather than by diet. When diet is used, a caging system under negative pressure or under laminar airflow directed toward HEPA filters should be used. Monitored by the Institutional Animal Care Committee.
- 8.4.3 Procedures will be used to minimize contaminated aerosol from food, urine and feces; HEPA filtered vacuum equipment for cleaning. Moisten contaminated bedding before removal from cage.

Mix diets in closed containers in hood. Monitored by the Institutional Animal Care Committee.

- 8.4.4 Plastic or rubber gloves and fully buttoned lab coats will be worn in the animal room.

9.0 Chemical Spills, Releases and Accidents

In the event of a chemical spill, release or other accident, SCSU personnel should adhere to the procedure outlined in the Emergency Response Plan as required by OSHA standard 29 CFR 1910.38 and 1910.20.

All science instructors should be familiar with the Emergency Action Plan, as found in the Compliance Section of Emergency Action Plan. This plan contains emergency telephone numbers and spill response contacts for SCSU.

- 9.1 When Chemical spills occur within the laboratory, the following procedures are to be followed by the supervisor of the area to prevent injury or property loss:
 - 9.1.1 Provide any first aid (if necessary) to affected personnel. Liberally use eyewash station and/or safety shower to flush affected areas. The ACS Safety Committee recommends that flushing continue for AT LEAST 15 minutes. A highly toxic, large exposure or large dose to the body may merit ambulatory service.

- 9.1.2 Notify superior of spill if spill is large. If spill is large or extremely hazardous, the Chemical Hygiene Officer and Safety Administrator and perhaps the St. Cloud Fire Department Hazmat Team and Minnesota Duty Officer (1-800-422-0798) will be notified. First aid personnel may require notification.
 - 9.1.3 Evacuate students from the area.
 - 9.1.4 If spilled materials exhibit flammability, eliminate ignition sources, such as hot plates, Bunsen burners, etc.
 - 9.1.5 Avoid all skin contact with spilled material. If necessary, don protective gloves, gown, goggles, and/or respirator.
 - 9.1.6 Obtain supplies from Chemical Spill Clean-up Kit.
 - 9.1.7 Neutralize collected materials and label container with name of contents and also "Hazardous Waste."
 - 9.1.8 Always refer to MSDS for special precautions or spill cleanup requirements.
- 9.2 Liquid Spills
- 9.2.1 Confine spill to small area as practical.
 - 9.2.2 For small quantities of acids or bases, use the neutralizing agent from the chemical spill cleanup kit. An absorbent material specially prepared for acid/base spills may also be used.
 - 9.2.3 For small quantities of other materials, such as organic solvents, utilize an absorbent material to clean up spill. Examples of absorbent materials are vermiculite, dry sand, paper towels, etc.
 - 9.2.4 For large quantities of inorganic acids and bases, flush with large amounts of water, preferably toward a containment area of drain.* CAUTION must be taken not to add too much water to create a flood which may react with water-reactive materials and cause spattering and additional personnel exposure.

- 9.2.5 If possible, utilize a mop to pick up as much of the spilled material. An excellent clean-up device is the mop bucket and wringer to collect the liquid.
 - 9.2.6 Carefully pick up and decontaminate bottles, broken glass, and/or other containers. Decontaminate over the bucket or pail to collect contaminated wash.
 - 9.2.7 Avoid using any shop vacuum which is not rated for chemical clean-up. A potential exists for atomizing hazardous wastes and creating a potential human inhalation exposure.
 - 9.2.8 If the spill is extremely volatile (high vapor pressure), consider allowing the spill to evaporate and exhaust out the laboratory exhaust (e.g. fume hood).
 - 9.2.9 Properly containerize, label, store and/or dispose of collected hazardous waste. (See waste disposal section for methods)
- 9.3 Solid Spills
- 9.3.1 If possible, sweep solid spills of low toxicity into a designated, easily decontaminated, dust pan and place in a labeled container for storage and/or disposal.
- 9.4 Additional Spills
- 9.4.1 Mercury—Clean-up with spill clean-up kit. Collect Hg in a sealed container to prevent exposure to Hg vapors. For large spills or spills that render some Hg unavailable for clean-up (e.g. Hg in floor cracks or beneath lab benches), an airborne evaluation of Hg vapor content may be required. Refer back to 9.2.6. Notify Minnesota Duty Officer (1-800-422-0798)
- 9.5 Compressed Gas Cylinders
- 9.5.1 Several small cylinders of compressed gas are located in the chemical storage area. Although these do not pose a hazard from a toxicity standpoint, they should be properly stored to prevent physical damage.
- 9.6 Incident Report

- 9.6.1 An incident investigation should take place after each spill of an extremely hazardous chemical and/or accident. The incident report (form provided as a guideline) should be completed by the Supervisor/Instructor and forwarded to the Chemical Hygiene Officer, and SCSU Safety Committee.

10.0 Annual Chemical Hygiene Plan Audit

The Chemical Hygiene Officer should conduct an audit of all phases of the Chemical Hygiene Plan each year. Results should be provided to the ranking official and the laboratory manager. Supervisors are responsible for taking corrective action. Appendix J will be used as a guide for the audit.

- 11.0 References and Recommended Reading (Some available in COSE conference room, some in Chemistry stockroom).

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

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

Freeman, N.T., Introduction to Safety in the Chemical Laboratory, Academy Press, 1982.

Manufacturing Chemists' Association, Inc., Guide for Safety in the Chemical Laboratory, D. Van Norstrand Company, Inc., 1954.

Green, Michael E., Safety in Working with Chemicals, MacMillan Publishing Co., Inc., 1984.

Pipitone, David A., Safe Storage of Laboratory Chemicals, Wiley & Sons, Inc., 1984.

Code of Federal Regulations, 29 CFR, part 1910, subpart z, section 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories, 1990.

In the Dean's Conference Room:

Laboratory Safety and Health, The American Chemical Society, Washington, DC, 1999.

Young, Jay A., Developing a Chemical Hygiene Plan, American Chemical Society, Washington, DC, 1990.

NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals, National Fire Protection Association, 1996.

Safety in Academic Chemistry Laboratories, American Chemical Society, Washington, DC, 1995.

Chemical Risk: A Primer, Department of Government Relations and Science Policy, American Chemical Society, Washington, DC, 1996.

Chemical Risk: Personal Decisions, Department of Government Relations and Science Policy, American Chemical Society, Washington, DC, 1989.

Hazardous Waste Management, Department of Government Relations and Science Policy, American Chemical Society, Washington, DC, 1992.

Prudent Practices in the Workplace, National Research Council, Washington, DC, 1995.

APPENDIX L
OCCUPATIONAL SAFETY AND HEALTH STANDARDS
SUBPART: Z; TOXIC AND HAZARDOUS SUBSTANCES
1910.1450; OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN
LABORATORIES

A. Scope and application.

1. This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.
2. Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:
 - i. For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.
 - ii. Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.
 - iii. Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.
3. This section shall not apply to:
 - i. Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.
 - ii. Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:
 - a. Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and
 - b. Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

B. Definitions --

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

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (*see select carcinogen*).

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

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

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

Compressed gas means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg. C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

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

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

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

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

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

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

(ii) **Gas, flammable** means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

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

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

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

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

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

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

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

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

- (i) Chemical manipulations are carried out on a "laboratory scale;"
- (ii) Multiple chemical procedures or chemicals are used;
- (iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and
- (iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

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

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

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

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

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

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

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

- (i) It is regulated by OSHA as a carcinogen; or
- (ii) It is listed under the category, "known to be carcinogens," in the Annual Report on

Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

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

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

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

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

C. Permissible exposure limits.

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

D. Employee exposure determination --

1. **Initial monitoring.** The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).
2. **Periodic monitoring.** If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.
3. **Termination of monitoring.** Monitoring may be terminated in accordance with the relevant standard.
4. **Employee notification of monitoring results.** The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

E. Chemical hygiene plan -- General.

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

1. Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:
 - i. Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and
 - ii. Capable of keeping exposures below the limits specified in paragraph (c) of this section.
2. The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.
3. The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;
 - i. Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;
 - ii. Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;
 - iii. A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;
 - iv. Provisions for employee information and training as prescribed in paragraph (f) of this section;
 - v. The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;
 - vi. Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;
 - vii. Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and
 - viii. Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:
 - a. Establishment of a designated area;
 - b. Use of containment devices such as fume hoods or glove boxes;

- c. Procedures for safe removal of contaminated waste; and
 - d. Decontamination procedures.
- 3. The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

F. Employee information and training.

- 1. The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.
- 2. Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.
- 3. ***Information.*** Employees shall be informed of:
 - i. The contents of this standard and its appendices which shall be made available to employees;
 - ii. The location and availability of the employer's Chemical Hygiene Plan;
 - iii. The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;
 - iv. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and
 - v. The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.
- 4. Training.
 - i. Employee training shall include:
 - a. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);
 - b. The physical and health hazards of chemicals in the work area; and
 - c. The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work

practices, emergency procedures, and personal protective equipment to be used.

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

G. Medical consultation and medical examinations.

1. The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:
 - i. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.
 - ii. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
 - iii. Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.
2. All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.
3. ***Information provided to the physician.*** The employer shall provide the following information to the physician:
 - i. The identity of the hazardous chemical(s) to which the employee may have been exposed;
 - ii. A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and
 - iii. A description of the signs and symptoms of exposure that the employee is experiencing, if any.
4. ***Physician's written opinion.***
 - i. For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:
 - a. Any recommendation for further medical follow-up;

- b. The results of the medical examination and any associated tests;
 - c. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and
 - d. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
- ii. The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

H. Hazard identification.

- 1. With respect to labels and material safety data sheets:
 - i. Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
 - ii. Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.
- 2. The following provisions shall apply to chemical substances developed in the laboratory:
 - i. If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.
 - ii. If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.
 - iii. If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

I. Use of respirators.

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

J. Recordkeeping.

1. The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.
2. The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

K. [Reserved]

L. Appendices.

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

[55 FR 3327, Jan. 31, 1990; 55 FR 7967, March, 6, 1990; 55 FR 12777, March 30, 1990; 61 FR 5507, Feb. 13, 1996; 71 FR 16674, April 3, 2006]

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Foreword

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

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

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

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

Corresponding Sections of the Standard and this Appendix

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

Paragraph and topic in laboratory standard	Relevant appendix section
(e)(3)(i) Standard operating procedures for handling toxic chemicals.	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposures.	D
(e)(3)(iii) Fume hood performance	C4b
(e)(3)(iv) Employee information and training (including emergency procedures).	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities.	E2b, E4b

(e)(3)(vi) Medical consultation and medical examinations.	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities.	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances.	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A-D. Those recommendations of primary concern to employees who are actually handling laboratory chemicals are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

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

1. It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2, 10). Skin contact with chemicals should be avoided as a cardinal rule (198).
2. Avoid underestimation of risk. Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).
3. Provide adequate ventilation. The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).
4. Institute a chemical hygiene program. A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6, 11). Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers (13).
5. Observe the PELs, TLVs. The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

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

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

2. Supervisor of the department or other administrative unit, who is responsible for chemical hygiene in that unit (7).
3. chemical hygiene officer(s), whose appointment is essential (7) and who must:
 - (a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);
 - (b) Monitor procurement, use, and disposal of chemicals used in the lab (8);
 - (c) See that appropriate audits are maintained (8);
 - (d) Help project directors develop precautions and adequate facilities (10);
 - (e) Know the current legal requirements concerning regulated substances (50); and
 - (f) Seek ways to improve the chemical hygiene program (8, 11).
4. Laboratory supervisor, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:
 - (a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);
 - (b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);
 - (c) Know the current legal requirements concerning regulated substances (50, 231);
 - (d) Determine the required levels of protective apparel and equipment (156, 160, 162); and
 - (e) Ensure that facilities and training for use of any material being ordered are adequate (215).
5. Project director or director of other specific operation, who has primary responsibility for chemical hygiene procedures for that operation (7).
6. Laboratory worker, who is responsible for:
 - (a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and
 - (b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. Design. The laboratory facility should have:
 - (a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);
 - (b) Adequate, well-ventilated stockrooms/storererooms (218, 219).
 - (c) Laboratory hoods and sinks (12, 162);
 - (d) Other safety equipment including eyewash fountains and drench showers (162, 169); and
 - (e) Arrangements for waste disposal (12, 240).
2. Maintenance. Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continual appraisal and be modified if inadequate (11, 12).
3. Usage. The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially, to the quality of ventilation (13).
4. Ventilation –
 - (a) General laboratory ventilation. This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).
 - (b) Hoods. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201-206 for a discussion of hood design, construction, and evaluation.
 - (c) Other local ventilation devices. Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).
 - (d) Special ventilation areas. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).

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

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

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

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

D. Components of the Chemical Hygiene Plan

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

2. Chemical Procurement, Distribution, and Storage

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

(b) Stockrooms/storerooms. Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218-19).

Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

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

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

3. Environmental Monitoring

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

4. Housekeeping, Maintenance, and Inspections

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

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

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

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

5. Medical Program

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

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

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

6. Protective Apparel and Equipment

These should include for each laboratory:

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

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

(c) An eyewash fountain (162)

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

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

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

7. Records

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

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

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

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

8. Signs and Labels

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

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

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

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

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

9. Spills and Accidents

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

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

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

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

10. Information and Training Program

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

(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169).

Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6).

Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

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

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

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

11. Waste Disposal Program.

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

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

(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27).

Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

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

(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241).

Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or adding them to mixed refuse for landfill burial is unacceptable (14).

Hoods should not be used as a means of disposal for volatile chemicals (40, 200).

Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

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

1. General Rules

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

(a) Accidents and spills - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172).

Ingestion: Encourage the victim to drink large amounts of water (178).

Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33).

Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24, 33). See pp. 233-237 for specific clean-up recommendations.

(b) Avoidance of "routine" exposure: Develop and encourage safe habits (23); avoid unnecessary exposure to chemicals by any route (23);

Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199).

Inspect gloves (157) and test glove boxes (208) before use.

Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

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

(d) Eating, smoking, etc.: Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are

present (22, 24, 32, 40); wash hands before conducting these activities (23, 24).

Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

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

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

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

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

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

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

(k) Personal protection: Assure that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154).

Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159).

Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169).

Use any other protective and emergency apparel and equipment as appropriate (22, 157-162).

Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155).

Remove laboratory coats immediately on significant contamination (161).

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

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

(n) Use of hood: Use the hood for operations which might result in release of toxic chemical vapors or dust (198-9).

As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm (13).

Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200).

Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).

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

(p) Waste disposal: Assure that the plan for each laboratory operation includes plans and training for waste disposal (230).

Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24).

Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

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

2. Working with Allergens and Embryotoxins

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

(b) Embryotoxins (34-5) (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been

confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.

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

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

Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

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

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

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

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

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

(c) Location: Use and store these substances only in areas of restricted access with special warning signs (40, 229).

Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to prevent their discharge with the hood exhaust (40).

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

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

(f) Prevention of spills and accidents: Be prepared for accidents and spills (41).

Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39).

Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper (40).

If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) Waste: Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40).

Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

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

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

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

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

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

Decontaminate the controlled area before normal work is resumed there (50).

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

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

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

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

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

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

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

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

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

5. Animal Work with Chemicals of High Chronic Toxicity

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

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

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

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

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

F. Safety Recommendations

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

1. Corrosive agents: (35-6)
2. Electrically powered laboratory apparatus: (179-92)
3. Fires, explosions: (26, 57-74, 162-64, 174-5, 219-20, 226-7)
4. Low temperature procedures: (26, 88)
5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)

G. Material Safety Data Sheets

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

- o Acetyl peroxide (105)
- o Acrolein (106)
- o Acrylonitrile
- Ammonia (anhydrous)(91)
- o Aniline (109)
- o Benzene (110)
- o Benzo[a]pyrene (112)
- o Bis(chloromethyl) ether (113)
- Boron trichloride (91)
- Boron trifluoride (92)
- Bromine (114)
- o Tert-butyl hydroperoxide (148)
- o Carbon disulfide (116)
- Carbon monoxide (92)
- o Carbon tetrachloride (118)
- *Chlorine (119)
- Chlorine trifluoride (94)
- o Chloroform (121)
- Chloromethane (93)
- o Diethyl ether (122)
- Diisopropyl fluorophosphate (41)
- o Dimethylformamide (123)
- o Dimethyl sulfate (125)
- o Dioxane (126)
- o Ethylene dibromide (128)
- o Fluorine (95)
- o Formaldehyde (130)

- o Hydrazine and salts (132)
- Hydrofluoric acid (43)
- Hydrogen bromide (98)
- Hydrogen chloride (98)
- o Hydrogen cyanide (133)
- o Hydrogen sulfide (135)
- Mercury and compounds (52)
- o Methanol (137)
- o Morpholine (138)
- o Nickel carbonyl (99)
- o Nitrobenzene (139)
- Nitrogen dioxide (100)
- N-nitrosodiethylamine (54)
- o Peracetic acid (141)
- o Phenol (142)
- o Phosgene (143)
- o Pyridine (144)
- o Sodium azide (145)
- o Sodium cyanide (147)
- Sulfur dioxide (101)
- o Trichloroethylene (149)
- o Vinyl chloride (150)

PART B

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

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

1. American Chemical Society, *Safety in Academic Chemistry Laboratories*, 4th edition, 1985.
2. Fawcett, H.H. and W.S. Wood, *Safety and Accident Prevention in Chemical Operations*, 2nd edition, Wiley-Interscience, New York, 1982.
3. Flury, Patricia A., *Environmental Health and Safety in the Hospital Laboratory*, Charles C. Thomas Publisher, Springfield IL, 1978.
4. Green, Michael E. and Turk, Amos, *Safety in Working with Chemicals*, Macmillan Publishing Co., NY, 1978.
5. Kaufman, James A., *Laboratory Safety Guidelines*, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.
6. National Institutes of Health, *NIH Guidelines for the Laboratory use of Chemical Carcinogens*, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.
7. National Research Council, *Prudent Practices for Disposal of Chemicals from Laboratories*, National Academy Press, Washington, DC, 1983.
8. National Research Council, *Prudent Practices for Handling Hazardous Chemicals in Laboratories*, National Academy Press, Washington, DC, 1981.
9. Renfrew, Malcolm, Ed., *Safety in the Chemical Laboratory*, Vol. IV, J. Chem. Ed., American Chemical Society, Easlton, PA, 1981.
10. Steere, Norman V., Ed., *Safety in the Chemical Laboratory*, J. Chem. Ed. American Chemical Society, Easlton, PA, 18042, Vol. I, 1967, Vol. II, 1971, Vol. III, 1974.
11. Steere, Norman V., *Handbook of Laboratory Safety*, the Chemical Rubber Company Cleveland, OH, 1971.
12. Young, Jay A., Ed., *Improving Safety in the Chemical Laboratory*, John Wiley & Sons, Inc. New York, 1987.

(b) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211-4438.
2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.
4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.
5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.
6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).
7. IARC Monographs on the Evaluation of the Carcinogenic Risk of chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).
8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).
9. Occupational Health Guidelines, NIOSH/OSHA. NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.
10. Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes).
11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of documents US. Govt. Printing Office, Washington, DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.
14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications. Park Ridge, NJ, 1981.

(c) Information on Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.
2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y. 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.
4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.

Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.

Fire Protection Guide on Hazardous Materials, 7th edition, 1978.

National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF7-1980, 1101 16th Street, NW., Washington, DC 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.
 2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.
- [55 FR 3327, Jan. 31, 1990; 57 FR 29204, July 1, 1992; 61 FR 5507, Feb. 13, 1996]

APPENDIX K
OCCUPATIONAL SAFETY AND HEALTH STANDARDS
SUBPART H; HAZARDOUS MATERIALS
1910.119 APP A; LIST OF HIGHLY HAZARDOUS CHEMICALS, TOXICS
AND REACTIVES

This Appendix contains a listing of toxic and reactive highly hazardous chemicals which present a potential for a catastrophic event at or above the threshold quantity.

Chemical Name	CAS**	TQ**
Acetaldehyde.....	75-07-0	2500
Acrolein (2-Propenal).....	107-02-8	150
Acrylyl Chloride.....	814-68-6	250
Allyl Chloride.....	107-05-1	1000
Allylamine.....	107-11-9	1000
Alkylaluminums.....	Varies	5000
Ammonia, Anhydrous.....	7664-41-7	10000
Ammonia solutions (greater than 44 percent ammonia by weight).....	7664-41-7	15000
Ammonium Perchlorate.....	7790-98-9	500
Ammonium Permanganate.....	7787-36-2	7500
Arsine (also called Arsenic Hydride)..	7784-42-1	100
Bis(Chloromethyl) Ether.....	542-88-1	100
Boron Trichloride.....	10294-34-5	2500
Boron Trifluoride.....	7637-07-2	250
Bromine.....	7726-95-6	1500
Bromine Chloride.....	13863-41-7	1500
Bromine Pentafluoride.....	7789-30-2	2500
Bromine Trifluoride.....	7787-71-5	15000
3-Bromopropyne (also called Propargy Bromide).....	106-96-7	100
Butyl Hydroperoxide (Tertiary).....	75-91-2	5000
Butyl Perbenzoate (Tertiary).....	614-45-9	7500
Carbonyl Chloride (see Phosgene)...	75-44-5	100
* Carbonyl Fluoride.....	353-50-4	2500
Cellulose Nitrate (concentration greater than 12.6 percent nitrogen)..	9004-70-0	2500
Chlorine.....	7782-50-5	1500
Chlorine Dioxide.....	10049-04-4	1000
Chlorine Pentafluoride.....	13637-63-3	1000
Chlorine Trifluoride.....	7790-91-2	1000
Chlorodiethylaluminum (also called Diethylaluminum Chloride).....	96-10-6	5000
1-Chloro-2,4-Dinitrobenzene.....	97-00-7	5000
Chloromethyl Methyl Ether.....	107-30-2	500
Chloropicrin.....	76-06-2	500
Chloropicrin and Methyl Bromide Mixture.....	None	1500
Chloropicrin and Methyl Chloride mixture.....	None	1500
Commune Hydroperoxide.....	80-15-9	5000
Cyanogen.....	460-19-5	2500
Cyanogen Chloride.....	506-77-4	500
Cyanuric Fluoride.....	675-14-9	100
Diastole Peroxide (concentration greater than 70 percent).....	110-22-5	5000
Diazomethane.....	334-88-3	500

Dibenzoyl Peroxide.....	94-36-0	7500
Diborane.....	19287-45-7	100
Dibutyl Peroxide (Tertiary).....	110-05-4	5000
Dichloro Acetylene.....	7572-29-4	250
Dichlorosilane.....	4109-96-0	2500
Diethylzinc.....	557-20-0	10000
Diisopropyl Peroxydicarbonate.....	105-64-6	7500
Dilauroyl Peroxide.....	105-74-8	7500
Dimethyldichlorosilane.....	75-78-5	1000
Dimethylhydrazine, 1,1-.....	57-14-7	1000
Dimethylamine, Anhydrous.....	124-40-3	2500
2,4-Dinitroaniline.....	97-02-9	5000
Ethyl Methyl Ketone Peroxide (also Methyl Ethyl Ketone Peroxide; concentration greater than 60 percent).....	1338-23-4	5000
Ethyl Nitrite.....	109-95-5	5000
Ethylamine.....	75-04-7	7500
Ethylene Fluorohydrin.....	371-62-0	100
Ethylene Oxide.....	75-21-8	5000
Ethyleneimine.....	151-56-4	1000
Fluorine.....	7782-41-4	1000
Formaldehyde (Formalin).....	50-00-0	1000
Furan.....	110-00-9	500
Hexafluoroacetone.....	684-16-2	5000
Hydrochloric Acid, Anhydrous.....	7647-01-0	5000
Hydrofluoric Acid, Anhydrous.....	7664-39-3	1000
Hydrogen Bromide.....	10035-10-6	5000
Hydrogen Chloride.....	7647-01-0	5000
Hydrogen Cyanide, Anhydrous.....	74-90-8	1000
Hydrogen Fluoride.....	7664-39-3	1000
Hydrogen Peroxide (52 percent by weight or greater).....	7722-84-1	7500
Hydrogen Selenide.....	7783-07-5	150
Hydrogen Sulfide.....	7783-06-4	1500
Hydroxylamine.....	7803-49-8	2500
Iron, Pentacarbonyl.....	13463-40-6	250
Isopropylamine.....	75-31-0	5000
Ketene.....	463-51-4	100
Methacrylaldehyde.....	78-85-3	1000
Methacryloyl Chloride.....	920-46-7	150
Methacryloyloxyethyl Isocyanate.....	30674-80-7	100
Methyl Acrylonitrile.....	126-98-7	250
Methylamine, Anhydrous.....	74-89-5	1000
Methyl Bromide.....	74-83-9	2500
Methyl Chloride.....	74-87-3	15000
Methyl Chloroformate.....	79-22-1	500
Methyl Ethyl Ketone Peroxide (concentration greater than 60 percent).....	1338-23-4	5000
Methyl Fluoroacetate.....	453-18-9	100
Methyl Fluorosulfate.....	421-20-5	100
Methyl Hydrazine.....	60-34-4	100
Methyl Iodide.....	74-88-4	7500
Methyl Isocyanate.....	624-83-9	250
Methyl Mercaptan.....	74-93-1	5000

Methyl Vinyl Ketone.....	79-84-4	100
Methyltrichlorosilane.....	75-79-6	500
Nickel Carbonyl (Nickel Tetracarbonyl).....	13463-39-3	150
Nitric Acid (94.5 percent by weight or greater).....	7697-37-2	500
Nitric Oxide.....	10102-43-9	250
Nitroaniline (para Nitroaniline).....	100-01-6	5000
Nitromethane.....	75-52-5	2500
Nitrogen Dioxide.....	10102-44-0	250
Nitrogen Oxides (NO; NO(2); N2O4; N2O3).....	10102-44-0	250
Nitrogen Tetroxide (also called Nitrogen Peroxide).....	10544-72-6	250
Nitrogen Trifluoride.....	7783-54-2	5000
Nitrogen Trioxide.....	10544-73-7	250
Oleum (65 percent to 80 percent by weight; also called Fuming Sulfuric Acid).....	8014-94-7	1000
Osmium Tetroxide.....	20816-12-0	100
Oxygen Difluoride (Fluorine Monoxide).....	7783-41-7	100
Ozone.....	10028-15-6	100
Pentaborane.....	19624-22-7	100
Peracetic Acid (concentration greater than 60 percent Acetic Acid; also called Peroxyacetic Acid).....	79-21-0	1000
Perchloric Acid (concentration greater than 60 percent by weight)..	7601-90-3	5000
Perchloromethyl Mercaptan.....	594-42-3	150
Perchloryl Fluoride.....	7616-94-6	5000
Peroxyacetic Acid (concentration greater than 60 percent Acetic Acid; also called Peracetic Acid).....	79-21-0	1000
Phosgene (also called Carbonyl Chloride).....	75-44-5	100
Phosphine (Hydrogen Phosphide)....	7803-51-2	100
Phosphorus Oxychloride (also called Phosphoryl Chloride).....	10025-87-3	1000
Phosphorus Trichloride.....	7719-12-2	1000
Phosphoryl Chloride (also called Phosphorus Oxychloride).....	10025-87-3	1000
Propargyl Bromide.....	106-96-7	100
Propyl Nitrate.....	627-3-4	2500
Sarin.....	107-44-8	100
Selenium Hexafluoride.....	7783-79-1	1000
Stibine (Antimony Hydride).....	7803-52-3	500
Sulfur Dioxide (liquid).....	7446-09-5	1000
Sulfur Pentafluoride.....	5714-22-7	250
Sulfur Tetrafluoride.....	7783-60-0	250
Sulfur Trioxide (also called Sulfuric Anhydride).....	7446-11-9	1000
Sulfuric Anhydride (also called Sulfur Trioxide).....	7446-11-9	1000
Tellurium Hexafluoride.....	7783-80-4	250
Tetrafluoroethylene.....	116-14-3	5000

Tetrafluorohydrazine.....	10036-47-2	5000
Tetramethyl Lead.....	75-74-1	1000
Thionyl Chloride.....	7719-09-7	250
Trichloro (Chloromethyl) Silane.....	1558-25-4	100
Trichloro (dichlorophenyl) Silane....	27137-85-5	2500
Trichlorosilane.....	10025-78-2	5000
Trifluorochloroethylene.....	79-38-9	10000
Trimethoxysilane.....	2487-90-3	1500

Footnote(*) Chemical Abstract Service Number

Footnote(**) Threshold Quantity in Pounds (Amount necessary to be covered by this standard.)

[57 FR 7847, Mar. 4, 1992]