

SOUTHERN OREGON UNIVERSITY

SCIENCE HALL

CHEMICAL HYGIENE PLAN

Occupational Exposure to
Hazardous Chemicals in
Laboratories

Revised February 2008

Reference OAR437 Division 2 subdivision 2
and 29 CPR 1910.1450

FORWARD

On January 31, 1990 the Occupational Safety and Health Administration (OSHA) promulgated a final standard (29 CFR 1910.1450) for occupational exposure to hazardous chemicals in laboratories. Included in the standard, which became effective on May 1, 1991, is a requirement for all employers covered by the standard to develop and carry out a Chemical Hygiene Plan (CHP). The Southern Oregon University (SOU) Science Hall is covered by the standard.

A CHP is a written plan to protect employees from chemical hazards in the laboratory. A CHP must include procedures to assure safety and health in the laboratories, criteria for the implementation of control measures, provisions for training and information dissemination, provisions for medical consultation, designation of responsible personnel to maintain safe conditions, and identification of particularly hazardous substances (i.e., labeling). Since we annually purchase many different chemicals at SOU, this is an important undertaking.

This document describes the Chemical Hygiene Plan developed for SOU Science Hall. For definitions in the CHP refer to Appendix A--Laboratory Standard (29CFR 1910.1450). All laboratory personnel must know and follow the provisions outlined in this plan. In addition, employees are expected to develop safe personal chemical hygiene habits aimed at minimizing chemical exposures to themselves and coworkers. This CHP will be reviewed, evaluated and updated at least annually and must be made readily available to employees, their representatives and any representative of the Assistant Secretary of Labor for Oregon OSHA.

While the legal requirements outlined above and specified in this plan may appear difficult and possibly obstructive to science at SOU, they are neither. A fairly simple set of procedures that many SOU researchers use presently are now required by law. The major emphasis will be an increase in documentation and a greater emphasis on training.

The State (OR-OSHA) may monitor SOU laboratory operations periodically and, if the Chemical Hygiene Plan is not being followed, the University could be fined substantially. More importantly, following the CHP will assure that all SOU employees work in a safe and healthy setting.

TABLE OF CONTENTS

1	Chemical Hygiene Responsibilities	
1.1	Dean of College of Arts and Sciences	6
1.2	Chemical Hygiene Officer	6
1.3	Chemical Hygiene Committee	6
2	Employee Training	
2.1	Training of Employees	6
2.2	Elements of the Program	7
2.3	Training on New Hazards	7
2.4	Documentation of the Program	7
2.5	Reference Materials.....	7
3	Recordkeeping	
3.1	Record Types	8
3.2	OSHA Standard	8
4	Hazard Identification	
4.1	Labels on Incoming Containers	8
4.2	Material Safety Data Sheets for Incoming Chemicals	8
4.3	Laboratory Generated Chemicals	9
5	Employee Exposure	
5.1	Permissible Exposure Limits	9
5.2	Employee Exposure Determination.....	9
6	Medical Consultation	
6.1	Circumstances Leading to Medical Consultation	10
6.2	Routine Exposures over PEL's For Substance Specific Standards ...	10
6.3	Medical Examination	10
6.4	Information Provided to the Physician	11
6.5	Medical Examination Results	11
7	Specific Laboratory Areas	
7.1	Requirements for Designated Areas	11
7.2	Warning Signs and Labels	11
7.3	Food Handling	12

8	Laboratory Protective Equipment & Accident Reporting	
8.1	General Principles	12
8.2	Portable Fire Extinguishers	12
8.3	Safety Showers and Eyewash Fountains	12
8.4	Accident Reporting	13
9	Personal Protective Equipment	
9.1	Eye and Face Protection	13
9.2	Glove Protection	13
9.3	Respirators	14
10	Fume Hood Program	
10.1	Safe Use of Fume Hoods	14
10.2	Initial Fume Hood Inventory	15
10.3	Annual Hood Performance Surveys	15
11	Safe Work Practices in Laboratories	
11.1	Safe Work Practices	15
11.2	Health and Hygiene	16
11.3	Housekeeping	16
11.4	Guarding for Safety	16
11.5	Shielding for Safety	17
11.6	Glassware	17
11.7	Unattended Operations	17
11.8	Systems Under Pressure	17
12	Specific Chemical Groups	
12.1	Flammable Liquids	17
12.2	Corrosive Materials	18
12.3	Reactives and Explosives	18
13	Specialized Laboratory Equipment	
13.1	Compressed Gases	18
13.2	Cold Traps and Cryogenic Hazards	19
14	Conclusion	20

Appendices

The Standards and chemical lists below are also available on the web at www.osha.gov

Appendix A – Standards

Laboratory Standard - 29 CFR 1910.1450
Hazard Communication Standard - 29 CFR 1910.1200
Access to Employee Records Standard - 29 CFR 1910.20
Respiratory Protection Standard - 29 CFR 1910.134
ANSI Eye and Face Protection Standard - Z87.1-1989

Appendix B - Chemical Lists

Table of Air Contaminants - 1910.1000 subpart Z
Specific Standard Substances - 1910.1000 subpart Z
NTP List of Carcinogens - Fifth Annual Report
IARC List of Carcinogens - Supplement 7

Appendix C - SOU CHP Forms

Initial Fume Hood Inventory
Annual Fume Hood Inventory Form
Exposure Monitoring Form

LABORATORY CHEMICAL HYGIENE PLAN

1 CHEMICAL HYGIENE RESPONSIBILITIES

- 1.1 Dean of the College of Arts and Sciences
The Dean of the College of Arts and Sciences has the ultimate responsibility for chemical hygiene throughout the science departments and, with the assistance of staff and faculty, provides ongoing support for chemical hygiene at SOU.
- 1.2 Chemical Hygiene Officer
The Chemical Hygiene Officer is responsible for the annual review, evaluation, and updating of the provisions of this Chemical Hygiene Plan.
- 1.3 Chemical Hygiene Committee
The Chemical Hygiene Committee is responsible for providing technical guidance in the annual review, evaluation and updating of the Chemical Hygiene Plan. The committee is composed of the following members:

<u>JOB TITLE</u>	<u>DEPARTMENT</u>
Director, EH & Safety	Environmental Health and Safety
Chemical Hygiene Officer	Science
Science Lab Preparator	Biology
Manager-Chemical Storeroom	Chemistry
Faculty Representative	Biology
Faculty Representative	Chemistry
Faculty Representative	Environmental Studies
Faculty Representative	Physics
Dean, College of Arts & Sciences	

2 EMPLOYEE TRAINING

- 2.1 Training of Employees
All laboratory employees exposed or potentially exposed to hazardous substances must participate in chemical hygiene training.

A representative of the Science Hall Office or a Department designee will provide the names of new employees affected by SOU's Science Hall Chemical Hygiene Plan to the Chemical Hygiene Officer. At the time of initial assignment a new employee receives the required training from the Chemical Hygiene Officer or their designee. Refresher information is provided as needed.

2.2 Elements of the Program

The training program will cover the following areas:

- 1) Explanation of OAR 437 Div. 2 (29 CFR 1910.1450): Occupational Exposure to Hazardous Chemicals in Laboratories. Appendix A
- 2) How to obtain and use the Chemical Hygiene Plan.
- 3) Training on applicable details of the CHP.
- 4) Location and availability of reference materials, Material Safety Data Sheets (MSDSs), and lists of hazardous substances with applicable permissible exposure limits. (PEL) Appendix B

2.3 Training on New Hazards

Whenever an employee orders a new chemical, the employee is provided with the MSDS and reminded of the availability of PEL information on the new hazard. Lab Supervisors (SOU employees in charge of lab activities) will provide other employees affected by the new hazard with the MSDS and PEL information of the new hazard. Lab supervisors will provide training for their employees if appropriate.

2.4 Documentation of the Program

Records of faculty, staff, and student employee training are stored in SC 222B. Copies are provided to the employee and to his/her Department upon request.

2.5 Reference Materials

The following is a list of reference materials and their locations:

Reference

Chemical Hygiene Plan
www.sou.edu/cas/policies.html

Location

Room #SC 173, 204,
359 and the EH & Safety Dept.

Electronic Material Safety Data Sheets:

www.ilpi.com/msds/index.html
www.setonresourcecenter.com/MSDS/index.htm
www.sou.edu/ehs/links.html

MSDSs for all hazardous substances
in the Science Building. (Paper copies)

Room #SC173, 359
(Biology MSDSs) and
Safety Dept. (552-6909)

Safety in Working With Chemicals

SOU Library

Prudent Practices For Handling Hazardous
Chemicals In Laboratories

SOU Library

Prudent Practices in the Laboratory
Handling and Disposal of Chemicals

Room #SC226

<u>CRC Handbook of Laboratory Safety</u>	Room #SC204 and the SOU Library
<u>Safety in the Chemical Laboratory</u>	SOU Library
<u>Merck Index</u>	Room #SC204, 226 & 359
<u>Hazardous Laboratory Chemical Disposal Guide Second Edition</u>	Room #SC 359
<u>Small Quantity Hazardous Waste Generator Handbook</u>	Room #SC 359

3 RECORDKEEPING

3.1 Record Types

The Department of Environmental Health and Safety maintains Employee exposure monitoring records (section 5).

Human Resources maintain Employee medical records (section 6).

The Chemical Hygiene Officer maintains Employee OSHA required training records (section 2) and Annual fume hood survey records (section 10).

3.2 OSHA Standard

The Department of Environmental Health and Safety assures that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20-OSHA Recordkeeping Standard. (Appendix A)

4 HAZARD IDENTIFICATION

4.1 Labels on Incoming Containers

Suppliers of chemical products must label their materials in accordance with the OSHA Hazard Communication Standard [29 CFR 1910.1200 (Appendix A)]. As a minimum, the following information must appear on containers of hazardous substances shipped to SOU:

- 1) "Identity" of the material.
- 2) Hazard warnings.
- 3) Name and address of the manufacturer or importer.

No container is accepted unless it is properly labeled with the required information.

4.2 Material Safety Data Sheets for Incoming Chemicals

Material Safety Data Sheets (MSDS) are obtained from manufacturers and/or distributors for all chemicals purchased.

MSDSs for hazardous materials are readily available to employees and are located in SC Room #173. Additionally, they are maintained on file at SOU's Environmental Health and Safety Department, 351 Walker Ave., 552-6881.

4.3 Laboratory Generated Chemicals

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

- 1) If the composition of the chemical substance is known, the Lab Supervisor (SOU employees in charge of lab activities) determines if it is a hazardous chemical as defined by the OSHA Hazard Communication Standard. If the chemical is determined to be hazardous, the Lab Supervisor provides appropriate training as required by this CHP (see section 2--Employee Training).
- 2) If the chemical produced is a byproduct whose composition is not known, it is assumed that the substance is hazardous and subject to the CHP.
- 3) If the chemical substance is produced for another user outside of the laboratory, the Lab Supervisor complies with the OSHA Hazard Communication Standard 29 CFR 1910.1200 including the requirements for preparation of material safety data sheets and labeling.

5 EMPLOYEE EXPOSURE

5.1 Permissible Exposure Limits

Reasonable precaution is taken by Lab Supervisors (SOU employees in charge of lab activities) to limit exposure of OSHA regulated substances. Tables to help laboratory employees to identify and obtain the permissible exposure limits (PEL's) for OSHA regulated substances are available in the Chemical Hygiene Plan Appendix B or at <http://www.osha.gov/comp-links.html>. PEL's are specified in 29 CFR part 1910, subpart Z.

5.2 Employee Exposure Determination

Initial Monitoring

The Department of Environmental Health and Safety monitors an employee's exposure to any substance regulated by an OSHA standard only if there is reason to believe that exposure levels for that substance routinely exceed the PEL for that substance. The standard for that substance is used to determine the method for monitoring. If there is no cause to suspect a hazard or an exposure, no monitoring is done.

Some circumstances which might prompt exposure monitoring include:

- 1) The manner in which a chemical procedure or operation is conducted, i.e. use of open vessel instead of a closed system.
- 2) The use of a procedure that involves significant quantities or that is performed repeatedly over an extended period of time.
- 3) Accidental breakage of a hazardous material container.
- 4) Caustic splash to eyes, face, or body.

- 5) Signs and symptoms of exposure, e.g. odor, taste, skin or eye irritation, shortness of breath, nausea, headache, etc., which are experienced by an employee.

An employee will request monitoring by filling out an Exposure Monitoring Form. Monitoring forms can be found in appendix C of the Chemical Hygiene Plan. Exposure monitoring will be evaluated by the Department of Environmental Health and Safety to see if monitoring is indicated.

Periodic Monitoring

If monitoring is performed and this initial monitoring shows no evidence of exposure, the monitoring is discontinued. If initial monitoring indicates an exposure, steps are taken by SOU or their representative to reduce the exposure to permissible limits. Monitoring is performed periodically to verify that the steps to reduce the exposure have been effective.

Termination of Monitoring

Monitoring is terminated after complying with the applicable standard for the hazardous material.

Monitoring Results

Results of exposure monitoring are given to the employee within 15 working days after their receipt, and are maintained on file in SOU's Environmental Health and Safety Department for 30 years after an employee's last day of employment.

6 MEDICAL CONSULTATION

6.1 Circumstances Leading To Medical Consultation

Laboratory employees are provided the opportunity for medical attention when:

- 1) The employee exhibits signs and symptoms associated with chemicals to which he/she has been exposed.
- 2) The employee is subjected to events such as a spill, leak, explosion, or other occurrence where there is a likelihood of a significant exposure to hazardous chemicals.

6.2 Routine Exposures over PEL's for Substance Specific Standards

If air monitoring results indicate that laboratory employee exposures are above the limits prescribed for an OSHA regulated substance, then medical monitoring is provided as required in the applicable standard for the regulated substance.

6.3 Medical Examination

Medical examinations are provided by licensed physicians at no cost to employees, and are scheduled at a reasonable time for the employee.

- 6.4 Information Provided to the Physician
SOU shall provide the following information to the physician:
- 1) The identity of the hazardous chemical(s) to which the employee may have been exposed.
 - 2) A description of the conditions under which the exposure occurred including quantitative exposure data, if available.
 - 3) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

- 6.5 Medical Examination Results
The physician informs the employee of the results of the examination and provides the personnel officer with a written opinion.
Doctors' written opinions are retained in the employees personnel file. Faculty personnel files are kept forever and staff files are kept for 75 years after an employee's last day of employment.

7 SPECIFIC LABORATORY AREAS

- 7.1 Requirements for Designated Areas
Any laboratory work which uses select carcinogens, reproductive toxins, or high acute toxicity chemicals must be performed in a Designated Area. A Designated Area may be the entire laboratory, an area of a laboratory, or a device such as a laboratory hood.

All Designated Areas must be clearly marked with a sign, such as the following sample.

DANGER

DESIGNATED AREA

REPRODUCTIVE TOXINS IN USE

AUTHORIZED PERSONNEL ONLY

- 7.2 Warning Signs and Labels
- 1) Laboratory areas that have special or unusual hazards should be posted with warning signs. (Standard signs and symbols have been established for a number of special situations, such as radioactivity hazards, biological hazards, fire hazards, and laser operations.)
<http://ehs.sc.edu/modules/HazComm/hhazard04.htm>
<http://www.osha.gov/dsg/hazcom/ghs.html>
 - 2) Signs must be posted to show the locations of safety showers, eyewash stations, exits, fire extinguishers, and personal protective equipment.
 - 3) Waste containers must be labeled for the type of waste that can be safely deposited.

7.3 Food Handling

- 1) SOU employees do not eat, drink, smoke, or apply cosmetics or nasal decongestants in any laboratory while using chemicals. After working with chemicals, wash hands thoroughly before performing these activities.
- 2) Laboratory areas where food is permitted are prominently marked with a sign (e.g., EATING AREA--NO CHEMICALS).
- 3) Glassware or utensils that have been used for laboratory operations are never used to prepare or consume food or beverages.
- 4) Laboratory refrigerators, freezers, ice chests, or cold rooms, are not used for food storage. Separate equipment should be dedicated to either food or chemical storage and prominently labeled. (e.g. CHEMICALS STORAGE – NO FOOD)

8 LABORATORY PROTECTIVE EQUIPMENT & ACCIDENT REPORTING

8.1 General Principles

The need for specific types of safety equipment is dependent upon the types of operations and the nature and quantity of the materials in use and must be assessed on a case by case basis.

All laboratories in which chemicals are used have fire extinguishers and eyewash fountains. Safety showers are present when appropriate. In addition, personal protective equipment such as eye and face protection, gloves, respiratory protection, and other protective clothing is worn when appropriate.

8.2 Portable Fire Extinguishers

Portable fire extinguishers suitable to the conditions and hazards involved are provided and maintained in an effective operating condition.

Portable fire extinguishers are conspicuously located and readily accessible. Extinguishers are not obstructed or obscured from view.

Portable fire extinguishers receive maintenance service at least once a year and a written record is kept showing the maintenance or recharging date. SOU's Environmental Health and Safety Department is responsible for this maintenance.

8.3 Safety Showers and Eyewash Fountains

Safety showers and eyewash fountains are clearly marked. Employees must be familiar with their location and use.

Access to safety showers and eyewash fountains must be free of clutter at all times.

Once a year safety showers and eyewash fountains are examined and their mechanical function tested. SOU's Facilities Management and Planning is responsible for their maintenance. Sink mounted eye-washes are tested by the department designee once a year.

8.4 Accident Reporting

- 1) Emergency telephone numbers to be called in the event of fire, accident, flood, or hazardous chemical spill are posted prominently in each laboratory.
- 2) All accidents must be reported to supervisors, and an SOU Incident Report Form must be filled out. If medical care is anticipated a SAIF 801 form is also completed.
- 3) Environmental Health and Safety Department at SOU is notified of all accidents. The Department of Environmental Health and Safety investigates all accidents to establish cause and to make recommendations to improve safety.

9 PERSONAL PROTECTIVE EQUIPMENT

9.1 Eye and Face Protection

Eye and face Protection must be worn in the laboratory whenever there is a reasonable probability of an injury that could be prevented by their use. This applies to employees, students, and visitors.

Persons using corrective lenses in spectacles that are required to wear eye protection must wear face shield, goggles, or spectacles of one of the following types:

- 1) Spectacles with protective lenses providing optical correction.
- 2) Goggles worn over corrective spectacles without disturbing the adjustment of the spectacles.
- 3) Goggles that incorporate corrective lenses mounted behind the protective lenses.

Contact lenses do not provide eye protection, and in no circumstances are they allowed without suitable eye protection.

All eye and face protection must be in accordance with ANSI Z87.1-1989-- Practice for Occupational and Educational Eye and Face Protection.

9.2 Glove Protection

Wear appropriate chemical-resistant gloves at all times when hands may come in contact with hazardous chemicals.

Inspect and wash gloves immediately after each use.
Discard damaged or deteriorated gloves immediately.

9.3 Respirators

Where the use of respirators is necessary to maintain exposure below permissible exposure limits, SOU 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--OSHA Respiratory Protection Standard. Minimum requirements include the following:

- 1) Written Standard Operating Procedures governing the selection and use of respirators shall be established.
- 2) Respirators shall be selected on the basis of hazards to which the worker is exposed.
- 3) The user shall be instructed and trained in the proper use of respirators and their limitations.
- 4) Where practicable, the respirators should be assigned to individual workers for their exclusive use.
- 5) Respirators shall be regularly cleaned and disinfected. Those issued to more than one worker, shall be thoroughly cleaned and disinfected after each use.
- 6) Respirators shall be stored in a convenient, clean, and sanitary location.
- 7) Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use shall be thoroughly inspected at least once a month and after each use.
- 8) Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.
- 9) There shall be regular inspection and evaluation to determine the programs continue effectiveness.
- 10) Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment.
- 11) Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against a particular hazard for which it is designed in accordance with National Institute of Occupational Safety & Health (NIOSH) standards.

10 FUME HOOD PROGRAM

10.1 Safe Use of Fume Hoods.

It is SOU's policy to ensure that each laboratory employee is trained in the safe use of fume hoods. The following safe practices shall be adhered to:

- 1) Familiarize yourself with the physical and chemical properties of the materials you plan to work with by consulting the Material Safety Data Sheets and other available references.

- 2) Do not assume that a fume hood is operating properly. Always review the results of the most recent fume hood survey by consulting the hood sticker or the survey report.
- 3) Before using, check the fume hood's operating indicator light. If there are questions about proper performance, resolve them before using the hood.
- 4) Based upon the hazards posed by the substances being manipulated and the results of the most recent hood survey, determine whether the hood is adequate for the work being completed.
- 5) Perform all chemical manipulations at least six inches inside the hood face.
- 6) Locate all laboratory equipment as far back in the hood as practical and make certain that hood exhaust slots are not blocked.
- 7) Elevate large pieces of equipment off the work surface to reduce turbulence and improve airflow characteristics, thus optimizing hood performance.
- 8) Avoid cross drafts in front of the hood from pedestrian traffic in the vicinity of the hood. Rapid movements by the user also tend to disrupt the airflow into the hood and reduce the containment provided.
- 9) Minimize chemical storage in the fume hood to avoid impairing its effectiveness.
- 10) Do not allow paper, disposable gloves, or other debris to be drawn into the slots at the rear of the hood.
- 11) Avoid placing your head inside hood while performing chemical manipulations.

10.2 Initial Fume Hood Inventory

An initial fume hood inventory of all Science Building fume hoods was done on 2/25/92 and 4/16/92. All movable sashes were marked at the locations where they provided an average of 100 linear feet per minute capture velocity at the hood face. A report is located in appendix C.

10.3 Annual Hood Performance Surveys

Hood face velocity surveys are conducted annually by the Chemical Hygiene Officer or their designee. An Annual Hood Performance Survey form can be found in appendix C. Copies of the annual fume hood surveys are kept in the chemical hygiene plans in SC173 and 204. The person responsible for correcting deficiencies in fume hood performance is the Science Building Manager or their designee.

11 SAFE WORK PRACTICES IN LABORATORIES

11.1 Safe Work Practices

- 1) Know the safety rules and procedures that apply to the work that is being done. Review the potential hazards (e.g., physical, chemical, biological) and appropriate safety precautions before beginning any new operation.

- 2) Know the location of and how to use the emergency equipment as well as how to obtain additional help in an emergency.
- 3) Know the types of protective equipment available and use the proper type for each job.
- 4) Be alert to unsafe conditions and bring them to the attention of your supervisor immediately so that corrections can be made as soon as possible.
- 5) Avoid hazards to the environment by following DEQ guidelines for waste disposal practices.
- 6) Be certain all chemicals are correctly and clearly labeled.
- 7) Horseplay is forbidden in the laboratory.
- 8) Use equipment only for its designed purpose.
- 9) Position and clamp reaction apparatus in order to permit manipulation without the need to move the apparatus until the entire reaction is completed.

11.2 Health and Hygiene

- 1) Wear appropriate eye and face protection at all times.
- 2) Use protective apparel, including face shields, gloves, and other special clothing or footwear as needed. Sandals or exposed feet are prohibited in laboratories.
- 3) Confine long hair and loose clothing when in the laboratory.
- 4) Avoid exposure to gases, vapors, and aerosols. Use appropriate safety equipment and work in a fume hood whenever such exposure is likely.

11.3 Housekeeping

- 1) Work areas should be kept clean and free from obstructions. Cleanup should follow the completion of any operation or at the end of each day.
- 2) Wastes should be deposited in appropriate receptacles.
- 3) Spilled chemicals should be cleaned up immediately and disposed of properly.
- 4) Unlabeled containers and chemical wastes should be disposed of promptly, by using appropriate procedures. Such materials, as well as chemicals that are no longer needed, should not accumulate in the laboratory.
- 5) Floors shall be cleaned regularly.
- 6) Stairways and hallways shall not be used as storage areas.
- 7) Access to exits, emergency equipment and controls should never be blocked.

11.4 Guarding for Safety

All mechanical equipment shall be adequately furnished with guards that prevent access to electrical connections or moving parts.

11.5 Shielding for Safety

- 1) Safety shielding is used for any operation having potential for explosion such as:
 - a) Whenever a reaction is carried out under non-ambient conditions.
 - b) Whenever a reaction is attempted for the first time.
 - c) Whenever a familiar reaction is carried out on a larger than usual scale (e.g., 5-10 times more material).
- 2) Shields must be placed so that all personnel in the area are protected from hazard.

11.6 Glassware

- 1) All labs using glassware will have a clearly identified (labeled) broken glass container. Broken glassware will be immediately disposed of in this container.
- 2) High-vacuum evacuated glass apparatus will be shielded to contain chemicals and glass fragments should implosion occur.
- 3) Label all secondary containers of chemicals (containers that are intended only for the immediate use of the employee who performed the transfer are exempt from labeling requirements).
- 4) Labels shall be informative, durable, and, at a minimum, will identify contents, source, date of acquisition, storage location, and the initials or identifier of the person who prepared the container.
- 5) Glass-blowing operations should not be attempted unless proper annealing facilities are available.
- 6) When inserting glass tubing into rubber stoppers or hoses, lubricate the glass and rubber with glycerol and protect your hands with gloves.

11.7 Unattended Operations

- 1) When conducting unattended operations it is essential to plan for interruptions in utility services such as electricity, water, and inert-gas.

11.8 Systems under Pressure

- 1) Reactions should never be carried out in, nor heat applied to, an apparatus that is a closed system unless it is designed and tested to withstand pressure. Pressurized apparatus should be equipped with relief devices.
- 2) If the reaction cannot be opened directly to the air, an inert gas purge and bubbler system should be used to avoid pressure buildup.

12 SPECIFIC CHEMICAL GROUPS

12.1 Flammable Materials

- 1) Always consult the MSDS when working with flammable materials.
- 2) For liquids, correctly interpret hazards by evaluating such properties as flash point, auto ignition temperature, explosive limits, vapor density, and compatibility with other reagents.

- 3) Use steam baths, hot plates, or heating mantles instead of open flames whenever possible. Before lighting a match or a burner, be sure that there are no open solvent containers or flammable vapors in the area.
- 4) When large quantities of flammable liquids are dispensed, ensure that all vessels used are of metal and are electrically connected and grounded.
- 5) Quantities of flammable substances in laboratories should be kept to a minimum. When not in use flammable liquids are stored in flammable liquid storage cabinets.
- 6) When flammable liquids are transported appropriate carriers should be used (for other than small glass bottles).

12.2 Corrosive Materials

- 1) Always consult MSDSs before working with these materials.
- 2) It is essential that approved eye and face protection be worn in all laboratories where corrosive chemicals are handled.
- 3) Gloves and other chemically resistant protective clothing shall be worn to protect against skin contact.
- 4) To avoid a flash steam explosion due to the large amount of heat evolved, always add acids or bases to water (and not the reverse).
- 5) Acids and bases should be segregated for storage.
- 6) Liquid corrosives should be stored below eye level.
- 7) Adequate quantities of spill control materials should be readily available.
- 8) Wear appropriate respiratory protection and perform manipulations of materials in a fume hood when working with materials that pose an inhalation hazard.

12.3 Reactives and Explosives

- 1) Always consult MSDSs when working with these materials.
- 2) Pay special attention to work practices which minimize friction, shock, heat, or contamination which all can detonate these materials.
- 3) All materials prone to peroxidation should be dated upon receipt and not kept for prolonged periods once they have been opened.
- 4) Pay special attention to substances which are inherently unstable and can detonate under certain conditions of pressure and temperature (e.g., acetylene, carbon disulfide, and substances prone to autopolymerization).

13 SPECIAL LABORATORY EQUIPMENT AND PROCEDURES

13.1 Compressed Gases

- 1) Position cylinders so that the cylinder valve is accessible at all times. The main cylinder valve should be closed as soon as the gas is no longer being used.
- 2) Store full and empty cylinders separately.

- 3) Avoid dragging, rolling, or sliding cylinders. Move cylinders by using a suitable hand truck with a strap, chain, or other device for securing the cylinder.
- 4) Never drop cylinders or permit them to strike each other violently.
- 5) Leave the valve-protection cap on each cylinder until it has been secured against a wall or bench, or placed in a cylinder stand, and is ready to be used.
- 6) Place cylinders where they will not become part of an electric circuit.
- 7) Bond and ground all cylinders, lines, and equipment used with flammable compressed gases.
- 8) Check for leaks with a water and soap solution. Never use a flame.
- 9) Use compressed gases only in a well-ventilated area. Toxic, flammable, and corrosive gases should be used in a hood. Only small cylinders of toxic gases should be used.
- 10) Never tamper with safety devices in valves or cylinders.
- 11) Use a trap or suitable check valve when discharging gas into a liquid to prevent the liquid to prevent the liquid from getting back into the cylinder or regulator.
- 12) Use appropriate safety equipment such as safety goggles, face shield, and rubber gloves when using corrosive gases.
- 13) Do not force a cylinder valve that is stuck or frozen. Seek advice from the vendor.
- 14) A regulator should be attached to a cylinder without lubrication and without forcing the threads.
- 15) After the regulator has been attached to the cylinder valve outlet, turn the delivery pressure adjusting screw counter-clockwise until it turns freely. This will prevent unintended gas flow through the regulator.
- 16) Open the cylinder valve slowly until the inlet gauge on the regulator registers the cylinder pressure: If the cylinder pressure reading is lower than expected, this may indicate that the cylinder valve is leaking.
- 17) With the flow control valve at the regulator outlet closed, turn the delivery pressure adjusting screw clockwise until the required delivery pressure is reached. The regulator itself should not be used as a flow control by adjusting the pressure to obtain different flow rates.
- 18) When done using the gas, close the cylinder valve and release the regulator pressure.

13.2 Cold Traps and Cryogenic Hazards

- 1) Gloves and a face shield need to be used when preparing cold baths.
- 2) Neither liquid nitrogen nor liquid air should be used to cool a flammable mixture in the presence of air.
- 3) Insulated gloves should be used when handling dry ice, which should be added slowly to the liquid portion of the cooling bath to avoid foaming over.

14 CONCLUSION

The decision to purchase a chemical shall be a commitment to handle and use the chemical properly from receipt to disposal. Chemicals used in the laboratory must be within the capability of the lab workers to use them safely.