SMITH COLLEGE
Clark Science Center

Prepared for Smith College by Stefan Wawzyniecki, CIH, CHMM

With acknowledgements to OSHA's Occupational Exposure to Hazardous Chemicals in Laboratories (29 CFR 1910.1450), Michigan State University, and other sources as presented in Appendix II

Chemical Hygiene Plan

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Margaret A. Rakas, Ph.D.
Chemical Hygiene Officer

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1.0 STATEMENT OF RESPONSIBILITY

It is the responsibility of Smith College, as an employer, to take every reasonable precaution to provide a work environment that is free from recognizable hazards for its employees in accordance with Federal and State regulations, and for the College's student researchers as well. This document, a Chemical Hygiene Plan, establishes policies, procedures and guidelines necessary to comply with regulatory standards as well as provide a safe environment for employees, students and visitors.

1.1 SCOPE AND APPLICATION

This document serves as the written guide for Smith College employees' compliance with the Occupational Health and Safety Administration's (OSHA) Laboratory Standard and related Chemical Hygiene Plan (CHP) requirements. Because Smith College has determined that these safety standards should be followed by all personnel working in the laboratories, they also apply to visitors, students and other non-employees. All departments at Smith College engaged in the laboratory use (as defined by this document) of hazardous chemicals are required to comply with this document.

The primary objective of this document is to inform employees and students about laboratory related health and safety hazards and to provide a general guide for safely handling hazardous chemicals in laboratories. The Chemical Hygiene Plan establishes the basic safety principles for laboratory procedures and engineering control methodologies, as well as equipment and work practices that are capable of protecting employees and students from physical and health hazards of hazardous chemicals in laboratories. This document is intended only to highlight those general safety measures necessary for achieving a safe and healthy work environment. Where the scope of hazards are not adequately addressed by this general document, specific Standard Operating Procedures must be developed by the project director. This CHP does not, however, apply to:
1. Work involving chemicals that do not meet the conditions of the definition of laboratory use of hazardous chemicals. In such cases, the employer shall comply with all relevant specific substance standards even if such use occurs in a laboratory type setting.
2. Work involving the laboratory use of hazardous chemicals that does not have the potential for employee or student exposure.
This document will hereafter be known as the Smith College Chemical Hygiene Plan (CHP).

1.2 HAZARDOUS CHEMICAL DEFINITIONS

A hazardous chemical is defined by OSHA as any chemical, chemical compound, or mixture of compounds which is a physical and/or health hazard.
A chemical is a **physical hazard** by definition if there is scientifically valid evidence that it is:
- a flammable or combustible liquid
- a compressed gas
- an organic peroxide
- an explosive
- an oxidizer

• a pyrophoric
• an unstable material (reactive)
• a water reactive material

A chemical is a **health hazard** by definition if 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 or students. Included are:
• allergens • embryotoxicants • carcinogens • toxic or highly toxic agents
• reproductive toxicants • irritants • corrosives • sensitizers
• hepatoxins (liver) • nephrotoxins (kidneys) • neurotoxins (nervous system)
• hematopoietic systems agents (blood) • agents which damage the lungs, skin, eyes or mucous membranes

Particularly hazardous substances are defined by OSHA as select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity.
Select carcinogens are chemicals listed as carcinogens, by the National Toxicology Program (NTP) as "known to be carcinogens" and by the International Agency for Research on Cancer (IARC) as Group 1 carcinogens. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP and that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
• 1. 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
• 2. After repeated skin application of less than 300 mg/kg of body weight per week
• 3. After oral dosages of less than 50 mg/kg of body weight per day; IARC Group 1, 2A, and 2B, as well as the NTP carcinogens, are listed in Appendix J.

Reproductive toxins are defined as any chemical which affects the reproductive capabilities of males or females, including chromosomal damage (mutagenesis) and effects on fetuses (teratogenesis). Information on reproductive effects will be listed on the MSDS.

Chemicals with a high degree of acute and chronic toxicity are defined by OSHA. Chemicals with a high degree of acute toxicity are chemicals that have a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each. The LD_{50} is that dose at which a lethal response is observed in 50% of the test animals. Chemicals may also be acutely toxic via the dermal or inhalation route. The Material Safety Data Sheet or label provides this information.

The following sources, while not a comprehensive list, have established lists of hazardous chemicals based on substantiated tests:.
1. OSHA, 29 CFR 1910.1200 Subpart Z, Toxic and Hazardous Substances and Appendices A and B of OSHA 29 CFR 1910.1200

2. American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment" The hazard(s) of a chemical may also be listed on its container label.

Additionally, if the hazard of a chemical is not evident from the container label, the **Material Safety Data Sheet (MSDS)** will list the specific hazards. Use the MSDS to address chronic and acute toxicity. For further help in determining the hazard of a chemical, contact your supervisor, instructor, or Principle Investigator (PI). The Chemical Hygiene Officer can also assist in this process if requested.

References:

OSHA 1910.1450, Standard for Occupational Exposure to Hazardous Chemicals in Laboratories
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106

OSHA 1910.1200, Hazard Communication, App. A, Health Hazard Definitions
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10100

2011 TLVs® and BEIs®, *ACGIH®* Publication #0111

1.3 RESPONSIBILITY

The Dean for Academic Development/Associate Provost shall be responsible for assuring College compliance with State and Federal standards and for preparing any reports, as required under the Laboratory Standard and the Chemical Hygiene Plan.

The **Chemical Hygiene Officer (CHO)** of Smith College is Margaret Rakas, Clark Science Center. The CHO provides technical support for the College's Safety Program, assistance to faculty and staff members in incorporating safety into curricula and research, and serves as the College's representative during inspections by relevant government agencies (DEP, DOT-FAA, DPH, etc.)

The Institutional Chemical Hygiene Committee (ICHC) is comprised of tenured faculty from the departments of Biological Sciences, Art or Theatre, Engineering, and Chemistry; one faculty member drawn from one of the other Division 3 science departments; the Director of the Clark Science Center; the Chemical Hygiene Officer; and two non-Smith affiliates representing the community and/or the chemical hygiene profession. The ICHC has the authority as vested by the President of the College to enforce College policies, the College Chemical Hygiene Plan, and ICHC approved Chemical Hygiene Protocols. The ICHC Mandate may be found in Appendix III.

Working with the ICHC and Department and Program Chairs, the CHO can assign areas of responsibility to departments, project directors, laboratory supervisors, and other individuals as necessary, to implement and carry out the provisions of the CHP. The

CHO will serve on the Institutional Chemical Hygiene Committee (ICHC), and in turn, the ICHC will share in responsibility for oversight of the CHP.

Individual departments, institutes, schools, outlying field stations, and laboratory facilities are responsible for maintaining a unit safety system, which may include identification of a safety officer. They have the responsibility to support and ensure the enforcement of the CHP and to support the CHO and the ICHC in implementing the provisions of this plan within their respective units.

Principle Investigators have the legal responsibility for safety and well-being of all personnel in contact with any College-related activity utilizing radiation, chemical or biological hazards, and related physical hazards. Specifically, the PI is responsible for:
1. Ensuring all employees, visitors, and students under his/her supervision have received general chemical safety training.
2. Providing all employees, visitors, and students under his/her supervision with site-specific training and documenting such training.
3. Following appropriate guidelines prescribed in this document.

Since the PI in most cases has the most extensive knowledge of and experience with best practices within his/her specific area of research, any new safety procedure should be designed with maximum input from the PI(s) involved. If the PI(s) and the CHO cannot come to agreement on what represents a reasonable procedure, or if these parties would like broader input on design of a procedure, the matter should be brought to the PI's department Chair and then, if necessary, to the ICHC for resolution.

Irrespective of the laboratory location, the PI assumes responsibility for their student working in that space. If the laboratory is under the control of another faculty member, instructor, lab technician or other Smith employee, once the PI makes arrangements with the person in charge of the lab for the appropriate training and for the work to be conducted by the student and the arrangements are accepted by both parties, the person in charge of the laboratory is responsible for the student.

Employee. Individual laboratory employees are responsible for their own safety. All individuals performing work with hazardous substances must accept a shared responsibility for operating in a safe manner once they have been informed about the extent of risk and safe procedures for their activities. They also have the responsibility to inform their supervisors of accidents and work practices or working conditions they believe hazardous to their health or to the health of others.

Student. While students (as non-employees) are not covered under the provisions of the OSHA Laboratory Standard, students should be made aware of chemical health and safety hazards in both teaching and research laboratories and should be provided with information and equipment to protect themselves from those hazards. Departments should provide student training at the beginning of each course in which hazardous chemicals are used. Specific safety instructions should be provided at the beginning of each class period. PI's are responsible for providing safety training and information

regarding lab-specific chemicals and processes at the beginning of a student's participation in lab activities and on an ongoing basis as necessary.

Visitor. Visitors to laboratory facilities are those who are present for a short time period (hours to a few weeks) and are not otherwise affiliated with Smith College or any Five College program. Visitors should be made aware of chemical health and safety hazards in the laboratories in which they are working/observing and should be provided with information and equipment to protect themselves from those hazards. For visitors who are present at the request of faculty or staff, it is the responsibility of the faculty or staff member to provide the safety information and equipment relevant to the visitor's participation. Students should request permission from their faculty advisors before bringing visitors to their research labs. Visitors are not covered by the OSHA Laboratory Standard but Smith College wants its standards of safety to be equal for everyone in College laboratories.

1.4 EMPLOYEE & STUDENT RIGHTS

It is the employee's and student's right to receive information about the known physical and health hazards of the hazardous chemicals in their work areas and to receive adequate training to work safely with these substances.
Employees and students have the right to work in a safe environment and inform the PI or laboratory supervisor about potential risks in the laboratory.

1.5 AVAILABILITY

The Chemical Hygiene Plan must be readily available to employees and students through their PI, supervisor or departmental office.
Copies of this document are available from Clark Science Center office and the web site: http://www.science.smith.edu/resources/safety/labsafety.html

1.6 ANNUAL REVIEW

The Chemical Hygiene Plan will be reviewed annually from its effective date by the Chemical Hygiene Officer and the Institutional Chemical Hygiene Committee.

1.7 EMPLOYEE AND STUDENT INFORMATION AND TRAINING

Employees and students must have access to information and training to ensure that they are apprised of the hazards of chemicals present in the work area. Such information must be provided at the time of an employee's or student's initial assignment to a work area where hazardous chemicals are present and prior to assignment involving new exposure situations. Employees and students should receive periodic refresher information and training to ensure that they are aware of the risks of exposure to hazardous chemicals. (Citation: 1910.1450(f)(1), 1910.1450(f)(2))

Information. Information provided by the PI/Supervisors to employees and students must include:
1. The contents of the Laboratory Standard. Citation: 1910.1450(f)(3)(i)
2. The location and availability of the CHP. Citation: 1910.1450(f)(3)(ii)3. The permissible exposure limits for OSHA regulated substances or published

exposure limits for other hazardous chemicals where there is no applicable OSHA standard. Citation: 1910.1450(f)(3)(iii)
4. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory (available on Material Safety Data Sheets). Citation: 1910.1450(f)(3)(iv)
5. The location and availability of known reference materials 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 supplier. Citation: 1910.1450(f)(3)(v)

Method of Training. General training will be provided by the CHO and may take the form of individual instruction, group seminars, audiovisual presentations, handout material, web-based training, or any combination of the above. Site-specific training will be provided by PIs or a qualified substitute.
Please call the CHO for information about the general chemical safety course and/or bloodborne pathogen training, or email the CHO (mrakas@smith.edu).

General awareness training provided by the CHO to employees and students will include:
1. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.).
Citation: 1910.1450(f)(4)(i)A
2. General physical and health hazards of chemicals in the work area. This must include an awareness that many factors influence whether a given chemical might constitute a hazard (e.g. dose, exposure time, genetic background, developmental state, mixtures of interactions of chemicals, etc.).
Citation: 1910.1450(f)(4)(i)B
3. The measures employees and students can take to protect themselves from these hazards, including specific procedures the College or department has implemented to protect employees and students from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
Citation: 1910.1450(f)(4)(i)C
4. The applicable details of the CHP.
Citation: 1910.1450(f)(4)(ii)

Site-specific training provided by Lab Supervisors to employees and students will include:
1. Site-specific standard operating procedures.
2. Specific physical and health hazards of chemicals in the work area (available on Material Safety Data Sheets).

Documentation. General awareness training required by the CHP will be documented by the CHO. Site-specific training must be documented and maintained by the PI/Supervisor.

1.8 RECORD KEEPING

The CHO will retain records of all employees and students who attend the general chemical safety seminar, bloodborne pathogen training, and any other subject specific safety training provided by the CHO.
It is required that records of specific laboratory training for individual laboratories be retained by the PI in the laboratory or the department.
Accident records for employees and students should be forwarded to the CHO, ideally within 24 hours. All accidents which require first aid (other than paper cuts) need to be reported.
Ideally, training records should be retained indefinitely.
Accident reports for employees, including faculty, are located at
http://www.smith.edu/hr/documents/frm_forms_FirstReportofInury.pdf

Accident report forms for students can be obtained from either the Burton Hall main office (B115), or the Ford Hall main administrative office (FH 255) and are also located at
http://www.science.smith.edu/resources/safety/studentaccident.html

2.0 EMERGENCY / MEDICAL PROCEDURES

The first priority in emergency response is the protection of life and health. ALWAYS make sure everyone in the immediate vicinity is aware of the problem. Pull the alarm to evacuate the building if the emergency cannot be contained or if there is any doubt as to the severity of the situation. Summon aid by calling 800 or 413-585-2490 from a safe location.

2.1 BASIC STEPS FOR EMERGENCY AND SPILL RESPONSE

Releases of hazardous substances that pose a significant threat to health and safety or that, by their very nature, require an emergency response regardless of the circumstances surrounding the release or the mitigating factors are emergency situations. The following definitions designate an **emergency situation**:

1. The situation is unclear to the person causing or discovering the spill.
2. The release requires evacuation of persons.
3. The release involves or poses a threat of one or more of the following:
    A. Fire, suspected fire, explosion or other imminent danger
    B. Conditions that are Immediately Dangerous to Life and Health (IDLH)
    C. High levels of exposure to toxic substances.
4. Laboratory workers are uncertain they can handle the severity of the hazard with the personal protective equipment (PPE) and response equipment that has been provided and/or the exposure limit could easily be exceeded.

Conversely, releases that do not pose significant safety or health hazards to person(s) in the immediate vicinity or to the person(s) cleaning releases, do not have the potential to become emergencies within a short time frame are not emergency situations. The following situations **ARE NOT emergency situations**:

1. The person causing or discovering the release understands the properties and can make an informed decision as to the exposure level.

2. The release can be appropriately cleaned up by the lab personnel using authorized spill kits.
3. The materials are limited in quantity, exposure potential, or toxicity and present minor safety or health hazards to persons in the immediate work area or those assigned to clean up the activity.

2.1.1 Emergency Situation - Fire. The following steps are basic protocol for handling a fire or fire-related emergency situation in the laboratory:
1. Pull the fire alarm.
2. Call 800 from a safe location. **(413-585-2490 from a cell phone**) and give as much information as you can about the situation.
3. Evacuate

2.1.1.2. Fires in the Laboratory

Many small laboratory fires can be controlled by removing the source of ignition, dousing with water (**do not apply water to chemical fires**) or smothering the flame with a watch glass or beaker to eliminate the oxygen needed to sustain the fire. If the fire cannot be extinguished with such immediate actions or those actions are not successful the following actions should be taken.

A. If the fire is in a hood, close the sash.
B. If your clothing or hair is on fire, drop to the floor and roll, use the deluge shower, or use the fire blanket to extinguish the flames.
C. Decide if the fire can be safely fought with a fire extinguisher based on the guidelines listed below.
D. Pull the alarm to signal evacuation.
E. Evacuate the building.
F. Call ext. 800 to notify Security.
G. Assist the fire department by providing them with information on the exact location of the fire, hazards in the area, and location of emergency shutoffs.

Using Fire Extinguishers

Fire extinguishers are in the laboratory to assist in the evacuation of laboratory occupants and extinguish incipient stage fires.

They should only be used to fight a fire only if **ALL** the following are true.

A. Someone has been sent to pull the alarm for evacuation and to call Security at ext. 800.
B. The fire is small and confined to the immediate area where it started (e.g., in a wastebasket).
C. There are no flammable chemicals or other combustible materials near the fire area.
D. You can fight the fire while retaining a safe escape route.

E. You have had training in the use of the extinguisher and are confident that you can operate it effectively.
F. Evacuate immediately if releasing the contents of one fire extinguisher is not enough

Extinguishers are inspected monthly by the custodial staff to ensure that each extinguisher:

1. is located in the designated place,
2. is not obstructed in access or visibility,
3. has visible operating instructions and nameplate,
4. has unbroken seals,
5. indicates pressure is in the operable range, and
6. has no physical damage, corrosion or leakage.

The inspection tag is dated and initialed for every inspection. Annual extinguisher maintenance and periodic hydrostatic testing in accordance with OSHA 29 CFR 1910.157 is done by a contractor under the supervision of Facilities.

2.1.2 **Emergency Situation – Personal Injury, Unknown Cause**

In the event an individual observes someone in a lab in distress, but does not know what has occurred:

A. Call **800 (413-585-2490 from a cell phone)**
B. Contact the faculty member responsible for the space
C. Students are advised NOT to enter a chemical/biological/radiological laboratory without the assistance of faculty or an emergency responder (such as Public Safety or the CHO)

2.1.2.2 Hazardous Chemical Contamination.

In the event of **eye contamination** take the following action.

1. Go immediately to an eyewash station or drench hose and flush the eye for at least **15 minutes** (the 15 minute flushing time is essential to prevent damage to the eyes).
2. Hold the eyes open (contact lenses must be removed).
3. Medical attention is required for <u>all</u> cases of eye contamination. Call Public Safety at **800** (**413-585-2490** from a cell phone) to receive transportation to either Health Services or Cooley Dickinson Hospital.

In the event of **skin or clothing contamination** take the following action:

1. Use the safety shower, drench hose or laboratory sink to thoroughly flush the area (do not go to the restroom to wash).
2. Remove all contaminated clothing. If the head has been contaminated flush well prior to removing safety goggles so that contaminants are not flushed into the eyes.
3. Call Security for assistance at ext. **800 (413-585-2490 from a cell phone)**
4. In cases of visible tissue damage, contamination of a large area, or contamination with an acutely toxic substance, immediate medical attention is required. In other cases, follow the first aid recommendations on the Material Safety Data Sheet (MSDS) for the substance. If the MSDS indicates a medical consultation is necessary, either call the Health Service at ext. 2800 during the semester to request this or else request transport from Public Safety **2490 (413-585-2490** from a cell phone) to Cooley Dickinson Hospital for advice on the need for immediate medical treatment.
5. Take the MSDS with you
6. A clean lab coat or fire blanket can be used as a wrap during transportation.

2.1.3 Emergency Situation - Spill. If the spill is of high toxicity or flammability or you are unsure of how to proceed or is more than one liter, execute the following:
1. Call **800** from a safe distance. **(413-585-2490 from a cell phone**) and give as much information as you can about the chemical(s) involved.
2. Evacuate
Evacuation of the building is mandatory if chemicals or contaminants could become re-entrained into the air handling system of a building.

2.1.4 Mercury Spills.
This Policy approved by the Institutional Chemical Hygiene Committee February 9, 2012

Mercury Device Remediation Requirements

In order to protect the health of those in the labs, offices and common spaces of Ford, Sabin Reed, McConnell, Bass, and Burton, and to prevent contamination spreading outside of laboratories, the following interim mercury remediation policy is in effect.

Any breakage of a mercury-containing device (such as a thermometer, barometer, manometer, etc.), which results in any spillage of elemental mercury must be remediated using the steps below:

All initial mercury spill cleanup must be supervised by a faculty or staff member. All mercury spill cleamup must be inspected by either Margaret Rakas or Richard Korzeniowski before the area can be reopened for normal activities. Students may not assess or remediate any incident involving broken mercury-containing devices unless under the direct supervision of a faculty or staff member.

1) Initial Steps

a. If a mercury spill has occurred in the context of a larger emergency (e.g. FIRE, OTHER HAZARDOUS CHEMICAL SPILL, MEDICAL EMERGENCY) a fire alarm should be pulled as the space and building are evacuated. From a safe location call 800 (CAMPUS PHONE) or 413-585-2490 (CELL PHONE).

b. Where there is only a mercury spill those individuals in the area of the spill should travel immediately to the nearest phone, **avoiding the area of the spill. Call the supervising faculty or staff member by phone if they are known to be in the immediate area.**

c. A call to x 2490 (413-585-2490) to report a broken mercury device and ask they contact Margaret Rakas or Richard Korzeniowski MUST be made even if the faculty member is available. Once the phone calls have been made, the caller must stay close to the spill site to provide information to the responders. Wait for either the faculty member or Margaret/Rich to arrive.

d. Do not walk around more than necessary as shoes or pants may be contaminated and 'shed' miniscule mercury droplets. Keep others away from the contaminated area. Mercury droplets can travel a significant distance; it is best to assume at least a 5-foot radius in the area of the breakage/spill.**.**

2) Next Steps:

a. If the faculty or staff supervisor is in the immediate area, mercury cleanup can begin if the faculty/staff member is familiar with the mercury spill response procedures and does not want to wait for assistance. Important: never use a vacuum cleaner; instead, push pools of mercury together with cardboard, index cards, pieces of cardstock (a file folder is a good weight for this), or use a glass pipette with a bulb to pick up droplets.

b. If the faculty/staff member does not feel comfortable assessing the situation or beginning cleanup, keep the area clear until Margaret or Rich arrive.

c. Activities in the area of the spill must cease until spill clean-up is completed and assessed to ensure there are no tiny mercury beads remaining. Those in the immediate vicinity of the spill must have their clothes and shoes checked for mercury droplets and should not leave the area of the spill until testing has occurred.

d. Margaret/Rich will assess the spill cleanup and determine whether additional remediation is necessary or if the area may be re-opened for normal use.

We understand these guidelines may result in significant inconvenience to faculty, staff, students, and other researchers; however, the potential health effects and disruption of space use and programming from mercury contamination in lab and other work/common spaces are significant reasons for concern.

Faculty and staff can reduce the impact of this policy on their laboratory operations by replacing mercury-containing devices with alternatives wherever possible, and cautioning researchers to be extremely careful when using mercury-containing devices.

More Information about Remediation of Mercury Spills-
1. Do not use a vacuum cleaner or large broom. DO push the droplets together with small pieces of cardboard or mercury cleanup sponges, or use mercury cleanup powder or a mercury 'vacuum', all available from the spill kits. Some have found that index cards or sections cut from file folders are very effective for this cleanup.
2. Place residue (including any brushes) in a container with a hazardous waste label for hazardous waste collection.
3. For mercury spills which occur in heated apparatus, if the apparatus can be easily placed in a fume hood, do so. If not, turn it off in place, evacuate the room, and call 800. **For large mercury spills, call 800 (413.585.2490 from a cell phone**), and ask Public Safety to **contact the CHO for spill cleanup assistance.**

2.1.5 Spill Kits.

Spill kits are available in the hallways of laboratory buildings (outside Ford Hall 226 and 326, and in the hallway outside Sabin Reed 112 and opposite Sabin Reed 414). Contact the CHO if one is missing, or if supplies need replenishing.

If there are questions about proper spill response techniques, call the CHO.

2.1.6 Power Outages. If there is a power outage and emergency lighting is activated, evacuate the building after the following steps have been taken:
• Place lids on all open containers of volatile chemicals
• Lower the sash on chemical fume hoods
• Shut down all equipment (leave cooling water and purge gases on as necessary)
• Turn off ignition sources
• Secure or isolate reactions that are underway (boiling liquid on a hot plate, distillations)
• Close fire doors
• Take your books, coats, purse/wallet, keys, etc.
• Lock outside door to lab
In anticipation of possible power outages, do the following:
• Have a flashlight conveniently located or other emergency lighting
• Make sure that all emergency contact numbers on the door are accurate and updated

2.2 INJURY AND ILLNESS

For medical treatment, under current Smith College policies and procedures found in the Safety Handbook, employees must coordinate their care with Human Resources. All faculty and staff must file an accident report as soon as feasible for any injury requiring first aid. For emergency or critical medical care, employees should call 800 and request transportation to Cooley Dickinson Hospital's Emergency Room. If the accident/injury is less serious, employees may want to choose AEIOU Occupational Health & Urgent Care in Amherst , which has some evening and weekend hours. Their number is 413-461-3530, and they are located at 170 University Drive.

Faculty must encourage any student requiring first aid to seek a professional medical opinion. Faculty or lab instructors must have students complete a student accident form as soon as reasonable, and for minor injuries during the academic year, urge students to call the College's Health Services (x2800) to inquire whether they should be seen. For minor injuries requiring additional treatment, students should go to Health Services when it is open (call x2800 to confirm). When Health Services is closed, students should go to Cooley Dickinson Hospital's Emergency Room. Smith College Public Safety will transport or arrange for an ambulance as soon as required (immediately for urgent cases, within a short time period for less urgent care needs).

The supervisor or instructor must ensure the appropriate injury report forms are completed. See Human Resources website for copies of the appropriate forms. The web link to Human Resources is http://www.smith.edu/hr/forms.php
Student accident forms can be obtained from either Burton or Ford Hall main offices, or online at
http://www.science.smith.edu/resources/safety/forms.html
or from
http://www.science.smith.edu/resources/safety/studentaccident.html

If you have any questions regarding injury and illness procedures, contact your faculty supervisor, instructor or Human Resources.

2.3 MEDICAL CONSULTATIONS AND EXAMINATIONS

1. Smith College will provide medical consultations for employees under any of the following circumstances:

A. When an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee must be provided an opportunity to receive an appropriate examination.
B. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) 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.

C. 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 consultations shall be for the purpose of determining the need for a medical examination.
D. All medical consultations and examinations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place. Employees requesting medical consultation should contact the EH&S Office or the Science Center Director's Office.
3. The laboratory PI or supervisor shall provide the following information to the physician:
A. The identity of the hazardous chemical(s) to which the employee may have been exposed.
B. A description of the conditions surrounding the exposure, including available quantitative exposure data.
C. A description of the signs and symptoms of exposure that the employee is experiencing, if any.

Employee exposure and medical records relevant to the employee are available to employees and their designated representatives in accordance with 29 CFR 1910.20. Exposure records are maintained by the EH&S Office. Access to medical and exposure records will be provided within 15 days of written request to the director of the Health Service or the Chemical Hygiene Officer.

3.0 STANDARD OPERATING PROCEDURES

Smith College, through the Clark Science Center, has developed generic standard operating procedures relevant to safety and health when laboratory work involves the use of hazardous chemicals. Where the scope of hazards is not adequately addressed by this general document, departments, units and/or PIs must develop written standard operating procedures for work area specific operations. Standard operating procedures must be provided to all affected laboratory employees and students.
***The Standard Operating Procedures in this document specify <u>minimum guidelines</u>- it is expected that Smith College faculty and staff develop and implement additional rules in their respective laboratories.**

3.1 GENERAL SAFETY PRINCIPLES

The following guidelines have been established to minimize hazards and to maintain basic safety in the laboratory. They have been sourced from “Prudent Practices”, 2011.

A. Examine the known hazards associated with the materials being used. Never assume all hazards have been identified. Carefully read the label before using an unfamiliar chemical. Always review the Material Safety Data Sheet (MSDS) for special handling information involving hazardous chemicals. Determine the potential hazards and use appropriate safety precautions before beginning any new operation.
B. Be familiar with the location of emergency equipment - fire alarms, fire extinguishers, emergency eyewash and shower stations and know the appropriate emergency response procedures.

C. Avoid distracting or startling other workers when they are handling hazardous chemicals.
D. Use equipment and hazardous chemicals only for their intended purposes.
E. Always be alert to unsafe conditions and actions and call attention to them so that corrective action can be taken as quickly as possible.
F. Wear eye and face protection when a splash or spray hazard exists, when in a lab with hazardous chemicals in use, or when the lab contains acutely toxic or pyrophoric materials. When working with, or in close proximity to acutely toxic chemicals, corrosive materials, cryogenic liquids (dry ice/acetone , liquid nitrogen) or pyrophoric materials, chemical splash goggles are required. Safety glasses are permitted when working with hazardous chemicals that do not fall into these categories, and/or whose MSDS's indicate these are appropriate.
G. Always inspect equipment for leaks, tears, cracks and other damage before using with a hazardous chemical. This includes fume hoods, gloves, goggles, glassware, etc.
H. Avoid tasting or smelling hazardous chemicals.

3.2 HEALTH AND HYGIENE
The following practices have been established to protect laboratory employees and students from health risks associated with the use of hazardous chemicals.
A. Avoid direct contact with any hazardous chemical. Know the types of protective equipment available and use the proper type for each job.
B. Confine long hair and loose clothing and always wear closed-toe footwear.
C. Do not mouth pipette.
D. Use appropriate safety equipment whenever exposure to gases, vapors or aerosols is suspected and ensure exhaust facilities are working properly.
E. Wash thoroughly with soap and water after handling chemicals, before leaving the laboratory and before eating or drinking.
F. Contact lenses are allowed only with safety eyewear when using hazardous chemicals.
G. Replace personal protective equipment as appropriate.
H. Laboratory employees and students shall be familiar with the symptoms of exposure for the chemicals with which they work and the precautions necessary to prevent exposure.

3.3 FOOD AND DRINK IN THE LABORATORY
The following statement is the accepted practice at Smith College, and persons working in laboratories must be made aware of it:
"Neither food nor drink is allowed in laboratories, nor is smoking, gum-chewing,or applying cosmetics allowed in laboratories which have radioactive materials, biohazardous materials, or hazardous chemicals present".
There shall be no storage, use, or disposal of these 'consumable' items in laboratories. Refrigerators within laboratories for personal use are not allowed.

3.4 HOUSEKEEPING
Safety follows from good housekeeping practices. Use the following guidelines:
A. Keep work areas clean and uncluttered with chemicals and equipment. Clean up laboratory bench areas upon completion of an operation or at the end of each work day.

B. Dispose of waste as per the Smith College **Hazardous Waste Disposal Guide**.
C. A separate waste receptacle must be designated for laboratory glass.
D. Any item that could puncture skin (such as a needle, razor blade, wooden pointed dowel, or a plastic "Pipetteman tip" with a sharp point) must be disposed of in a puncture-proof container, available at either Ford or Sabin Reed Stockroom
E. Clean minor spills immediately and thoroughly. A chemical spill kit is available in the second and third floor hallway of Ford Hall (outside FH 226 and FH 326), and on the first and fourth floor of Sabin Reed (outside SR 112 and opposite SR 414). Only trained laboratory workers should attempt minor spill cleanup.

i."Minor" spills cannot be defined specifically based on toxicity and/or volume; the laboratory worker must not attempt any spill response if adequate Personal Protection Equipment (PPE) is not available, nor should the worker place herself/himself or others in a risky situation. At a minimum, minor spill cleanup requires appropriate PPE, such as nitrile gloves, a labcoat, and safety glasses.

ii. Students may clean up those spills which faculty members or instructors have given permission for, or when instructors and faculty are present.

iii. It is suggested that faculty periodically discuss with students what types of spills could occur in their teaching and/or research labs, and which spills students may clean up, and how to do so.

iv. For ALL mercury spills (including mercury from devices such as thermometers) please follow the Mercury Remediation Policy in Section **2.1.4**

F. Do not block exits, emergency equipment or control panels, or use hallways and stairways as storage areas.
G. No chemicals, apparatus, books, or other materials may be stored within 18 inches of the plane of sprinklers.
H. Properly segregate hazardous chemicals into compatible categories. For assistance in suggested shelf storage patterns, consult with the CHO or Appendix IV at the end of this document.

3.5 CHEMICAL HANDLING AND STORAGE

Proper chemical use at Smith College starts at initial receipt and continues through to disposal. The Science Center has a Chemical Inventory program, and faculty and staff can view chemicals present in their lab. Please see the CHO for further details and to obtain a password.

A. Information on proper handling, storage and disposal of hazardous chemicals and access to related Material Safety Data Sheets should be made available to all laboratory employees and students prior to the use of the chemical.
B. Always purchase the minimum amount necessary to maintain operations.

C. Chemical containers with missing or defaced labels or that violate appropriate packaging regulations should not be accepted.
D. Hazardous chemicals should not be stored above 5 feet and large bottles (4 Liter or larger) should be stored no more than at the level of the fume hood or benchtop.
E. Chemicals shall be segregated by compatibility. See Appendix IV of this manual for details on compatible storage.
F. Chemical storage areas must be designated as such.
G. Storage of chemicals at the lab bench or other work areas shall be kept to a minimum.
H. Any chemical mixture prepared in the laboratory shall be assumed to be as toxic as its most toxic component.
I. Substances of unknown toxicity shall be assumed to be toxic.
(Citation: 1910.1450(h)(2)(ii)

3.6 TRANSPORTING OF CHEMICALS WITHIN A BUILDING/COMPLEX
When transporting chemicals outside the laboratory, precautions should be taken to avoid dropping or spilling chemicals.
A. Carry glass containers in specially designed capped bottle carriers or a leak resistant, unbreakable secondary container.
B. When transporting chemicals on a cart, use a cart that is suitable for the load and secondary containment.
C. Open containers of laboratory liquids which have to be transported through hallways either must be in secondary containment, such as a tray, or on a cart in secondary containment.
D. Chemical transport in Ford Hall must be through the South wing of the building, and avoid the central staircase and North wing. Either the South elevator or South stairs may be used.
E. Transport of hazardous chemicals or biologicals across Green Street (to/from Ford Hall and Sabin Reed) requires the use of an Igloo cooler or similar hard-sided container, and secondary containment within the carrier. The outside of the container must be marked "Research Samples-If Found Call X2490" and have the name of the faculty member (not student) on it. No mercury or acute toxins may be transported across Green Street by students, staff or employees; if absolutely required, with advance notice this can be performed by the College's hazardous materials handler or an air shipping company.
F. Both to protect valuable research as well as respect the concerns of others, transport of nonhazardous biologicals and chemicals should occur in labeled, closed secondary containment, so that there is no risk of spillage or loss of small vials. This can be as straightforward as a Styrofoam box with top or a closed cardboard box, labeled with the researcher's name.

3.7 COMPRESSED GASSES
Special systems are needed for handling materials under pressure. Cylinders pose mechanical, physical, and/or health hazards, depending on the compressed gas in the cylinder.
A. **Cylinders with regulators must be individually secured**. Only cylinders with valve protection caps securely in place may be safely gang-chained (chained in groups).

B. When storing or moving a cylinder, have the valve protection cap securely in place to protect the valve stem.
C. Cylinders must be secured in an upright position at all times. Use suitable racks, straps, chains, or stands to support cylinders against an immovable object, such as a bench or a wall, during use and storage.
D. Use an appropriate cart to move cylinders. **DO NOT MOVE CYLINDERS BY ROLLING THEM!**
E. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
F. Oil or grease on the high pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator and only use an oxygen approved regulator.
G. Always wear goggles or safety glasses with side shields when handling compressed gases.
H. Check cylinders, connections, and hoses regularly for leaks.
I. Always use a regulator sold for use with the specific gas; adapters may only be added on the downstream (low pressure) side of the regulator. All fittings, hoses, and other materials in contact with the gas should be compatible.
J. When working with a toxic, flammable (not including 'house' natural gas already plumbed into the labs), corrosive, or reactive gas is planned, prior approval by the ICHC is required. These gases may need to be used and stored with local exhaust ventilation such as a gas cabinet designed for that purpose, and require purge systems, regulators, or other equipment installed according to manufacturer's specifications.

3.8 UNATTENDED OPERATIONS

Leaving a laboratory operation (e.g. reactions, distillations, experiments involving heat or water condensers) unattended is discouraged. When circumstances require such action, the following basic guidelines must be in place:
A. Always check with your laboratory supervisor to determine if it is necessary to leave a laboratory operation unattended. If necessary, develop a protocol with your laboratory supervisor for the unattended operation of potentially dangerous equipment or methods. Develop a protocol for potential interruptions in electric, water, inert gas and other services and provide containment for the potential release of hazardous substances as part of the protocol.
B. A warning notice must be posted on the door of the lab housing the experiment if hazardous conditions are present. This notice must include the cell phone number of the researcher and the name of the supervisor/PI, along with any other relevant information (process requires cooling water at all times, OK to stop stirring motor, etc).

3.9 Laboratory Use and Student Supervision
Definitions
After Class-<u>all times other than regularly scheduled laboratory periods</u>

<u>Open Hours</u>: when the Science Center is open (main doors unlocked)

Academic Year

Monday-Friday	7:00 AM-6:00 PM

Summer

Monday-Friday	8:00 AM-6:00 PM

<u>After Hours</u>- all times when the Science Center is not open

Buddy System- Another person within voice contact or in the same lab, with whom a researcher has made arrangements for assistance if necessary. The 'buddy' must be a member of the Smith Community (a Five-College student who is enrolled in the same laboratory class or working with a Clark Science Center researcher qualifies, as does a Five-College graduate student working with a Smith faculty member).

<u>Working Alone</u>- A person is 'working alone' when there is no other person in the laboratory or within voice contact. The second person must be a member of the Smith Community and must be aware they are serving in the 'buddy' capacity.

<u>Hazardous Operations</u>-Laboratory operations that could result in personal injury, chemical overexposure, or fire under normal procedures or in the event of human error or equipment failure.

The following operations are deemed hazardous

1. Use of any controlled radiation source (the Radiation Safety Program requires the approved Investigator is present on campus)
2. Work on electrical installations that pose a significant shock hazard (e.g., DC greater than 40 volts, AC greater than 24 volts)
3. Experiments which pose an explosion or implosion hazard
4. Use of open flames
5. Handling of greater than 4 liters or 1 kg flammable or corrosive chemicals
6. Handling of ANY quantity of reactive or acutely toxic chemical

Faculty members are responsible for evaluating all other operations to determine if they are defined as hazardous for the purpose of this CHP. Faculty are invited to apply to the ICHC for a determination of the hazard status of any operation**.**

3.9.1 WORKING ALONE-Faculty and Technical Staff

It is essential that more than one person be present when highly toxic materials are handled. Otherwise, avoid working alone whenever possible. Each faculty or associate is expected to avoid working alone whenever possible and to use good judgment when evaluating hazardous operations in 'working alone' situations. This in no way implies that any other safety regulations are waived; on the contrary, the use of good judgment implies expert knowledge of safe procedures and practices.

3.9.2. STUDENT LABORATORY USE

3.9.2.1 Performing Hazardous Operations

Undergraduates, teaching assistants, graduate students, and research assistants are not allowed to perform any hazardous operations *when working alone* unless permission for a specific operation or experiment is granted by the supervising faculty member. Faculty members should only grant such permission after careful review of the operation and a determination that the hazard is minimal. The Buddy System is required for **all after-hours** laboratory work.

3.9.2.2 Working Alone-Students

If circumstances require a laboratory employee or student to work alone, supervisors must be notified prior to the occurrence, and emergency contact information must be in place. Only non-laboratory work, such as working on a computer, may be done without a buddy **after hours** (this includes all day Saturday and Sunday) by students. No laboratory experiments, hazardous or not, may be performed after hours without a buddy present or within voice range.

3.9.2.3 After Class Laboratory Coursework

Undergraduate students, in courses with regularly scheduled laboratory periods, are not allowed to perform class experiments or work in teaching laboratories at other than regularly scheduled class periods if such work includes hazardous operations without the direct supervision of a faculty member or instructor. Non-hazardous operations require the permission of the faculty member or instructor; any laboratory experiments, hazardous or not, require the use of the Buddy System.

3.9.3. RESEARCH SUPERVISION

It is essential for the safety of our students that research students working in the laboratory have a faculty member or technical staff member available to review procedures and answer questions. A faculty member supervising students working in a laboratory who is going to be away from Northampton must make arrangements with another faculty member or technical staff member, knowledgeable about the

experimental procedures and equipment being used, to provide interim supervision. The student(s) and the Administrative Office should be informed of this supervisory arrangement and the relevant dates. There is no need to specify the reason for the absence.

3.10 STORAGE AND DISPOSAL OF HAZARDOUS WASTE

For guidelines on the storage and disposal of hazardous wastes from laboratory operations refer to the Smith College Hazardous Waste Disposal Guide. It can be found at **http://www.science.smith.edu/resources/safety/beta.html**

3.11 Guidelines for Independent Projects in Classes

(To be written)

4.0 STANDARD LABORATORY SAFE HANDLING / STORAGE REQUIREMENTS

4.1 HAZARD IDENTIFICATION

Identifying the specific hazard associated with a chemical greatly reduces chances of misuse by regular laboratory employees, students, new users, or visitors to the laboratory. At the very minimum, hazardous chemical containers must have the chemical name(s) and hazards identified.

1. Faculty/Supervisors must ensure that labels on incoming containers of hazardous chemicals for laboratory use are not removed or defaced.
2. Faculty/Supervisors must ensure that laboratory-use chemical containers (those containers filled from the original shipping container) are labeled with the same hazard warnings found on the original container.
3. Faculty/Supervisors must ensure that hazardous chemical storage areas are labeled per the guidelines established in section 5.1.4.
4. Faculty/Supervisors must ensure that entranceways to laboratory facilities are labeled with the appropriate warning signs per the guidelines established.
5. Faculty/Supervisors must ensure that employees and students have access to MSDS's

4.2 HAZARDS SUBJECT TO REVIEW OR PRIOR APPROVAL

The Laboratory Standard requires that PIs/supervisors identify those activities that are of a sufficiently hazardous nature to warrant prior approval before implementation by an employee or student.

4.3 CHEMICALS DEVELOPED IN THE LABORATORY

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

1. If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the Faculty must determine if it is a hazardous chemical. This can be done by a literature search for similar substances. If the chemical is determined to be hazardous, the PI must provide appropriate training to protect employees and students.
2. If the chemical produced is a product or a by-product whose composition is not known, the PI must assume that the substance is hazardous and must comply with the requirements of the CHP. See Section 4.4.1.b.

4.4 LABELING

4.4.1 Container Labels. All containers of hazardous chemicals must be labeled with the name of the chemical and the hazard(s), if not provided by the manufacturer. If a chemical has more than one hazard, it must be labeled with both hazards. For example, acetaldehyde is both flammable and a carcinogen, and must be labeled appropriately. Additionally, these guidelines shall be followed:

1. Labeling Basics

a. For containers labeled by the manufacturer:

- Inspect the labeling on incoming containers.
- Replace damaged or semi-attached labels.

b. For transferred products or prepared solutions labeled by the user:
• Label each chemical container with the chemical name and hazard warning.
• Refer to the Material Safety Data Sheet (MSDS) for hazard warning

2. Labeling Peroxide Forming Chemicals

a. Peroxidizable chemicals (such as diethyl ether) must be labeled with:
• Date Received
• Date Opened

It is recommended that unused peroxide formers be disposed of or tested for peroxides and adequately stabilized within general guidelines based on date of opening. For a list of peroxide formers see
http://blink.ucsd.edu/safety/research-lab/chemical/storage/peroxide/chemicals.html

3. Consumer Products. Anything available over the counter to the general public is exempt from labeling requirements if it has already been labeled by the manufacturer. This includes consumer products such as cans of spray paint or turpentine. Any food or over-the-counter drugs used as part of a laboratory experiment or research project must be labeled with the phrase "Not For Human Consumption" or "Do Not Eat".

4.4.2 Waste Containers. All hazardous chemical waste should be segregated and labeled according to the Hazardous Waste Disposal Guide. Special attention should be given to the following areas:
1. Waste containers for non-contaminated glass **must be labeled** (label as "Broken Glass") and kept separate from other non-contaminated waste.
2. Upon initial waste collection, attach a Hazardous Waste label to the container and check the appropriate hazard box.
3. Please request a hazardous waste pick-up from the CHO.
4. Label the contents with full chemical name- formulae or abbreviations may be present ONLY if the full chemical name is alongside.
5. Keep a cap on the container at all times except when adding to it.
6. Provide secondary containment for liquid wastes if stored in a hood or near a sink.

4.5 PROVISIONS FOR PARTICULARLY HAZARDOUS SUBSTANCES

4.5.1 Permissible Exposure Limits. The Laboratory Standard requires that employers, for laboratory uses of substances regulated by OSHA/MIOSHA occupational health standards, assure that employees' and students' exposures do not exceed the Permissible Exposure Limits (PELs). The PELs represent Time Weighted Averages (TWA's) in parts per million (ppm) or milligrams of substance per cubic meter of air (mg/m3). The TWA represents the ratio between exposure and work shift.
The American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLV's), which are TWA values similar to PEL's. The TLV's are in some cases lower than the PELs.

4.5.2 Employee Exposure Determination. Employers must contact the CHO to perform employee or student exposure monitoring under the following circumstances:
1. Initial monitoring must be performed if there is reason to believe employee or student exposure levels routinely exceed the action level, or Permissible Exposure Limit (PEL).

Signs and symptoms, based on the MSDS or other resource material, may provide such information.
2. Periodic monitoring must be performed when initial monitoring reveals an exposure. The employer should comply with exposure monitoring provisions of the relevant standard.
29 CFR 1910.1450 (d) (1-2)

4.5.3 Special Considerations. Additional precautions for employee and student protection must be followed for the laboratory use of select carcinogens, reproductive toxins and chemicals with a high degree of acute and chronic toxicity . It is the faculty member's responsibility to inform researchers they are working with a particularly hazardous substance and to ensure the procedures below are implemented. Written procedures (aka "SOP" or Standard Operating Procedure) are recommended by the US Chemical Safety Board, and are required to be reviewed by the Institutional Chemical Hygiene Committee (ICHC) prior to purchase and use of acute toxins. The PI or laboratory supervisor must create specific SOP's for the specific hazard (not necessarily the specific chemical). Links to several sample formats for an SOP are included in Appendix V; the Chemical Hygiene Officer is available to assist any faculty or staff member in preparing an SOP.

The following general hygiene standards must be observed when using select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity.
Establish a designated area.
A. Use and store materials only in **designated areas**: a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances. Assure that all personnel with access are aware of necessary safety precautions.
B. Label all containers, storage and use areas appropriately. All non-original containers must have the chemical name and a warning indicating it is an acute toxin, reproductive hazard, or select carcinogen.
Use proper containment devices for the protocol and chemical(s) being used.
A. Use a hood or other containment device for procedures which may result in the generation of aerosols or vapors;
B. It is recommended that breakable containers be stored in chemical-resistant trays. Work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.
C. Glassware must be decontaminated or rinsed and the rinseate collected as hazardous waste before it is washed . "Empty" bottles of particularly hazardous substances may still be hazardous and should be labeled and collected as hazardous waste.

4.6 PHYSICAL HAZARDS
Materials which present a physical hazard can be safely used if the specific hazard(s) are understood. If appropriate precautions are not taken, personal injury or property damage may occur. Additionally, certain chemicals cannot be safely mixed or

stored with other chemicals because of the danger of a violent reaction or a reaction that generates toxic gas. See Appendix IV for details on compatible storage.
Hazardous chemicals require that employees and students follow special procedures for handling and storage.

4.6.1 Flammable/Combustible Material: The National Fire Protection Agency (NFPA) places flammable and combustible liquids in the following classes:

Flammable
Class IA < 73 °F (22.8 °C) < 100 °F (37.8 °C)
Class IB < 73 °F (22.8 °C) ≥ 100 °F (37.8 °C)
Class IC ≥ 73 °F (22.8 °C) & < 100 °F (37.8°C)
Combustible
Class II ≥ 100 °F (37.8 °C) & < 140 °F (60 °C)
Class IIA ≥ 140 °F (60 °C) & < 200 °F (93 °C)
Class IIIB ≥ 200 °F (93 °C)
These classes give a measure of the fire risk. Below are some examples of common flammable and combustible chemicals, classified according to the categories above (all, from NFPA's website http://www.nfpa.org/faq.asp?categoryID=920&cookie_test=1)

- Class IA - Diethyl Ether, Ethylene Oxide, some light crude oils
- Class IB - Motor and Aviation Gasolines, Toluene, Lacquers, Lacquer Thinner
- Class IC - Xylene, some paints, some solvent-based cements
- Class II - Diesel Fuel, Paint Thinner
- Class IIIA - Home Heating Oil
- Class IIIB - Cooking Oils, Lubricating Oils, Motor Oil

Note: the flash point is defined as the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

For handling Flammable/Combustible materials, observe the following guidelines:
A. Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity. Remove unneeded chemicals and other combustibles from the vicinity of operations.
B. Store in appropriate flammable liquid containers or storage cabinets, in an area isolated from ignition sources or in a special storage room designed for flammable materials.
C. Ensure there is proper bonding and grounding when transferring or dispensing a flammable liquid from a large container or drum.
D. Evaluate that appropriate fire extinguishers and/or sprinkler systems are in the area.

4.6.2 Corrosives
A. Use appropriate containers and equipment for storage of corrosives.
B. Safety goggles and rubber gloves must always be used when handling corrosive materials. A faceshield, rubber apron, and rubber boots may also be appropriate, depending on the work performed.
C. **Never add water to acid.** When mixing concentrated acids with water, add the acid slowly to water.
D. An eyewash and safety shower must be readily accessible to areas where corrosives are used and stored. In the event of skin or eye contact with corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Obtain medical help.

4.6.3 Oxidizers are materials which oxidize other substances by accepting electrons and undergoing reduction. This reaction may result in fire or explosion. The intensity of the reaction depends on the oxidizing-reducing potential of the materials involved. Safe handling involves the following:
A. Know the reactivity of the materials involved in the experiment or process.
B. If the reaction is anticipated to be violent or explosive, conduct the experiment in a fume hood or use other methods for isolating the materials.

4.6.4 Water Reactive Materials are materials which react with water to produce a flammable or toxic gas or other hazardous condition, which can lead to a fire or explosion. Safe handling of water reactive materials will depend on the specific material and the conditions of use and storage. Examples of water reactive chemicals include alkali metals such as lithium, sodium, and potassium; acid anhydrides, and acid chlorides.

4.6.5 Pyrophoric Materials are materials which ignite spontaneously upon contact with air, and often the flame is invisible. Examples of pyrophoric materials are sodium, lithium reagents, s, silicon tetrachloride, and white or yellow phosphorous. **Pyrophoric chemicals should be used and stored under inert conditions.**

4.6.6 Peroxidizable Chemicals (Organic Peroxides) are materials which undergo auto-oxidation (a reaction with oxygen in the air) to form peroxides which in turn can explode when paired with impact, heat, or friction.
A. Date all peroxidizables upon receipt and upon opening. Dispose of or check for peroxide formation routinely. Three months or one year are typical limitations for peroxidizable compounds once opened.
B. Do not open any container which has obvious solid formation around the lid.
C. It is recommended to chemically test for peroxides periodically. Consult with the CHO for test strips.

4.6.7 Light-Sensitive Materials are materials which degrade in the presence of light, forming new compounds that can be hazardous, or resulting in conditions such as pressure build-up inside a container. Examples of light sensitive materials include chloroform, tetrahydrofuran, ketones and anhydrides. Store light-sensitive materials in a

cool, dark place in amber colored bottles or other containers which reduce or eliminate penetration of light.

4.6.8 Unstable Materials are compounds which can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as peroxides, perchlorates (from perchloric acid), picric acid, and azides.
A. Contact the CHO when it is suspected that formation of shock-sensitive materials in ductwork (picrates), piping (azides), or within chemicals being stored, has occurred.
B. Date all containers of explosive or shock-sensitive materials upon receipt and when opened.
C. These materials typically require special handling. Perchloric acid must only be used in a specially-constructed stainless steel hood, with appropriate lab procedures. It must be stored in a glass secondary tray and the faculty member is responsible for having a procedure and materials in place to handle a small spill.
Materials containing sodium azide, even small amounts as a preservative, should not be drain-disposed, even if otherwise nonhazardous. Attach a hazardous waste label with the description "Nonhazardous materials with trace (name of azide) and check the "Toxic" box.

4.6.9 Cryogenic materials include liquefied gases that condense oxygen from the air, create an oxygen rich atmosphere and increase potential for fire if flammable or combustible materials and a source of ignition are present. Pressure is also a hazard due to the large expansion ratio from liquid to gas,
causing pressure build up in containers. Many materials become brittle at extremely low temperatures. Brief contact of flesh with materials at extremely low temperatures can cause burns similar to thermal burns.
A. Equipment should be kept clean, especially when working with liquid or gaseous oxygen.
B. Mixtures of gases or fluids should be strictly controlled to prevent formation of flammable or explosive mixtures.
C. Care should be exercised before dispensing cryogenic materials. It is recommended that an experienced lab worker train new employees and students before allowing them to dispense on their own. Always wear appropriate gloves, as well as goggles when handling. If there is a chance of a splash or spray, a full face protection shield, an impervious apron or coat, long pants (preferably with no cuffs), and shoes must be worn. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen spill.
D. Containers and systems containing cryogenic materials should have pressure relief mechanisms. They should be checked periodically to ensure they are not blocked.
E. Only containers designed to handle cryogenic materials should be used.
F. Be aware that glass ampoules can explode when removed from cryogenic storage if not sealed properly.

4.7 RADIOACTIVE MATERIAL HAZARDS

Use of radioactive materials at Smith College is strictly controlled and allowed only for licensed and trained individuals. Safety procedures covering their use is not covered under this Plan. See the Radiation Safety Manual, at
http://www.science.smith.edu/resources/safety/beta.html

4.8 BIOLOGICAL MATERIAL HAZARDS

Use of biological materials at or above Biosafety Level 2 at Smith College is strictly controlled. Safety procedures covering their use is not covered in this Plan. See the information under "Biosafety" at the EH&S website,
http://www.science.smith.edu/resources/safety/beta.html

5.0 STANDARD LABORATORY FACILITY REQUIREMENTS

5.1 SIGNS AND INFORMATION

Labels and warning signs should alert employees and students to potentially hazardous materials and allow those unfamiliar with the laboratory surroundings to identify hazardous chemical use and storage areas, safety facilities, emergency equipment, exits, and aid emergency response personnel.

5.1.1 Material Safety Data Sheets (MSDS's). A Material Safety Data Sheet (MSDS) is a document containing chemical hazard identification and safe handling information and is prepared in accordance with the OSHA Hazard Communication Standard. Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals an appropriate MSDS for each hazardous chemical/product purchased. One source for MSDSs can be found at
http://www.hazard.com

5.1.2 Generic Signs. Every laboratory shall have the following signs visibly posted: Emergency contacts (two names are preferred, but at least the Faculty of record, and a designated "second") on the exterior side of the door to the lab. These names shall be updated when personnel change. In case of an emergency, responders need this information to contact knowledgeable personnel about specific laboratory hazards. Faculty must have emergency contact information on file with Public Safety. For faculty with extremely sensitive equipment or materials, provisions should be made for emergencies in case the faculty member cannot be contacted. Those plans should be posted on the equipment with alternate contact personnel designated.

5.1.3 Restricted Access And Designated Areas. Facilities containing certain hazards must have warning signs posted at the designated area of the laboratory where the hazard exists, and at the entranceway to the laboratory. Any areas placarded as such are restricted access, designated areas and have certain standards regarding training and use by employees and students. Examples of these hazards are:

- Carcinogens

• Biological agents that require Biosafety Level 2 or higher*
• Radioisotopes*
Chemical hazards will be dealt with on a case-by-case basis, with consultation from Clark Science Center.

*Please contact the Biological Safety Officer or the Radiation Safety Officer at Smith College for requirements on these items.

5.1.4 Storage Areas. Chemicals should be stored according to compatibility, as designated by hazard classes. Particularly hazardous chemicals should be stored and handled with extreme care. When ordering chemicals that are unfamiliar, review the MSDS before purchase so that use and storage guidelines are understood. Assure that areas containing the following are identified as to the hazard within, and that the chemicals are stored appropriately:

1. Toxic chemicals
2. Corrosives
3. Flammable Liquids
4. Flammable Solids
5. Oxidizers
6. Perchloric Acid

5.2 CONTROL MEASURES
1. The PI or lab supervisor must implement control measures to reduce employee or student exposure by implementing one or more of the three types of control measures :

A. Administrative Controls: methods of controlling employee or student exposures to contaminants by job rotation, work assignment or time periods away from contaminant.
Examples include Standard Operating Procedures, Chemical Hygiene Plans and Safety Manuals.

B. Engineering Controls: methods of controlling employee or student exposures by modifying the source or reducing the quantity of contaminants released into the work environment.
Examples include fume hoods and biosafety cabinets

C. Personal Protective Equipment: personal safety equipment designed for secondary employee or student protection from hazardous chemicals.
Examples include gloves and lab coats.

2. Smith College requires control measures when the following circumstances are met:,

A. Whenever employees or students use hazardous chemicals.

B. Whenever employee or student exposures exceed the action level (or, in the absence of an action level, the Permissible Exposure Limit, the published exposure limit or the Threshold Limit Value).

C. Upon addition of new chemicals or changes in procedures.

Other situations should be dealt with on a case-by-case basis. Please consult with the CHO for assistance in establishing control measures.

3. The following general control measures are recommended for use in most situations requiring the use of hazardous chemicals:

A. Use the following primary methods for detecting exposures:
i. Determine the source of exposure.
ii. Determine the path the contaminant follows to reach the employee or student.
iii. Determine the employee's or student's work pattern and use of personal protective equipment.
iv. Change one or more of the above pathways to reduce or eliminate exposure.
B. Substitute less harmful chemicals for more harmful chemicals whenever possible.
C. Change or alter processes to minimize exposure.
D. Isolate or enclose a process or work operation to reduce the number of employees or students exposed (for example, use a fume hood).
E. Practice good housekeeping procedures to reduce unnecessary exposures.
F. Use training and education as primary administrative controls for reducing exposures.

5.3 PERSONAL PROTECTIVE AND SAFETY EQUIPMENT

Maintaining a safe laboratory environment is the responsibility of the Faculty of record, but all researchers play a role in observing safety guidelines. Personal protective devices and safety equipment must be provided to all employees and students under the appropriate circumstances and employees and students have the responsibility of properly using such equipment.

5.3.1 Personal Protective Equipment

Eye and Face Protection. Eye protection must be made available to all Science Center employees, students, or visitors to laboratories where chemicals are used and stored. Protective eye and face equipment must be used where there is a reasonable probability of injury from hazardous chemicals that can be prevented from such equipment. This requirement applies to students, faculty, staff and visitors. Exceptions to this requirement include class meetings in teaching labs where only lectures, data analysis, or group discussion are occurring, or when all work with hazardous chemicals has ceased for the period.

Standard visitor tours (such as those conducted for prospective students and their families) which enter only lower-hazard labs (such as instrumentation labs or teaching labs not in session) are not required to wear eye protection. Those individuals leading or arranging tours should contact the department head (or, if unsure who is responsible for the space, the Science Center Director or Associate Director) 48 hours in advance of a planned tour in order to ensrure the lab will be available and appropriate for a tour group without PPE. Tours which include labs where hazardous chemicals, biologicals, or

processes (such as machining parts) are in use during the tour must provide safety glasses to all tour members. Biosafety level 2 (BSL-2) labs should not be entered by standard tour groups, although discussing ongoing research with the group outside the lab is encouraged.

The minimum acceptable requirements are for hardened glass or plastic safety spectacles. **The PI or laboratory supervisor should establish the level of eye protection needed per laboratory activity based on the guidelines below:**

All eye protective devices must be stamped with "ANSI Z87" by the manufacturer.
1. Safety glasses with side shields offer minimal protection against flying fragments, chips, particles, sand and dirt. When a splash hazard exists, other protective eye equipment should be worn.
2. Safety goggles (impact goggles) offer adequate protection against flying particles.
3. Chemical splash goggles (acid goggles) have indirect venting for splash proof sides, which provide adequate protection against splashes. **Chemical splash goggles offer the best eye protection from chemical splashes.**
4. Faceshields protect the face and neck from flying particles and splashes. Always wear additional eye protection under faceshields.

Protection of Skin and Body. Skin and body protection involves the use of protective clothing to protect individuals from chemical exposure. Determine clothing needed for the chemical being used, as protective garments are not equally effective for every hazardous chemical by reviewing the MSDS and/or contacting the manufacturer. Some chemicals will permeate a garment in a very short time, whereas others will not.
The basic and most effective forms of protection are gloves and lab coats. Glove companies, such as Best Gloves or Showa Ansell gloves, are a resource for this information as they routinely provide information regarding effectiveness of a particular type of glove for a given chemical.

Protect exposed skin surfaces when there is a reasonable anticipation of a splash. No open-toed shoes, or sandals, are allowed when working with injurious or corrosive chemicals. Clothing that leaves large areas of skin exposed is inappropriate in laboratories where hazardous chemicals are in use. Personal clothing should fully cover the body.

Even when there is minimal danger of skin contact with an extremely hazardous substance, lab coats, coveralls, aprons, or protective suits must be utilized. **These garments should not leave the work site. Contact the CHO for instructions on how to access laundry service.**

Ensure that lab coats are made of material appropriate for the chemicals which are used and stored in the lab. Many synthetics and cotton/synthetic blends are not appropriate for use with flammable liquids due to both their lack of flame resistance and tendency to melt and adhere to skin when on fire.

Exposures to strong acids and acid gases, organic chemicals and strong oxidizing agents, carcinogens, and mutagens require the use of specialized protective equipment that prevents skin contamination. Impervious protective equipment must be utilized. Examples include: rubber gloves, aprons, boots and protective suits.

Respirators. Smith College discourages the use of respirators in laboratories. Respirator use is only allowed where engineering controls are not feasible or where they are being installed. Prior to using a respirator for the first time or for a new activity, employees and students must follow all elements of the Respiratory Protection Program. Contact the CHO if you believe your work requires a respirator.

5.3.2 Safety Equipment

Safety Showers. Safety showers provide an immediate water drench of an affected person.
The location of the shower should be clearly marked, well lighted and free from obstacles, closed doorways or turns.
Safety showers should be checked and flushed periodically, at least once per semester.

Eye Wash Facilities. Eye wash facilities are required in all laboratories where injurious or corrosive chemicals are used or stored, and are subject to the same proximity requirements as safety showers.
Eye wash stations should be flushed out ideally every day.

It is the responsibility of the custodial staff to flush eyewashes weekly and test safety showers before each semester. However, assigning students to perform additional weekly eyewash flushes will give them additional comfort if they ever need to use this device. An apparatus is available to collect safety shower water and faculty are encouraged to regularly demonstrate the use of closest safety shower to their research laboratory. Faculty should contact the custodian or the CHO if they would like assistance in demonstrating their safety shower.

5.4 VENTILATION CONTROLS

Ventilation controls are those controls intended to minimize employee or student exposure to hazardous chemicals by removing air contaminants from the work site. There are two main types of ventilation controls:
1. General (Dilution) Exhaust: a room or building-wide system which brings in air from outside and ventilates within. Laboratory air must be continually replaced, preventing the increase of air concentration of toxic substances during the work day.
General exhaust systems are not recommended for the use of most hazardous chemicals.
2. Local Exhaust: a ventilated, enclosed work space intended to capture, contain and exhaust harmful or dangerous fumes, vapors and particulate matter generated by procedures conducted with hazardous chemicals.

Proper Use of Local Ventilation Systems: Once a local ventilation system is installed in a work area, it must be used properly to be effective. For use of hazardous chemicals warranting local ventilation controls, the following guidelines should be observed:

1. Conduct all operations which may generate air contaminants at or above the appropriate PEL or TLV inside a fume hood.
2. Keep all apparatus at least 6 inches back from the face of the hood and keep the slots in the hood baffle free of obstruction by apparatus or containers. Large equipment should be elevated at least two inches off the base of the fume hood, to allow for the passage of air underneath the apparatus.
3. Do not use the hood as a waste disposal mechanism.
4. Minimize storage of chemicals in the hood.
5. Keep the hood sash closed at all times except when the laboratory worker is not actively working inside the hood.
6. Do not have sources of ignition inside the hood when flammable liquids or gases are present.
8. Use sash as a safety shield when boiling liquids or conducting an experiment with reactive chemicals. This does NOT remove the need for safety eyewear.
9. Periodically check the air flow in the hood using a continuous monitoring device (a strip of tissue taped to the sash is a simple solution) or another source of visible air flow indicator. If air flow has changed, contact the Clark Science Center for an inspection or Facilities Maintenance (x2400) for repair.

The system must be checked prior to each use to assure it is operating. **Never work with hazardous chemicals if the fume hood is not working.**

Appendix I
29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories," (also referred to as The Laboratory Standard)

Code of Federal Regulations
Title 29 - Labor
Volume: 6Date: 2011-07-01Original Date: 2011-07-01Title: Section 1910.1450 - Occupational exposure to hazardous chemicals in laboratories.Context:
Title 29 - Labor. Subtitle B - Regulations Relating to Labor (Continued). CHAPTER XVII - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR (CONTINUED). PART 1910 - OCCUPATIONAL SAFETY AND HEALTH STANDARDS (CONTINUED). 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 indvidual shall hold within the employer's organizational structure.

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

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

Compressed gas means:

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

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

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

Designated area means an area which may be used for work with “select carcinogens,” reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, 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 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °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 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

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

(iii) Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (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 moveable 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/m3;
(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.

(4) 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 chemical found in the 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 1910.20.

(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.

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

3. Chemical Hygiene Officer
4. Laboratory Supervisor
5. Project Director
6. Laboratory Worker
C. The Laboratory Facility
1. Design
2. Maintenance
3. Usage
4. Ventilation
D. Components of the Chemical Hygiene Plan
1. Basic Rules and Procedures
2. Chemical Procurement, Distribution, and Storage
3. Environmental Monitoring
4. Housekeeping, Maintenance and Inspections
5. Medical Program
6. Personal Protective Apparel and Equipment
7. Records
8. Signs and Labels
9. Spills and Accidents
10. Training and Information
11. Waste Disposal
E. General Procedures for Working With Chemicals
1. General Rules for all Laboratory Work with Chemicals
2. Allergens and Embryotoxins
3. Chemicals of Moderate Chronic or High Acute Toxicity
4. Chemicals of High Chronic Toxicity
5. Animal Work with Chemicals of High Chronic Toxicity
F. Safety Recommendations
G. Material Safety Data Sheets

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" deals 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/storerooms (218, 219);

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

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

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

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

3. Usage. The work conducted (10) and its scale (12) must be appropriate to the physicial 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 pesonnel 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). Safety showers should be tested routinely (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: diisopropylflurophosphate (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, 162-4, 174-5, 219-20, 226-7)
4. Low temperature procedures: (26, 88)

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

G. Material Safety Data Sheets

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

*Acetyl peroxide (105)
*Acrolein (106)
*Acrylonilrile (107)
Ammonia (anhydrous) (91)
*Aniline (109)
*Benzene (110)
*Benzo[a]pyrene (112)
*Bis(chloromethyl) ether (113)
Boron trichloride (91)
Boron trifluoride (92)
Bromine (114)
*Tert-butyl hydroperoxide (148)
*Carbon disulfide (116)
Carbon monoxide (92)
*Carbon tetrachloride (118)
*Chlorine (119)
Chlorine trifluoride (94)
*Chloroform (121)
Chloromethane (93)
*Diethyl ether (122)
Diisopropyl fluorophosphate (41)
*Dimethylformamide (123)
*Dimethyl sulfate (125)
*Dioxane (126)
*Ethylene dibromide (128)
*Fluorine (95)
*Formaldehyde (130)
*Hydrazine and salts (132)
Hydrofluoric acid (43)
Hydrogen bromide (98)
Hydrogen chloride (98)
*Hydrogen cyanide (133)
*Hydrogen sulfide (135)
Mercury and compounds (52)
*Methanol (137)
*Morpholine (138)
*Nickel carbonyl (99)
*Nitrobenzene (139)

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

Appendix B to § 1910.1450—References (Non-Mandatory)

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

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

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

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

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

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

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

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

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

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

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

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

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

(b) Hazardous Substances Information:

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

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 U.S. 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).

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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; 55 FR 7967, Mar. 6, 1990; 55 FR 12111, Mar. 30, 1990; 57 FR 29204, July 1, 1992; 61 FR 5508, Feb. 13, 1996; 71 FR 16674, Apr. 3, 2006]

Effective Date Note:

At 76 FR 33609, June 8, 2011, § 1910.1450 was amended by revising the "ingestion" paragraph under item (a) under Section E, subsection 1, effective July 8, 2011. For the convenience of the user, the revised text is set forth as follows:

§ 1910.1450

Occupational exposure to hazardous chemicals in laboratories.

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

E. * * *

1. * * *

(a) Accidents and spills— * * *

Ingestion: This is one route of entry for which treatment depends on the type and amount of chemical involved. Seek medical attention immediately.

Appendix II- Bibliography

29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories," (also known as The Laboratory Standard), available in Appendix I of this document and online at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106

"Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated," National Academy Press, Washington, D.C., 2011, http://www.nap.edu/catalog.php?record_id=12654

Chemical Hygiene Plan, The Office of Radiation, Chemical, and Biological Safety, Michigan State University, http://www.orcbs.msu.edu/chemical/programs_guidelines/chem_hygiene/chem_hygiene_plan/chp_02toc.htm

NFPA 30, "Flammable and Combustible Liquids Code"

NFPA 30 FAQ's: website at http://www.nfpa.org/faq.asp?categoryID=920&cookie_test=1

NFPA 45: "Standard on Fire Protection for Laboratories Using Chemicals"

"Improving Safety in the Chemical Laboratory," Jay Young, Ed., Wiley, 1987

"Handbook of Chemical Health and Safety," Robert J. Alaimo, Ed., American Chemical Society, 2001

Chemical Safety Resources, Harvard University Environmental Health and Safety Office, http://www.uos.harvard.edu/ehs/ih/lp_chemical_safety.shtml

Harvard University Chemical SOP's: http://www.uos.harvard.edu/ehs/ih/lp_chemical_safety_fs.shtml

Canadian Centre for Occupational Health and Safety: Chemical Hazards OSH Links: http://www.ccohs.ca/oshlinks/subject/hazardschemical.html

University of Vermont Safety Information Resources (SIRI), including online MSDS links: http://www.hazard.com/

Toxnet Toxicology Data Network: http://toxnet.nlm.nih.gov/

American Chemical Society Chemical Safety webpage:
http://portal.acs.org/portal/acs/corg/content?_nfpb=true&_pageLabel=PP_ARTICLEMAIN&node_id=195&content_id=CTP_006749&use_sec=true&sec_url_var=region1

American Chemical Society Division of Chemical Health and Safety webpage:
http://www.dchas.org/

Appendix III

Mandate for the Smith College Institutional Chemical Hygiene Committee (ICHC) May 15, 2009

A number of factors have led to an increased awareness of chemical use and management within college and university academic departments. This includes an increase in the sophistication of science and engineering research by faculty members and their undergraduate and graduate students, expanding regulatory and compliance requirements, advances in safety practices, and Department of Homeland Security mandates. To provide a uniform process within academic programs for addressing these factors at Smith College it is proposed that an Institutional Chemical Hygiene Committee (ICHC) be established. The ICHC will follow the general practices and structures of existing college review committees mandated by regulation, including the Institutional Animal Care & Use Committee, Institutional Biosafety, Institutional Review Board, and Radiation Safety Committee.

Purpose: As an employer and educational institution Smith College seeks to take reasonable precautions to provide a work and educational environment where recognizable hazards are identified and their risk minimized through appropriate practices or precautions for all people using or present in the facilities. The College seeks to ensure that the necessary work, research and educational practices, procedures and policies are implemented in College owned and operated classrooms and laboratories to protect all facility users from hazardous chemicals and related practices in the work area. Within this context, it is the responsibility of the College to ensure that all facility users, and the facilities in which they operate, are in compliance with local, state, and federal regulations.

Regulatory framework: The ICHC's will carry out its mandate in the context of accepted industry standards and best practices, in addition to the OSHA Standard for Occupational Exposure to Hazardous Chemical in Laboratories (29CFR 1910.1450), the Occupational Health and Safety Administration's Hazard Communication Standard (29 CFR 1910.1200), the OSHA General Duty Clause (29 USC 654, Section 5(a)(1)), and the Smith College Chemical Hygiene Plan (in revision).

Authority of the ICHC: The ICHC has the authority as vested by the President of the College to enforce College policies, the College Chemical Hygiene Plan, and ICHC approved Chemical Hygiene Protocols. The Dean for Academic Development/Associate Provost will serve as the Institutional Official. Regulatory guidelines and requirements are provided through the OSHA Standard for Occupational Exposure to Hazardous Chemical in Laboratories (29CFR 1910.1450), the Occupational Health and Safety Administration's Hazard Communication Standard (29 CFR 1910.1200), the OSHA General Duty Clause (29 USC 654, Section 5(a)(1), and accepted industry standards and

practices.

Mandate: Within the academic programs of the College, the ICHC will:

- Evaluate and advise the College on the safety of the research and teaching environment (buildings, classrooms, laboratories, support facilities) with respect to chemical use, processes, acquisition, disposal, and storage. The ICHC may mandate changes in use or practices it deems necessary for safety or regulatory compliance purposes.

- Require programs and individuals to comply with federal, state and local regulations, including the OSHA Standard for Occupational Exposure to Hazardous Chemical in Laboratories and the Occupational Health and Safety Administration's Hazard Communication Standard

- Facilitate and oversee a standardized protocol review process for the use, acquisition, disposal or storage of chemicals within academic programs. Require programs and individuals to submit to the ICHC Chemical Use Protocols in accordance with the Smith College Chemical Hygiene Plan. An approved protocol is required prior to the acquisition, use, disposal or storage of such chemicals for use within academic programming and facilities.

- Notify Facilities Management of physical plant related safety issues; provide guidance in regard to corrective actions.

- Develop policies for and oversee the safe use, acquisition, disposal or storage of chemicals within the academic programs of the College; implement policies and procedures as specified in the College Chemical Hygiene Plan.

- Review accident and incident reports; recommend or require changes in chemical use, processes or protocols.

- Provide activity reports to the Institutional Official/Office of the Provost on a semi-annual basis.

Appointment & Composition of ICHC Membership:

The ICHC membership and chair will be appointed by the President or Provost. The chair will be appointed by the President or Provost from the tenured membership of the committee. Membership is for term of two years and is renewable. The Associate Provost will serve as the Institutional Official (IO). The committee will be composed of:

- a tenured member of the Department of Chemistry
    - a tenured member of the Department of Biological Sciences
    - a tenured member of the Picker Engineering Program
    - an at-large member of the science or engineering faculty

- a tenured member of the Art or Theatre Departments
- two non-Smith affiliates representing the community and/or chemical hygiene profession
- the Clark Science Center Chemical Hygiene Officer
- the director of the Clark Science Center

Frequency of meetings: The ICHC will meet not less than quarterly, and may meet more frequently as dictated by departmental needs.

Appendix IV-Compatible Chemical Storage

This section taken from Prudent Practices, 2011

It is prudent to store containers of incompatible chemicals separately. Separation of incompatibles will reduce the risk of mixing in case of accidental breakage, fire, earthquake, or response to a laboratory emergency. Even when containers are tightly closed, fugitive vapors can cause deleterious incompatibility reactions that degrade labels, shelves, cabinets and containers themselves. IT IS IMPORTANT TO NOTE THAT a far more detailed review of incompatibilities needs to be done when chemicals are deliberately mixed. The classification system shown in the figure below is an example of a detailed classification system which Stanford University uses for the storage of groups of chemicals by compatibility. The system below classifies chemicals into 11 storage groups (many labs will have only 4-6 groups, based on the areas of study.) Each group should be separated by plastic trays or other secondary containment(if stored alongside) or ideally in its own storage cabinet (required for flammable liquids and solids). According to this system, it is most important to separate storage groups B (compatible water-reactive and pyrophoric chemicals) and X (chemicals incompatible with all other storage groups). Totally separate storage areas for these two groups is recommended.

There are other good classification systems for storing chemicals according to compatibility. At a minimum keep fuels (solvents such as the alcohols, ethers, acetone) separate from oxidizers (nitrates, ammonium persulfate, peroxides), and then the following can be stored separately:

- corrosives—inorganic bases;
- corrosives—inorganic acids, not including oxidizers or combustibles;
- reproductive toxins;
- select carcinogens; and
- substances with a high degree of acute toxicit

See the list in Table IV-1 for more examples

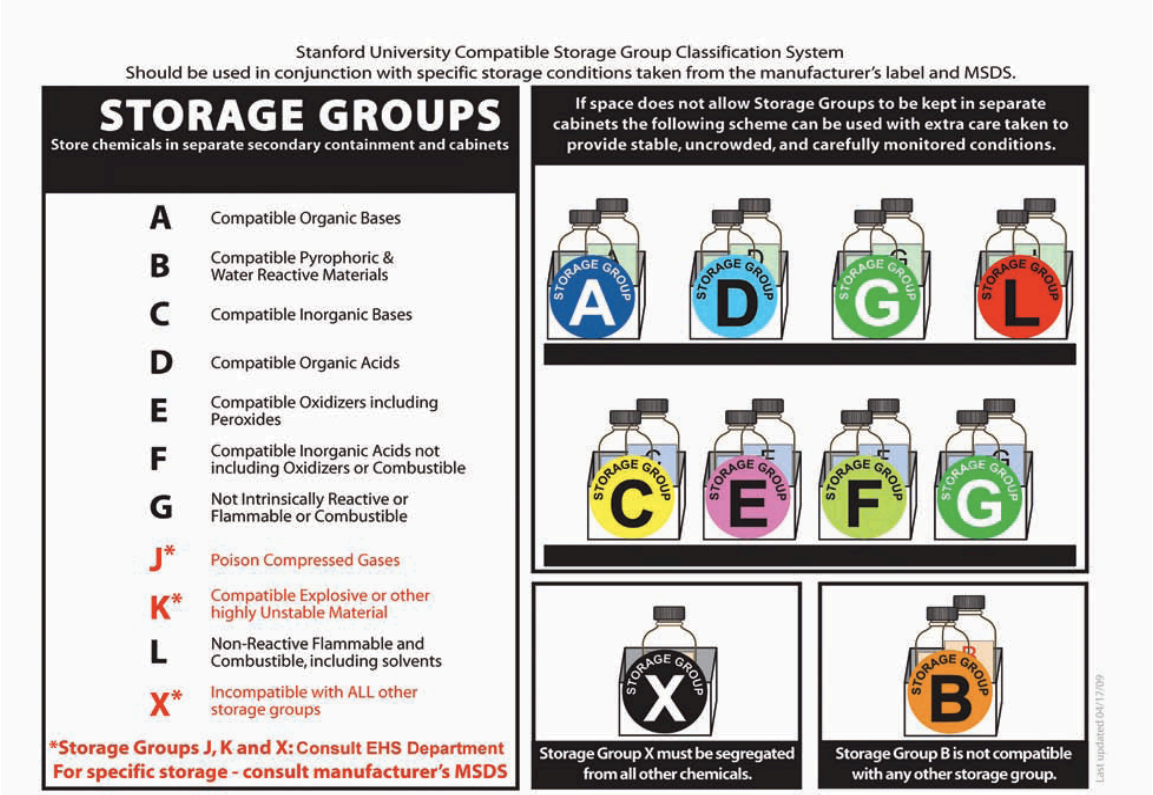

Figure 5.1.tif
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TABLE IV-1 Examples of Compatible Storage Groups

A: Compatible Organic Bases
Diethylamine
Piperidine
Triethanolamine
Benzylamine
Benzyltrimethylammonium hydroxide

B: Compatible Pyrophoric & Water-Reactive Materials
Sodium borohydride
Benzoyl chloride
Zinc dust
Alkyl lithium solutions such as methyl lithium in tetrahydrofuran
Methanesulfonyl chloride
Lithium aluminum hydride

C: Compatible Inorganic Bases
Sodium hydroxide
Ammonium hydroxide
Lithium hydroxide
Cesium hydroxide

D: Compatible Organic Acids
Acetic acid
Citric acid
Maleic acid
Propionic acid
Benzoic acid

E: Compatible Oxidizers Including Peroxides
Nitric acid
Perchloric acid
Sodium hypochlorite
Hydrogen peroxide
3-Chloroperoxybenzoic acid

F: Compatible Inorganic Acids not Including Oxidizers or Combustibles
Hydrochloric acid
Sulfuric acid
Phosphoric acid
Hydrogen fluoride solution

J: Poison Compressed Gases
Sulfur dioxide
Hexafluoropropylene

K: Compatible Explosives or Other Highly Unstable Materials
Picric acid dry(<10% H_2O)
Nitroguanidine
Tetrazole
Urea nitrate

L: Nonreactive Flammables and Combustibles, Including Solvents
Benzene
Methanol
Toluene
Tetrahydrofuran

X: Incompatible with ALL Other Storage Groups
Picric acid moist (10-40% H_2O)
Phosphorus
Benzyl azide
Sodium hydrogen sulfide

SOURCE: Prudent Practices, 2011: Adapted from Stanford University's Chem Tracker Storage System

Appendix V-Standard Operating Procedures

Here are several sites for SOP templates and examples

A.
http://www.uos.harvard.edu/ehs/ih/lp_chemical_safety_fs.shtml

Comment: A longer, more involved form but helps make sure the faculty member considers and informs regarding the hazards of all chemicals used in a process or reaction, specifies PPE, etc. The site has SOP's for use of concentrated acids, phenol-chloroform extractions, and other operations which may be of assistance to biology and disciplines in the life sciences.

B.
http://www.ehs.uci.edu/programs/sop_library/

Comment: A more 'free-form' template which might be easier to use for standard chemical reactions.

Both sites have extensive chemical information, including sample SOP's for a wide variety of chemical and biological materials. These are useful guides, but in order for the SOP to be accepted by the ICHC, it must describe the details of the experiment in the Smith lab and meet or exceed standards in the Smith Chemical Hygiene Plan and any other applicable guidance document. A careful review of the hazards of the planned use/experiment, the personal protective equipment needed and the facilities to be used will assist in the most efficient prerpation of the Smith SOP.

C. Sample SOP for an Acute Toxin

#1 - PROCESS

Use of **Potassium Cyanide** as a biological reagent in culturing.

#2 -CLASS OF HAZARDOUS CHEMICALS

Acutely hazardous material. Very toxic. CNS depressant. Arrythmyogenic.

#3 -PERSONAL PROTECTIVE EQUIPMENT

Skin: Avoid skin contact. Wear a laboratory coat and gloves when the potential for skin contact exists. Appropriate gloves include disposable nitrile, neoprene. Disposable nitrile gloves provide minimum protection for general laboratory use. Change gloves frequently or immediately whenever contamination is suspected.
Eyes: Protective goggles, or face shield.

#4 -ENGINEERING / VENTILATION CONTROLS

Facilities storing or utilizing potassium cyanide should be equipped with an eyewash and safety shower.
Control exposure to powders by performing manipulations of powders in fume hood.

#5 -SPECIAL HANDLING PROCEDURES & STORAGE REQUIREMENTS

Review MSDS and this SOP prior to use. Wash thoroughly after handling. Avoid contact with eyes and skin. Use with adequate ventilation. Minimize dust generations and accumulations. Do not ingest or inhale. Wash clothing before reuse.
Storage: Store in a tightly closed container. Keep from contact with oxidizing materials. Store in a cool, dry, well-ventilated area away form incompatible substances. Keep away from acids, acid salts, water, weak alkalis. Secure materials from theft.
Campus security will be called before and after use of solid KCN.
When transporting KCN solutions between labs, solutions must be in labeled secondary container.
All work with KCN will take place prior to 6:00 pm.
A cyanide antidote kit is available and located to the right of the fume hood in LAB XYZ immediately over the sink.

#6 -SPILL & ACCIDENT PROCEDURES

Bodily contamination: Remove all contaminated clothing immediately.

Eyes: While holding eyelids open, flush eyes with copious amounts of water for at least 15 minutes. Seek medical attention immediately.
Skin: Immediately wash skin with soap and copious amounts of water. Speed is essential; obtain medical aid immediately.
Inhalation: Remove to fresh air. Do not use mouth-to-mouth CPR. Keep warm. Speed is essential; obtain medical aid immediately.
Ingestion: Seek medical attention immediately.
Consult a medical professional for any necessary follow-up evaluations and treatments.

Small spills: Clean up spills immediately. Avoid generating dusts by gently sweeping up solids material and place into a suitable waste receptacle. If liquid, use adsorbent pad. Dispose collected spills through EH&S.
Large spills: Notify other in area of spill. Evacuate and post doors to spill area. Call 413-585-2490 (or 800 from a campus phone) to inform Public Safety of the incident. Restrict persons from area of spill until cleanup is complete.

#7 -WASTE DISPOSAL

Waste Disposal
Place complete EH&S waste label on container. Dispose of waste through EH&S within 90 days or when 250 grams combined liquid and solid waste is produced.

#8 -PRIOR APPROVAL REQUIRED

Dr. M is the only approved user for this protocol

#9 –DECONTAMINATION

Wash surfaces with soap and water, then triple rinse and collect rinseate as hazardous waste.

#10 -DESIGNATED AREA

Prepare solutions in fume hood located in LAB XYZ. Store in locked cabinet located in LAB ABC (-20 freezer) Experiments will be conducted in the LAB EFG. Incubator and experiment plates will be labeled while experiments using KCN are being housed in the incubator.