CHEMICAL HYGIENE PLAN

BATES COLLEGE
CAMPUS AVENUE
LEWISTON, MAINE

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

APPENDICES

1.0 PURPOSE AND RESPONSIBILITIES

1.1 Background

The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) promulgated regulations (29 CFR 1910.1450) designed to control Occupational Exposure to Hazardous Chemicals in Laboratories (Appendix A). The regulations (Standard) require employers to develop and follow a Chemical Hygiene Plan (Plan) that is capable of protecting employees from health and physical hazards associated with hazardous chemicals in their laboratories.

Chemical hygiene and safety practices are an important aspect of the educational and research missions of Bates College. Both are critical to protect the health of the employee and student populations at the college. In addition, instilling prudent practices in the student and employee populations is expected by the public and private organizations where graduates of Bates College will seek employment. Employees and students not employing prudent practices will put themselves and coworkers at an increased risk of harm. The increased risk associated with unsafe practices could ultimately result in increased costs for employers through lost time, higher insurance premiums, noncompliance and legal action.

This Plan is a part of the Bates College Environmental, Health and Safety (EHS) Program. Its function is to ensure that risk to employees and students involved with handling hazardous chemicals is minimized to the extent practicable.

1.2 Scope and Application of This Plan

This Plan has been developed as a model plan to be used by Laboratory Supervisors where “laboratory use” of hazardous chemicals occurs. It is the responsibility of each Laboratory Supervisor to develop specific Standard Operating Procedures (SOPs) for his or her laboratory to address the use of hazardous chemicals specific to each laboratory. Section 4.0 describes the guidelines to follow when developing SOPs for laboratories. The laboratories in Dana Chemistry and Carnegie Science are subject to the provisions of this Standard.

1.3 Statement of Policy

It is the policy of Bates College to fully comply with the provisions of this Plan. Bates College employees (herein referred to as employees) and laboratory students (herein referred to as students) will receive training appropriate to their level of activity with hazardous chemicals (as defined below, employee includes student employees, technicians, supervisors, instructors, lead researchers and physicians employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments). Compliance with the Plan provisions, will protect employees, students, visitors and the general public form the health and safety risks associated with the use and handling of hazardous chemicals in college laboratories. The Plan will also provide for protection of College property and the environment.

1.4 Chemical Hygiene Responsibilities

College Administration is responsible for establishment of College policy and providing resources for Plan implementation.

Chemical Hygiene Officer is the EHS Manager who is responsible for Plan implementation and maintenance. Specifically, the Chemical Hygiene Officer shall:

- Develop, implement, and maintain the Plan including appropriate chemical hygiene policies and guidance for use by the Laboratory Supervisors in developing SOPs specific to the laboratories.
- Ensure the Plan is implemented in a consistent manner at the various laboratory locations throughout the College.
- Serve as the Administration's representative for ensuring the Plan is consistent with College policy.
- Provide for annual review of the Plan.
- Ensure that appropriate training has been provided to employees and students.
- Provide Laboratory Supervisors with assistance when evaluating employee exposure levels to hazardous chemicals used in the laboratory.
- Ensure that changes to 29 CFR 1910.1450 are communicated to Laboratory Supervisors and that the Plan is fully compliant with the Standard.

Laboratory Supervisors have the ultimate responsibility for chemical hygiene in their individual laboratory area and, with the assistance of the Chemical Hygiene Officer, supports the chemical hygiene efforts of employees and students.

Specifically, the Laboratory Supervisor shall:

- Perform regular, formal chemical hygiene inspections, including inspections of safety and emergency equipment. The frequency of inspections will be established by the Laboratory Supervisor, based on his or her professional judgment. At a minimum, weekly housekeeping inspections and monthly equipment inspections are recommended.
- Develop SOPs specific to their laboratory's operations.

- Provide appropriate training of the implementation of the Plan to all employees and students.
- Determine and provide the proper type of personal protective equipment (PPE) for laboratory operations.
- With the assistance of the Chemical Hygiene Officer, determine when an evaluation of an employee’s exposure level to laboratory hazardous chemicals is required.
- Conduct regular, periodic inspections of their laboratory areas to ensure that Plan requirements and SOPs are being adhered to.
- Review and improve SOPs on an annual basis or more frequently as needed.

Employees are responsible for adhering to all SOPs and notifying the Laboratory Supervisor of areas where chemical hygiene practices may be improved.

Students are responsible for adhering to all SOPs at all times.

1.5 Definitions

The following definitions are found in the Standard and are used in Material Safety Data Sheets (MSDS) and chemical reference books.

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.

Carcinogen (see select carcinogen below).

Chemical Hygiene Officer means the employee (Bates College EHS Manager) 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 Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan means a written program developed and implemented by the employer which sets forth procedures, equipment, PPE and work practices that are capable of protecting employees from the health and physical hazards presented by hazardous chemicals used in that particular workplace and meets the requirements of 29 CFR 1910.1450.

Combustible liquid means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of

200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas means:

- A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or
- A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or
- A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 deg. 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 (including student employees, technicians, supervisors, lead researchers and physicians) employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments. This definition includes teaching, research and clinical activities.

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:

- ***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;
- ***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.

- ***Liquid, flammable*** means any liquid having a flashpoint below 100 deg. F (37.8 deg. C), except any mixture having components with flashpoints of 212 deg. F (100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.
- ***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:

- Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or
- Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or
- 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.

Glove boxes means small units that are used when working with hazardous chemicals and usually contain multiple openings in which arm-length rubber gloves are mounted.

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 hazardous 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.

Highly reactive chemical means a hazardous chemical that has the potential to be very reactive when in contact with certain types of materials. This interaction will undergo a reaction that releases energy that is too large to be absorbed by the immediate surroundings.

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. The laboratories located in Dana Chemistry and Carnegie Science are subject to the requirements in this plan.

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 safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

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

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

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

- Chemical manipulations are carried out on a "laboratory scale;"
- Multiple chemical procedures or hazardous chemicals are used;
- The procedures involved are not part of a production process, nor in any way simulate a production process; and
- "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 29 CFR 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.

Particularly hazardous substances means certain hazardous chemicals that are select carcinogens, reproductive toxins and compounds with a high degree of toxicity that require special handling procedures.

Permissible Exposure Limit means an air concentration exposure limit established by OSHA to protect employees against the health effects of exposure to hazardous chemicals.

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 hazardous chemicals that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Regulated hazardous chemical means any hazardous chemical that has a regulatory exposure limit established by OSHA.

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

- It is regulated by OSHA as a carcinogen; or
- 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
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or
- It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
  - (A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3; or
  - (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.

Toxic Chemical means a chemical having poisonous effects on the body and is dependent upon the extent of the exposure and the inherent toxicity of the chemical.

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.

2.0 EMPLOYEE AND STUDENT INFORMATION AND TRAINING

2.1 Training Requirement

Laboratory Supervisors are responsible, with support from the Chemical Hygiene Officer, for ensuring that all employees and students have access to information pertaining to the hazardous chemicals present in their laboratory work areas including storage requirements, use precautions, PPE, incidental spill equipment and emergency response procedures. Each employee shall receive training (i) at the time of initial assignment to the laboratory, (ii) at least annually, (iii) prior to assignments involving new exposure situations and (iv) as deemed necessary by the Laboratory Supervisor. Each student shall receive training at the beginning of each semester. All training will be recorded on the Training Documentation Form provided in Appendix B.

2.2 Training Guidance

Table 1 provides guidance on minimum training standards for employees and students. All Laboratory Supervisors should use this guidance when developing appropriate training programs for their laboratory areas.

Table 1

Employee and Student Minimum Training Guidance

TRAINING TOPIC	ASPECTS
OSHA 29 CFR 1910.1450	Location and contents of the Standard (included in Appendix A) and when it is available for employees to review
Chemical Hygiene Plan	Location and contents of Plan
Exposure Limits	Permissible exposure limits for OSHA regulated substances and recommended limits where there is no established exposure limit. Exposure limits are usually listed in the MSDS.
Exposure Symptoms	Specific exposure symptoms for hazardous chemicals present in the laboratory (e.g. Skin irritation, nausea, dizziness, etc.)
Chemical Information	Location of MSDS and other available information on the chemical and physical properties of hazardous chemicals used in the laboratory
Chemical Monitoring	Methods and observations that may be used to determine the presence or release of hazardous chemicals (air monitoring, continuous monitoring, visual observation, odors, etc.)
Chemical Hazards	Physical and health hazards of hazardous chemicals present in the laboratory. This information is available on MSDS and in Bates College Hazard Communication Program (Appendix C) and chemical reference books.
Exposure Prevention	Engineering controls, PPE, emergency procedures and work practices to prevent overexposure to employees
Waste Disposal	Proper characterization, management and documentation of waste disposal

3.0 IMPLEMENTATION AND MANAGEMENT OF ENGINEERING CONTROLS

Engineering controls provide a safe laboratory environment by minimizing employee exposure to chemical hazards. Engineering controls require proper maintenance and periodic inspections to ensure effective operations.

3.1 General Criteria

The goal of this Plan is to limit employee exposure to hazardous chemicals. As specified in OSHA regulations, employees are not to be exposed to OSHA-regulated hazardous chemicals in excess of the permissible exposure limits (PELs) specified in 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances or Threshold Limits Values, and established by the American Conference of Governmental Industrial Hygienists (ACGIH). PELs refer to airborne concentrations of hazardous chemicals that are averaged over an eight-hour day. A few substances also have "action levels". Action levels are airborne concentrations of hazardous chemicals below the PEL that require certain actions such as medical surveillance and workplace monitoring to take place. Any Laboratory Supervisor that suspects exposure concentrations will exceed action levels shall contact the Chemical Hygiene Officer for assistance in determining the most appropriate course of action.

<u>An employee's workplace exposure to any regulated hazardous chemical must be monitored if there is reason to believe that the exposure will exceed an action level or a PEL.</u> If exposures to any regulated hazardous chemical routinely exceed an action level or permissible exposure level, control measures must be implemented.

3.1.1 Professional Judgment

The Laboratory Supervisor can use professional judgment to assess the nature of hazardous chemical exposure resulting from a laboratory procedure and prescribed engineering controls and PPE to be used during the procedure. This judgment will be documented through use of SOPs, developed by the Laboratory Supervisor for the hazardous chemicals in use.

3.1.2 Air Sampling

Air sampling for evaluating employee exposure to hazardous chemicals shall be conducted on an as needed basis as determined by the Laboratory Supervisor with assistance from the Chemical Hygiene Officer. Air sampling will be conducted if there is reason to believe that exposure levels for regulated hazardous chemicals are likely to exceed the action level, or in the absence of an action level, the PEL. Air sampling will be conducted according to established industrial hygiene practices. It will be provided by qualified outside consultants who will be procured and managed by the Chemical Hygiene Officer. All results of air sampling studies performed in the laboratory will be provided to the Laboratory Supervisor and Chemical Hygiene Officer and maintained on file in the EHS Department.

3.2 Criteria for Implementation of Specific Control Measures

Engineering controls, PPE, hygiene practices, and administrative controls each play a role in a comprehensive laboratory safety program. Listed below are some specific control measures that may be implemented in the laboratory.

3.2.1 General Laboratory Ventilation

General laboratory ventilation must operate continuously to provide a source of air intake to local ventilation devices (fume loads). In general, an exchange of air within the room four to twelve times per hour is adequate. The ventilation system directs airflow into the laboratory from non-laboratory areas and out to the exterior of the building. General laboratory ventilation should not be relied on for protection from toxic substances.

3.2.2 Laboratory Fume Hoods

Laboratory Supervisors should follow the Bates College Fume Hood Safety Program for proper work practices, evaluations, repair and maintenance of fume hoods. The Fume Hood Safety Program is provided in Appendix D.

3.2.3 Hazardous Chemical Storage

Good housekeeping practice suggests storing every hazardous chemical in a well-labeled storage location when not in use. A storage procedure should be developed that ensures the segregation of incompatibles and provides secondary containment for liquid hazardous chemicals.

3.2.3.1 General Guidelines for Storing Hazardous Chemicals in Individual Laboratories

The following are general guidelines for the safe storage of hazardous chemicals:

a. Because of the risk of placing incompatible materials side-by-side, a storage procedure based solely on alphabetizing is prohibited. An effort shall be made to isolate particularly flammable, reactive, and/or toxic materials. Lists of incompatible materials are available in various references (see Section 10.0 of this Plan).

b. Storage areas should be checked periodically for cracked bottles, leakage, deteriorating labels, and other problems.

c. Whenever practical, storage trays should be used to contain possible spills.

d. Hazardous chemicals should not be stored on the floor or on top of high cabinets that are hard to see or reach.

e. Hazardous chemical storage should not be exposed to heat or direct sunlight.

f. Temporary covers should be placed over floor drains in areas where hazardous chemicals are being used.

g. Hazardous chemical storage on bench tops should be kept to a minimum.

h. Hazardous chemical storage in fume hoods should be kept to a practical minimum for better airflow and more workspace. Environmental Protection Agency (EPA) requires secondary containment of hazardous chemicals stored in fume hoods that are fitted with drains; a hazardous chemical spill could potentially cause hazardous conditions to workers of the Lewiston-Auburn Water Pollution Control Authority.

i. Date labeling

- In addition to the labeling required by OSHA, hazardous chemical containers should be labeled with the date they arrive at the College.
- When provided, the manufacturer's expiration date should be displayed.
- All hazardous chemical inventories should be reviewed periodically and expired hazardous chemicals and unwanted hazardous chemicals should be discarded appropriately.

j. Appropriate spill-control, cleanup, and emergency equipment must be available wherever hazardous chemicals are stored.

k. Store hazardous chemicals in refrigerators that are specifically designed for that purpose. Refrigerators of this type should be labeled: NO FOOD – CHEMICAL STORAGE ONLY.

l. All hazardous chemicals stored in refrigerators should be labeled with the contents, owner (i.e. Laboratory Instructor), date of acquisition or preparation and the nature of any potential hazard.

m. Refrigerators in which flammable materials are stored must be explosion-proof according to National Fire Protection Association (NFPA) standards and must be labeled as such.

n. Whenever practical, storage trays should be used to contain possible spills.

3.2.3.2 Storage of Flammables and Combustibles

NFPA defines flammables and combustible liquids in accordance with the following table:

Class	Flashpoint (deg. F)	Boiling Point (deg. F)
Class IA Flammable Liquids	<73	<100
Class IB Flammable Liquids	<73	≥100
Class IC Flammable Liquids	≥73	<100
Class II Combustible Liquids	100 to <140	
Class IIIA Combustible Liquids	140 to <200	
Class IIIB Combustible Liquids	≥200	

Container Size for Storage of Flammables and Combustibles

The storage of flammables and combustibles is regulated by OSHA and NFPA Standards 30 and 45. Limitations are based on the type of container and flammability of liquid being stored. In general, store flammable liquids in quantities greater than one liter in safety cans. Combustibles can be stored in either their original DOT-approved containers or safety cans. All safety cans should be labeled with the contents and hazard warning information. The following table, taken from *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*[1], lists the container storage requirements as defined by OSHA and NFPA:

Container	Flammable Liquids			Combustible Liquids	
	Class IA (Liters)	Class IB (Liters)	Class IC (Liters)	Class II (Liters)	Class IIIA (Liters)
Glass	0.5	1	4	4	4
Metal or approved plastic	4	20	20	20	20
Safety cans	7.5	20	20	20	20

Glass containers as large as four liters can be used, if needed, and if the required purity would be adversely affected by storage in a metal or approved plastic container, or if the liquid would cause excessive corrosion or degradation of a metal or approved plastic container. Portable and approved metal safety cans should be used when possible for storing flammable liquids.

Flammable liquids in quantities greater than 1 liter should be stored in metal containers. Flammable liquids purchased in large containers (greater than four liters) should be repacked into smaller safety cans for distribution to laboratories. Safety cans greater than 20 liters must be grounded and bonded during the transfer of flammable liquids.

Storage in flammable storage cabinets

NFPA storage limits on quantities of flammables and combustibles will be observed for each laboratory. As a rule of thumb, no more than 25 gallons of Class IA flammable liquids and no more than a day's supply of Class 1B and 1C flammable liquids can be stored outside of an approved flammable storage cabinet. The following guidelines should be followed when storing flammable and combustible chemicals in flammable storage cabinets:

- Large containers (greater than four liters but less than 20 literes) of flammable chemicals must be stored in flammable storage cabinets that meet OSHA and NFPA specifications: storage cabinet contents must be protected from temperatures exceeding 320 deg. F (160 deg. C) for at least 10 minutes, enough time for personnel to evacuate the area.
- Flammable storage cabinets must meet NFPA 30 Section 4-3.2 rating limits.
- Flammable storage cabinets must be marked:
  FLAMMABLE – KEEP FIRE AWAY
- Flammable storage cabinets are not required to be vented.
- If vented, venting is permitted to the exterior of the building in a manner that it will not compromise the performance of the cabinet. The outside area where the venting is taking place should be inspected to ensure chemical vapors will not create a safety hazard in the immediate area and for any intake vents that could cause the chemical vapors to re-enter the building.
- Flammable storage cabinets are not required to be grounded.
- Flammable storage cabinets may not obstruct a means of egress.
- Cabinet doors must be kept closed at all times except during hazardous chemical transfer. Do not remove air vent covers to chemical storage cabinets. Do not duct the storage cabinets to the ventilation system.
- Flammable and combustible liquids in 55-gallon drums should not be stored in

the laboratory but in the designated Hazardous Material Storage Rooms.

- No more than a total of 60 gallons of flammables and 120 gallons of combustibles may be stored in a flammable storage cabinet.

3.2.3.3 Storage of Compressed Gas Cylinders

Gas cylinders can pose a safety hazard if not handled appropriately. The following precautions are recommended for storing compressed gas cylinders:

- Always label cylinders with the name of the gas it contains and with an "empty" marking once it becomes empty.
- Ensure that all cylinders are secured to a wall or bench top.
- Ensure that incompatible classes of gases are stored separately. Keep flammables from reactives, which include oxidizers and corrosives.
- Once a cylinder is no longer in use, closed the valve, relieve the pressure in the gas regulator, remove the regulator and cap the cylinder.
- Segregate empty cylinders from full cylinders.
- Segregate gas cylinder storage from the storage of other hazardous chemicals.
- Return all gas cylinders to the supplier when finished with them.

3.2.3.4 Storage of Toxic Chemicals

To minimize injuries when working with toxic chemicals, the following precautions should be followed:

- Label areas where toxic chemicals are stored with warning signs, such as

  CAUTION! REPRODUCTIVE TOXIN STORAGE!

  or

  CAUTION! CANCER-SUSPECT AGENT STORAGE!

  and control access to those areas.
- Keep quantities of toxic chemicals to a minimum.
- Store chemicals that are considered highly toxic (including carcinogens) in ventilated storage in chemically-resistant secondary containers.
- Maintain a current inventory of all highly toxic chemicals.

3.2.3.5 Storage of Highly Reactive Chemicals

The following guidelines should be followed when storing highly reactive chemicals:

- Evaluate the storage requirements of these hazardous chemicals by reading the MSDS and other reference materials prior to bringing the hazardous chemical on site.
- Label and date each highly reactive chemical as soon as it is received. Each label should plainly read

  DANGER! HIGHLY REACTIVE CHEMICALS!

- Bring in the laboratory only the amount that is needed for immediate use (typically less than a three to six month supply, depending upon the reactive nature of the chemical).
- Attempt to dispose of highly reactive chemicals prior to the expiration date. If the expiration date has passed, the hazardous chemical should not be used and with assistance from the Chemical Hygiene Officer, a hazardous waste determination should be made on the expired hazardous chemical.
- **If crystals or precipitate are present, do not open liquid organic peroxide or peroxide former. Peroxide in this form is extremely unstable and could result in serious injury or death. Immediately contact the Chemical Hygiene Officer and he/she will arrange for the packaging and disposal of the hazardous chemical.**
- Store bottles of highly reactive chemicals in secondary containment of sufficient volume to hold its entire contents.
- Bottles containing perchloric acid should be stored in glass or ceramic trays.
- Peroxidizable materials should be stored away from heat and light.
- Thermally unstable chemicals should be stored in a specially-designed refrigerator. Contact the Chemical Hygiene Officer for more information.
- Hazardous chemicals that react vigorously with water should be stored away from water sources.

- Segregate highly reactive chemicals in the following manner:
    1) Pyrophoric compounds from flammables;
    2) Oxidizing agents from reducing agents and combustibles;
    3) Perchloric acid from reducing agents; and
    4) Strong reducing agents from readily reducible substrates.
- Since liquid peroxides are very sensitive during phase changes, store organic peroxides at the lowest possible temperature consistent with the freezing point.
- Due to their tendency to be unstable, all peroxide-forming chemicals should be inspected and tested periodically and containers that have exceeded their safe storage limits should be discarded.
- All questions or concerns about highly reactive chemicals should be brought to the attention of the Chemical Hygiene Officer immediately.

3.3 Personal Protective Equipment

Guidelines for use of PPE are provided in this section. Certain PPE, such as eye protection, should be worn in all laboratories where chemical splash hazards exist. Other PPE may be specified in SOPs or worn at the discretion of the user. SOPs generated by Laboratory Supervisors must specifically include information on the type of PPE required.

Users must be trained in the proper use of PPE. If respiratory protection is required, medical clearance and fit testing are also required - for assistance, contact the Chemical Hygiene Officer.

3.3.1 Overview of Types of PPE and Their Application

Below is a general overview of the types of PPE and the recommended application:

a. Eye protection: When an operation or activity has the potential of causing an eye injury from chemical splashes, chemical reactions and unexpected events.

b. Face protection: When an operation or activity has the potential of causing a face injury from chemical splashes, chemical reactions, unexpected events and flying glassware. Eye protection must always be worn under face protection.

c. Gloves: When an operation or activity has the potential to cut, burn, blister or bruise the hands, especially when working with corrosive hazardous chemicals and hot liquids.

d. Protective clothing (including laboratory coats): When an operation or activity involves a situation where normal working attire will not afford suitable protection from injury.

e. Disposable clothing: When an operation or activity has the potential of causing exposure to hazardous chemicals.

f. Respiratory protection: When an operation or activity has the potential for causing injury from harmful concentrations of dusts, fumes, gases, vapors, or radionuclides in the work environment.

g. Hearing protection: When the area is designated as a hearing protection area and/or when equipment generates a noise level of 85 dB or greater. The Chemical Hygiene Officer can provide assistance in evaluating this type of hazard.

h. Safety shoes: When an operation or activity has the potential for causing foot injury from falling objects.

3.3.2 Eye and Face Protection

In any area at any time where there exists the possibility of an eye and face hazard, all persons in the area must wear suitable protection. This rule applies to visitors, employees and students.

The type of protection - safety glasses or chemical splash goggles or face shields - depends on the hazard level. If there is a splash hazard, goggles and possibly a face shield should be worn. If there is a radiation hazard, specialized eye protection may be necessary.

For general, organic/inorganic and most physical chemistry instructional labs, all persons in the laboratory must wear chemical splash goggles (not safety glasses or spectacles) at all times, even when not performing a hazardous chemical operation. It is the responsibility of each Laboratory Supervisor to enforce this policy; alternate forms of eye and face protection are not permitted. However, in those physical chemistry labs where a hazardous chemical splash incident is extremely unlikely, the judgment of the Laboratory Supervisor regarding eye protection will be accepted.

3.3.3 Ear protection

Most laboratory activities do not involve operations that generate noise levels above 85 dB. When noise levels approach or exceed this level, hearing protection should be utilized.

Whenever there is doubt as to whether the noise levels generated from an operation within the laboratory exceed 85 dB, it is the responsibility of the Laboratory Supervisor to notify the Chemical Hygiene Officer, who will arrange for noise monitoring to be conducted by an outside contractor.

3.3.4 Gloves

It is appropriate to wear gloves in many laboratory situations. However, gloves should not be worn outside of the laboratory. Non-laboratory employees and students should not be exposed to hazardous chemical contact from using, for example, the lavatory facilities or the elevator.

There are no gloves available that protect against all potential hand hazards, and commonly available glove materials such as latex provide only limited protection against many hazardous chemicals. Therefore, it is important to select the most appropriate glove for a particular application and to determine how long it can be worn, and whether it can be re-used. For the best protection, check with the glove manufacturer for degradation and permeation information. A Glove Selection Guide has been provided in Appendix E, when information from glove manufacturers is not available. Disposable gloves should be discarded when removed. They should not be washed or re-worn. Gloves contaminated with hazardous chemicals should be discarded as hazardous chemical waste.

3.3.5 Shoes and Clothing

Clothing should be fitted, not excessively loose or flowing. The body should be covered, including the arms and legs from elbow to knee. Natural fabrics are more resistant to solvents and are recommended. To protect body and clothing, a laboratory coat or long-sleeved cotton shirt is recommended. Shoes must be flat and closed - no sandals or slides. Laboratory coats that may be contaminated with harmful residues must be cleaned in a responsible fashion; they should <u>not</u> be taken home for washing along with personal laundry.

3.3.6 Respirator Selection and Use

Respirators are generally not required for hazardous chemicals employed at Bates College. Laboratory Supervisors are responsible for assessing the need for respiratory protection for employees and students. If required, selection of respirators and respirator accessories, fit testing, and training must be coordinated through the Chemical Hygiene Officer. The Chemical Hygiene Officer will evaluate the work area for chemical toxicity, potential for exposure, concentration and duration of exposure and the limitation of the various types of respiratory protection that are available.

3.4 Emergency Equipment

During the initial orientation session provided by the Laboratory Supervisor, all employees and students should be made aware of the location of emergency equipment and first aid supplies. The following must be checked and maintained on a regular basis and access to each must be free and clear.

- Eye wash
- Shower - annual inspection arranged by the Chemical Hygiene Officer
- Fire extinguishers - annual inspection arranged by the Chemical Hygiene Officer
- Spill kit or absorbent material
- First aid kit.

4.0 STANDARD OPERATING PROCEDURES FOR LABORATORY CHEMICALS

4.1 Statement of Purpose

It is the intent of the Plan to promote a consistent approach to chemical hygiene practices. This Plan and SOPs developed by Laboratory Supervisors are the vehicles for the safe handling of hazardous chemicals. This section provides guidelines for the development and implementation of SOPs.

4.2 Format for Standard Operating Procedures

To facilitate use and understanding of SOPs, a standardized format for use by Laboratory Supervisors in developing SOPs is suggested. Since all SOPs ultimately become part of this Plan, a standardized format will also increase the utility of the Plan. The standardized SOP format used by Bates College is provided in Appendix F. This format should be used when developing an SOP for this Plan.

4.3 Laboratory Specific Standard Operating Procedures

Each Laboratory Supervisor will need to develop additional policies for his or her own laboratory. For example, there must be a policy about visitors. Laboratory regulations should be written down and posted or kept for reference at a convenient location. The SOP for a particular situation may simply be to follow generally accepted practice. However, there are times when an SOP must be substantially modified for a specific laboratory situation, or when one is not available, the Laboratory Supervisor must ensure that an SOP is written and a record maintained.

4.4 Periodic Inspections

SOPs must be maintained to ensure they are appropriate for current activities. SOPs should be reviewed annually at a minimum. SOPs for specific projects should include a termination date or review date to avoid implementing an outdated SOP. It is the responsibility of the Laboratory Supervisor to ensure that SOPs are being followed. The Chemical Hygiene Officer has the authority to review laboratory compliance with SOPs and College policy and an obligation to make findings known to the Administration.

4.5 Training Responsibility

Laboratory Supervisors are responsible for ensuring that all employees and students (when necessary) are trained on Laboratory Specific SOPs. Training should be documented on the Training Documentation Form provided in Appendix B and should be maintained within the department for at least five years.

5.0 MANAGEMENT OF PARTICULARLY HAZARDOUS SUBSTANCES

29 CFR 1910.1450 requires the Plan to include provisions for additional employee protection for work with particularly hazardous substances. These hazardous chemicals include "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity. A list of particularly hazardous substances found in *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*[1] is found in Appendix G. Specific consideration shall be given to the following provisions which shall be included where appropriate: establishment of a designated area; use of containment devices such as fume hoods or glove boxes; procedures for safe removal of contaminated waste; and decontamination procedures.

5.1 Management of Particularly Hazardous Substances

5.1.1 Designation of Areas

All areas designated for the use of particularly hazardous substances should comply with the following guidelines:

- Each laboratory utilizing these substances must designate an area for this purpose and mark this area with an appropriate hazard sign. The designated area may be an entire laboratory, an area of the laboratory, or a device such as a fume hood or glove box. The designated area should be marked with a "danger (specific agent), authorized personnel only," or comparable warning sign.
- An emergency response plan should be posted at the designated area.
- Detection equipment may be required in laboratories where highly toxic chemicals (especially poisonous gases) are used.

5.1.2 Use of Containment Devices such as Fume Hoods or Glove Boxes

In addition to adhering to the guidelines in Bates College Fume Hood Safety Program, when working with particularly hazardous substances in fume hoods and glove boxes the following precautions should be followed:

- Work with carcinogens, reproductive toxins and acutely toxic chemicals should be performed within a functioning fume hood, glove box, sealed system, or other containment device designed to minimize exposure to these substances. The exhaust air from the ventilation systems may require scrubbing before being released into the atmosphere. In all cases, work with these types of hazardous chemicals should be done in such a manner that the OSHA PELs or similar standards are not exceeded.

- The ventilation efficiency of the containment device, and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances, should be evaluated periodically by the laboratory personnel at intervals determined by the Laboratory Supervisor.
- Compressed gas cylinders that contain acutely toxic chemicals should be kept in ventilated gas cabinets.

5.1.3 Personnel

Personnel working with particularly hazardous substances should follow these guidelines:

- It is the responsibility of the Laboratory Supervisor to train all employees and students in the high-hazard area with regard to symptoms and deleterious effects of exposure. The training is required for all those who may be exposed, even if they do not actually work with the substances. This training should be documented in the Training Documentation Form provided in Appendix B.
- Employees and students using these substances must have access to appropriate PPE and must be trained on how to properly utilize this equipment.
- Notify the Chemical Hygiene Officer whenever respirators are to be worn because special training is required.

5.1.4 Specialized Handling Procedures

Whenever handling particularly hazardous chemicals, the following precautions should be adhered to:

- Quantities of these hazardous chemicals used and stored in the laboratory should be minimized, as should their concentrations in solution or mixtures.
- Special precautions to avoid release of and exposure to these hazardous chemicals should be observed. For instance, volatile substances should be kept cool and contained. Gas cylinders should have properly functioning valves, check valves, regulators, containment which can withstand pressure buildup, and appropriate piping. Dispersive solids should be kept in closed containers and used in places with minimal air currents. Appropriate contact materials should be used to avoid static charging.
- Emergency response planning for releases or spills should be prepared by the

Laboratory Supervisor and included in the training of the employees and students and others who may be affected in the building. The Chemical Hygiene Officer and the Lewiston Fire Department should be involved in this planning.

5.1.5 Procedures for Safe Removal of Waste and Decontamination

The following precautions should be followed when removing waste of particularly hazardous chemicals and decontaminating clothes and equipment:

- Waste removal and decontamination procedures must be reviewed and approved by the Chemical Hygiene Officer.
- Treatment of waste products to lessen or eliminate their toxicity as part of the experimental protocol is encouraged as a way of minimizing health hazards and the amount of waste, only if such treatment can be performed safely and is in accordance with State and Federal environmental regulations.
- Before initiating disposal, treatment, or recycling of waste, Laboratory Supervisors must contact the Chemical Hygiene Officer to ensure that the process meets safety and environmental regulatory requirements.
- The designated working area shall be thoroughly decontaminated and cleaned at regular intervals determined by the Laboratory Supervisor.

5.2 Prior Approval of Particularly Hazardous Substances

Bates College currently has a procedure in place for the approval of new hazardous chemicals. It is the policy of Bates College to require advance authorization for the acquisition and/or use of particularly hazardous substances. Such authorization by the appropriate committee (Biology or Chemistry) shall be in writing. The Chemical Hygiene Officer shall receive a copy of all such approvals. The authorization shall make reference to all SOPs required to ensure safe handling of the materials.

6.0 CHEMICAL SPILLS, RELEASES AND ACCIDENTS

All hazardous chemical spills that are larger than incidental quantities shall be immediately reported to Security Dispatch by calling extension 6111. Emergency phones are located throughout the hallways of Dana Chemistry and Carnegie Science buildings. One page emergency summaries are posted throughout the hallways of Carnegie Science building. Security will coordinate internal and external support as needed. Reference should also be made to the Bates College Integrated Contingency Plan (March 2004), which is hereby incorporated by reference. Specific spill kits are located in all laboratory areas and near hazardous chemical storage areas. Each spill kit contains absorbent pads, absorbent booms, safety goggles, chemical resistant gloves and signage.

7.0 MEDICAL CONSULTATIONS AND EXAMINATIONS

7.1 Availability

As required by 29 CFR 1910.1450, the College will provide all employees and students using hazardous chemicals the opportunity to receive appropriate medical consultations, and examinations, including follow-up examinations which the physician deems necessary, under any of the following circumstances:

- Whenever the employee or student develops signs and symptoms associated with a hazardous chemical to which he or she may have been exposed.
- Whenever OSHA-regulated substances are measured above permissible exposure limits (PELs).
- When an event takes place in the work area (such as a spill, leak, or explosion) resulting in the likelihood of a hazardous exposure.

Medical consultations and examinations are to be coordinated through the Chemical Hygiene Officer. An Incident Report Form, provided in Appendix H, shall be prepared for any medical consultation/examination required under this Plan. The medical examination and consultation must conform to the following rules:

- It is performed by or under the direct supervision of a licensed physician. Every effort should be made to refer employees and students to licensed physicians who have been trained to recognize signs and symptoms of chemical-related exposure and disease. For this reason, a first choice of provider is Occupational Health and Rehabilitation Services, Inc. of Lewiston, Maine, telephone: 784-1680. A second choice of provider is Work Med of Lewiston, Maine, telephone: 753-3080.
- It is performed at a reasonable time and place for the employee or student. Every effort should be made to schedule medical examinations and consultations during the employee or student's regularly scheduled work hours, provided there is no undue delay in medical attention. It is provided at no cost to the employee or student. It is provided without loss of pay to the employee or student. The employee or student may choose to forego the consultation and/or the examination.

7.2 Information

If possible, the Laboratory Supervisor should provide to the examining physician the information listed below; in the Laboratory Supervisor's absence, the information may be provided by the Chemical Hygiene Officer, Laboratory Instructor, or another knowledgeable individual:

- The identity (preferably, generic and trade names) of the hazardous chemicals to which the employee or student may have been exposed, and if available, the MSDS references for these hazardous chemicals;
- A description of conditions under which the exposure occurred, including quantitative exposure data if available; and
- A description of signs or symptoms of exposure experienced by the employee or student. In the event that the employee or student is unable to communicate, others in the laboratory may be able to recall symptoms either that they observed or that affected the employee or student's performance.

The above information will be collected by the Laboratory Supervisor and will be submitted to the Human Resources Department as well as to the examining physician. Within proximity of the exposure, other employees and students should be interviewed by the Laboratory Supervisor to determine if they experienced similar symptoms.

The College must obtain a written opinion from the examining physician. It must not reveal specific findings of diagnoses unrelated to occupational exposure. The written opinion must include the information:

- Results of the medical examinations and associated tests;
- Any medical condition revealed in the course of the examination, which may place the employee or student at increased risk as a result of exposure to hazardous chemicals;
- A statement confirming that the employee or student has been informed by the physician of the results of the consultation or examination, and of any medical condition that may require further examination or treatment; and
- Any recommendation for medical follow-up.

8.0 RECORD KEEPING

Bates College policy is to maintain safety records as required by OSHA at a minimum of 40 years.

8.1 Incident Reports

Incidents involving employee injuries should be recorded on the Incident Report Form provided in Appendix H. Incident reports are prepared by the Laboratory Supervisor with assistance from the Chemical Hygiene Officer. The incident reports are provided to and retained by the EHS Department for a minimum of five years. The Laboratory Supervisor will keep a copy of all incident reports in his/her department.

8.2 Exposure Evaluations

Any records of exposure evaluation carried out by individual departments will be kept by the Laboratory Supervisor and also sent to the Chemical Hygiene Officer. The Human Resources Department shall retain raw data for one year and summary data for 30 years after termination of employment.

8.3 Medical Consultation and Examinations

Results of medical consultations and examinations will be kept by the Human Resources Department for a length of time specified by the appropriate medical records standard. This time will be at least the term of employment plus 30 years as required by OSHA.

8.4 Training

Training involving Laboratory Specific SOPs or other aspects of the Chemical Hygiene Plan should be recorded on the Chemical Hygiene Plan Training Documentation Form provided in Appendix B. Laboratory Supervisors should maintain this training documentation on Laboratory Specific SOPs for at least five years.

8.5 Equipment Testing and Maintenance

Laboratory safety equipment and cleanup supplies should be inspected at least monthly. Inspections should be recorded on the Equipment Inspection Checklist Form provided in Appendix I. These inspection records will be maintained by the Laboratory Supervisor for five years. Data on annual fume hood monitoring will be kept in the EHS Department. Fume hood monitoring data are considered maintenance records and as such the raw data will be kept by the Laboratory Supervisor for one year and summary data for five years.

8.6 Periodic Inspections

Periodic inspections of engineering control systems are the responsibility of the Physical Plant Department (Physical Plant). Physical Plant will retain records for a period of five years.

9.0 ANNUAL PLAN REVIEW

The Chemical Hygiene Officer is responsible for the annual review of the Plan. Individual Laboratory Supervisors are responsible for the annual review of Laboratory specific SOPs (more frequently if warranted).

10.0 RELATED PROCEDURES, REFERENCES AND DOCUMENTS

10.1 Literature References

[1] National Resource Council, **Prudent Practices in the Laboratory: Handling and Disposal of Chemicals**, National Academy Press, Washington, D.C. 1995

NFPA 30, **Flammable and Combustible Liquids Code,** 1993 edition.

NFPA 45, **Standards on Fire Protection for Laboratories Using Chemicals,** 2000 edition

American Chemical Society, **Safety in Academy Chemistry Laboratories**, 5th ed., Washington, D.C., 1991

16 CFR 1500, Consumer Product Safety Commission, **Hazardous Substances and Articles**

29 CFR 1910.1200, OSHA, **Hazard Communication Standard**

29 CFR 1910.1450, OSHA, **Occupational Exposure to Hazardous Chemicals in the Laboratory**

10.2 Bates College Procedures

Bates College Integrated Contingency Plan, December 2003
Bates College Fume Hood Safety Program
Bates College Hazard Communication Program

Bates College

Chemical Hygiene Plan

Appendix A

29 CFR 1910.1450

Occupational Exposure to

Hazardous Chemicals in the Laboratory

29 CFR § 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/m^3;

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

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

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

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

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

(d) *Employee exposure determination*—(1) *Initial monitoring.* The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

(2) *Periodic monitoring.* If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

(3) *Termination of monitoring.* Monitoring may be terminated in accordance with the relevant standard.

(4) *Employee notification of monitoring results.* The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

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

(1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

(i) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

(ii) Capable of keeping exposures below the limits specified in paragraph (c) of this section.

(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:

(i) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

(ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

(iii) A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

(iv) Provisions for employee information and training as prescribed in paragraph (f) of this section;

(v) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

(vi) Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

(vii) Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee; and

(viii) Provisions for additional employee protection for work with particularly hazardous substances. These include “select carcinogens,” reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

(A) Establishment of a designated area;

(B) Use of containment devices such as fume hoods or glove boxes;

(C) Procedures for safe removal of contaminated waste; and

(D) Decontamination procedures.

(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) *Dates*—(1) *Effective date.* This section shall become effective May 1, 1990.

(2) *Start-up dates.* (i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

(ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(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.

Bates College

Chemical Hygiene Plan

Appendix B

Training Documentation Form

Bates College
Lewiston Campus
Training Documentation Form

Laboratory Supervisor: ____

Date:____________________ Department:________________________________

Room(s) No.: ____

Procedure and chemicals covered by this training: _____________________________

____

____

Topics covered in the training: ____

____

____

____

Training Instructor: ______________________________

Employees attending the training:

Print Name	Signature

Bates College
Lewiston Campus
Training Documentation Form (cont.)

Print Name	Signature

Chemical Hygiene Plan training documentation is required to be maintained by the Laboratory Supervisor for at least five years.

Bates College

Chemical Hygiene Plan

Appendix C

Bates College

Hazard Communication Plan

HAZARD COMMUNICATION PLAN

Compliance Statement

This Written Hazard Communication Plan is designed to explain how Bates meets the requirements of OSHA's Hazard Communication Standard (29 CFR 1910.1200) and the Maine Right To Know Law (Chapter 22, Title 26). Specifically, it describes how Bates obtains and uses material safety data sheets (MSDSs), labels products containing hazardous chemicals, and trains employees and contract workers about the hazardous chemicals they may be exposed to at Bates.

The college is committed to employee safety and requires all employees to follow this plan and maintain their work areas accordingly. A copy of this plan will be provided to Bates employees, their designated representatives, representatives of OSHA and the National Institute for Occupational Safety and Health ("NIOSH") upon request. In addition, other information required as part of Bates' hazard communication efforts (e.g., MSDSs and chemical lists) is available to employees upon request. Requesting to see such information is an employee's right and no employee will be penalized in any way for asking to review it. Using this information is part of Bates' shared commitment to a safe and healthy workplace.

Statement of Purpose

This Hazard Communication Plan is established to coordinate and administer the transmission of information concerning chemical hazards to all employees. All employees that may be exposed to chemicals are informed of the specific hazards of the chemicals that they may contact and the appropriate protective measures to use when handling the chemicals. This program defines how Bates will comply with the requirements of OSHA's Hazard Communication Standard (HCS), 29 C.F.R. § 1910.1200.

This program applies to all employees of Bates College, whether part-time, full-time, hourly or salaried, and at all locations affiliated with the college. Students employed by Bates while in the course of their work are also included. Sub-contractors hired for any reason who are using hazardous materials are also required to comply with program requirements. In addition, sub-contractors must inform the Safety Office if they are utilizing any hazardous chemicals which could endanger any nearby employees in the vicinity of work underway.

Program Review

This written program shall be reviewed on an annual basis by the departmental hazardous materials coordinators, Campus Safety Committee members and the EH&S Coordinator. Any revisions or updates shall be made and the policy shall be re-distributed to affected areas. The EH&S Coordinator may be contacted in Human Resources at ext. 6413 for information or in any case of emergency.

Hazardous Chemical Lists

All departments shall retain on file a complete inventory list of all hazardous materials utilized in that department. See Appendix E (not included in the Chemical Hygiene Plan) for the inventory. At a minimum, this shall include the name of each chemical, manufacturer, the area utilized, handled or stored, and verification as to whether the Material [4] OSHA defines a "hazardous chemical" as any chemical that poses a physical or health hazard. 29 C.F.R. 1910.1200©.

Safety Data Sheet (MSDS) is on file. Efforts should be made to obtain MSDSs for any hazardous chemicals used. Each department should designate one individual to document and maintain the inventory list and act as a point of a contact for this program. Copies of MSDSs shall be retained in the departments.

Material Safety Data Sheets (MSDS)

A current file of MSDSs is maintained in each department by the designated hazardous materials coordinator. A list of active chemicals is updated periodically as new chemicals are used in the process. Missing MSDSs are obtained from suppliers and/or manufacturers of chemicals. As a general rule, MSDSs should not be more than one (1) year old. When a product's use is discontinued and no remaining product is on-site, the product's MSDS is removed from Bates' active MSDS binder to an inactive binder. In accordance with OSHA rules, Bates maintains MSDSs on discontinued products for at least 30 years. 29 C.F.R. §§ 1910.20(e).

Content

The college uses a standard MSDS provided by the chemical supplier. MSDSs are in English and contain the following information:

1. The chemical identity used on the label, trade or chemical name, emergency phone numbers and the HMIS hazard rating.
2. The hazards of the chemical.
3. Precautionary measures and handling procedures.
4. Personal protective equipment and ventilation (routine handling).
5. Emergency procedures (first aid) and acute health effects.
6. Physical characteristics.
7. Fire, explosion, and reactivity hazards.
8. The health hazards, including signs and symptoms of exposure, and any medical conditions which are generally recognized as being aggravated by its exposure. The primary route(s) of entry, and target organs.
9. Spill and leak procedures.
10. Disposal procedures.
11. Ecological hazards.
12. Composition
13. Comments
14. Regulatory information, OSHA, DOT, EPA, etc.

Location

MSDSs are located at:

1. **EH&S Central File:** A complete inventory of all chemicals utilized at Bates and their Material Safety Data Sheets (MSDS) is located in the EH&S Coordinator's office for 24-hour/7-days per week access. An index of MSDSs on file is provided in Appendix E.
2. **Departmental Coordinator's Central File**: Each department utilizing, storing or handling hazardous materials maintains a central file of all MSDSs and a complete updated inventory list. Files contain a copy of this policy and documentation of any employee training conducted.

MSDS Distribution

MSDSs for the hazardous chemicals in use must be made available to all employees in the area of their work sites. Supervisors and Managers ensure that MSDSs are readily available for review or in case of emergency. In any case of exposure to a hazardous chemical, a copy of the MSDS shall accompany the injured person to the medical facility for reference if seeking treatment. This policy is available to all employees for review.

Trade Secret Information

The chemical manufacturer, importer, or employer may withhold the specific chemical identity, including the chemical name and other specific identification of a hazardous chemical, from the Material Safety Data Sheet if:

- It is a bonafide Trade Secret
- The hazards are disclosed
- The MSDS indicates that the specific chemical identity is being withheld as a Trade Secret
- The specific chemical identity is made available to health professionals where a treating physician or nurse determines that a medical emergency exists and the information is needed for first aid or emergency treatment.

Paragraph (I), 29 CFR 1910.1200, *Trade Secrets*, will be followed to ensure compliance with this section. In non-emergency situations, a chemical manufacturer must, upon written request, disclose a specific chemical identity or other trade secret information to a Safety/Medical Department professional based on one of the following reasons:
To assess the hazards of the chemicals to which employees will be exposed.
To conduct or assess monitoring of the workplace atmosphere to determine employee exposure levels.
To conduct pre-assignment or periodic medical surveillance of exposed employees.
To provide medical treatment to exposed employees
To select or assess appropriate personal protective equipment for exposed employees.
To design or assess engineering controls or other protective measures for exposed employees
To conduct studies to determine the health effect of exposure
To obtain trade secret information, a Safety Department professional will contact the manufacturer by telephone to acquire the information without the use of written arrangements. If a written arrangement is necessary, a request will be sent to the manufacturer.
All manufacturers' requests for confidentiality will be complied with including a strict procedure for signing, maintaining (for example, in a locked safe), and disseminating confidential information.

Labels, Labeling, and Warnings

All chemicals on site will be stored in their original or approved containers with proper labels clearly visible. Labels must include the name of the chemical, and the physical and chemical health hazards of the substance which is in the container.

Unmarked Containers

No unmarked containers of any size which contain hazardous chemicals are to be left unattended in the work area. Any container found shall be reported to the hazardous materials coordinator in your department for proper labeling to be completed.

Container Labels

1. Labels and other forms of warning are to be legible, in English and/or pictograms and prominently displayed on the container.
2. New labels do not need to be added if existing labels already convey the required information.
3. Numeric labeling systems are used to warn of hazards of the material are applied on site or arrive with incoming materials.

4. The NFPA (National Fire Protection Association) labeling system is based on a hazard rating of 0-4 for health, flammability, and reactivity. Specific hazards such as “oxidizers” and other instructions such as “no water for fire fighting” are indicated in a diamond shape.
5. The HMIS (Hazardous Material Information System) is also a hazard system which uses a 0-4 rating for health, flammability, and reactivity, but is laid out in rectangles. The bottom bar is for indicating appropriate personal protective equipment.
6. These hazard warning systems are based with 0 being no known or minimal hazard to 4 being a severe or highly toxic hazard.

Training

All Bates employees who work with or may be exposed to hazardous chemicals (defined at 29 C.F.R. § 1910.1200(c)) at the college are trained on the safe use and handling of the chemicals to which they may be exposed, the federal HCS and this plan. Records of any training conducted shall be maintained in the respective departments and a copy shall be forwarded to the EH&S Coordinator. Department supervisors are responsible for reviewing specific MSDSs of chemicals which their employees use in the department.

Training Requirements

Chemical hazard communication training is required (29 C.F.R. § 1910.1200(h)(1)):

1. Upon initial assignment to work area involving hazardous chemicals use or exposure.
2. When new hazardous chemical(s) are introduced to a work area or new information about a chemical is revealed. The MSDS for the new or existing chemical shall be reviewed with the applicable employees.
3. Annually on specific hazardous chemicals as identified in accordance to the Maine Chemical Substance Identification Law.

Training Materials

Materials used for hazard communication training include:

Commercially Produced Safety and Hazard Communication Videotapes;
Material Safety Data Sheets for hazardous chemicals used at Bates; and
Training session geared to familiarize employees with, and the location of, the hazardous chemicals in their work areas.

Scope of Training

Chemical Hazard Communication Training includes the following on which employees shall be fully trained:

1. The provisions of the Maine Chemical Substance Identification Law and the OSHA Hazard Communication Standard.
2. The Bates written policy and details of the Hazard Communication Plan.
3. The location, availability, details of this written plan and the list of hazardous chemicals.
4. The operations in the work area where hazardous chemicals are present.
5. The location of Material Safety Data Sheets and how to access the computer for viewing and printing copies of the MSDS.
6. The physical and health hazards of chemicals in the workplace; the methods of observations of detecting their presence or release, (such as appearance and odor of the chemical, or the use of meters that monitor and alarm in the presence of chemicals in the workplace).

7. The specific hazards of the material and their effect on certain target organs such as the liver, kidneys, lungs and heart.
8. The requirements for use and limitations of personal protective equipment and emergency procedures.
9. The chemical labeling requirements and the use of MSDSs as a source of chemical hazard information.
10. The methods used by the NFPA and HMIS warning systems to explain the health, flammability, and reactivity hazards of materials.
11. Non-routine tasks will be reviewed as to their possible chemical exposures. Employees shall be informed of the hazards, and personal protective equipment needed by reviewing the appropriate MSDS and evaluating the potential of reactants while these tasks are under way.
12. Contractors on site will be trained in these policies, shown how to follow the labeling requirements of this program, and shown how to obtain access to the MSDS.

See 29 C.F.R. § 1910.1200(h).

Outside Contractors

Prior to any outside contractor starting work within the college facilities, the Bates employee responsible for hiring the contractor will meet with him and discuss the work to be done. The contractor will be advised of the following:

Hazardous chemicals to which there may be possible exposure while on the job site;
Measures the contractor's employees may take to lessen the possibility of exposure; and
The availability of MSDSs for all hazardous chemicals on file and where a copy may be obtained.

The contractor will also be provided with a copy of Bates' Hazard Communication Program. The contractor will be responsible for providing adequate safeguards so his employees can complete the work without endangering themselves or others. The contractor is expected to have his own written program and be in full compliance with the applicable state and federal requirements. The contractor is expected to use signs, barricades and other appropriate means to keep unauthorized personnel out of the work area. The contractor shall provide MSDSs for any chemicals brought on site that could create a physical or health hazard to Bates employees and affected employees shall be made aware of this information.

Non-Routine Tasks

Any non-routine work will be reviewed for potential exposure to hazardous chemicals by the supervisor. Prior to starting non-standard work, each employee will be given information about hazardous chemicals involved with such activities. This information will include:

Specific chemical hazards; and
Protective/safety measures the employee can take.
A procedure will be agreed upon detailing appropriate actions and safeguards to control exposure to any hazardous chemical. This procedure will be used whenever the work is being done.

Hazardous Chemical Determination

The college relies on manufacturers' MSDSs to determine whether the products it uses are or contain hazardous chemicals.

Additional Information

For additional information regarding Bates' HCS Plan, chemical hazards, or MSDSs, employees should contact the EH&S Coordinator.

Bates College

Chemical Hygiene Plan

Appendix D

Bates College

Fume Hood Safety Program

1.0 INTRODUCTION

1.1 Policy

Laboratory exhaust ventilation systems used at Bates College will comply with the specifications and standards set forth in this document and in Appendicies D2 and D3. This program also set forth guidelines and work practices for the use of this equipment.

1.2 Purpose

This program was created and will concentrate on the aspects of fume hood operation that are critical to protecting the health and safety of faculty, staff, students and visitors as well as minimizing nuisance odors. The laboratory chemical fume hood is a critical health and safety control in the laboratory setting, ensuring an adequate level of protection from the possible harmful affects of chemicals. There are many different types and styles of laboratory fume hoods but they are generally of similar design. The purpose of fume hoods is to allow a researcher to work with volatile or reactive chemicals inside the hood, while minimizing the potential for exposure to airborne chemicals.

1.3 Scope

EH&S has established a program to inspect and certify all campus laboratory fume hoods. Since these hoods are the primary control method used to prevent worker exposure in the campus labs, the objective is that all hoods are inspected on a semi-annual basis. When a hood is determined to maintain at least the minimum requirements for airflow, it is marked with the name of the examiner on the calibration label located on the side of the hood.

The program addresses the use of all fume hoods on campus. It tracks all maintenance, inspections, evaluations and designations of the hoods located in Dana Chemistry, Carnegie Science, Pettengill Hall and Olin Arts. The program also sets forth Standard Safe Work Practices and Guidelines for all hoods and lists “hood specific” guidelines as well.

1.4 Goal

The intention of this program is to set a standard for use of the laboratory ventilation in order to maintain acceptable air quality in the laboratory buildings and surrounding areas.

2.0 FUME HOOD TYPES

2.1 Three Basic Types

2.2 Standard

The face velocity of a standard fume hood is inversely proportional to the open face area, allowing a constant volume of air to be exhausted. If the sash is lowered, the inflow air velocity increases.

Important: Face velocity that is too high may disturb sensitive apparatus, extinguish Bunsen burners or create excessive turbulence.

2.2.1 Bypass Fume Hoods

Bypass fume hoods are also called “balanced air” or “constant volume” fume hoods. As the sash is lowered, bypass fume hoods allow constant exhaust volumes that help keep the room ventilation system balanced. Constant exhaust volumes also eliminate the problem of high face velocity as the sash is lowered.

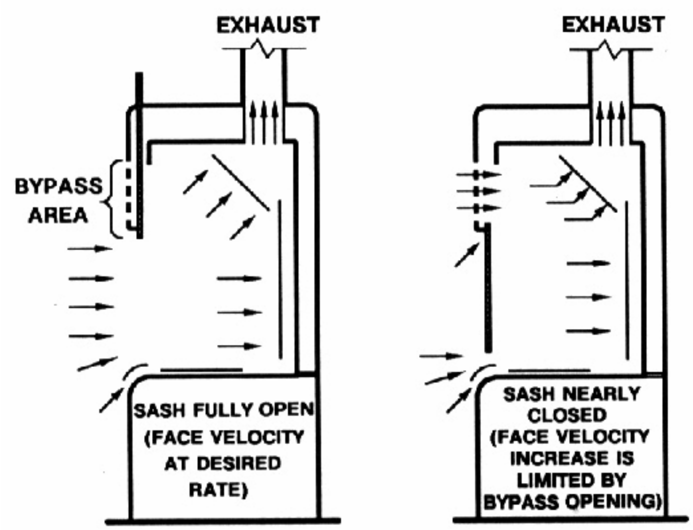

Figure 1. Bypass Fume Hood.

2.2.2 Auxiliary Fume Hoods

Auxiliary air fume hoods are also known as “supplied air” hoods. There is an outside air supply for 50% to 70% of the hood’s exhaust requirements. The face velocity of an auxiliary air fume hood may vary.

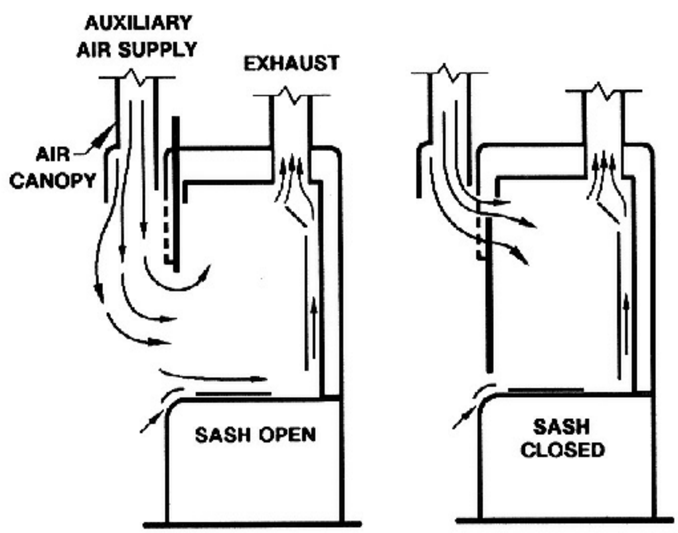

Figure 2. Auxiliary Fume hood.

2.2.3 Variable air volume principle

Variable air volume (VAV) hoods differ from constant air volume (CAV) hoods in their ability to vary air volume exhausted through the hood depending on the hood sash position. VAV hoods are becoming the preferred hood type, due to the elimination of excess face velocity. They also reduce the total quantity of supply and exhaust air to a space when not needed.

2.2.4 Variable air volume (VAV) hood

A VAV hood maintains a constant face velocity regardless of sash position. To ensure accurate control of the average face velocity, VAV hoods incorporate a closed loop control system. The system continuously measures and adjusts the amount of air being exhausted to maintain the required average face velocity. The addition of the VAV fume hood control system significantly increases the hood's ability to protect against exposure to chemical vapors or other contaminants. Many VAV hoods are also equipped with visual and audible alarms and gauges to notify the worker of hood malfunction or insufficient face velocity.

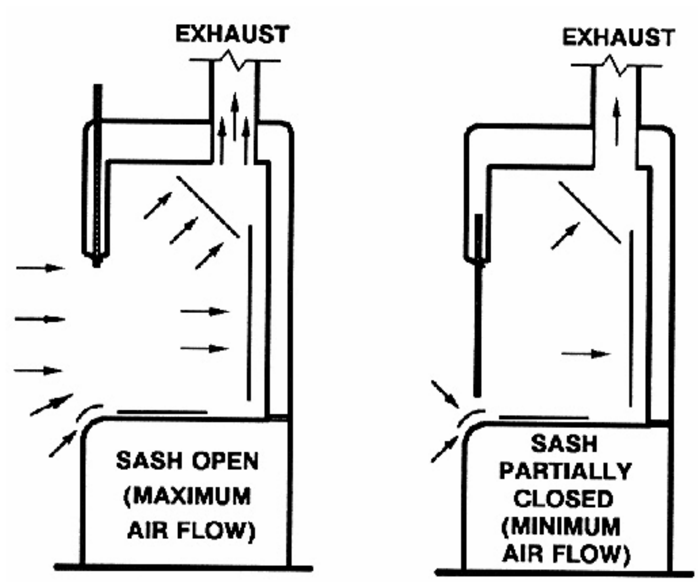

Figure 3. VAV Hood.

2.3 Vertical Sash Fume Hoods

They provide the best horizontal and vertical access to the hood interior and they also have the highest exhaust requirements. Using gravity sash stops can reduce the exhaust requirements, although this restricts the vertical access into the work area. Split sash hoods can be used where needed for two work areas.

2.4 Horizontal Sash Fume Hoods

They provide good access into the hood vertically and allow for lower exhaust requirements. These sashes do restrict the access across the hood for loading of equipment and apparatus. This limitation becomes less significant in larger hoods.

3.0 FUME HOOD USER'S GUIDE

A laboratory fume hood system is designed to protect the operator from undesirable substances being used, so its most important function is containment. While users have little control over a system, which is already in place, they can greatly increase or decrease its effectiveness by the way the hood is used. The purpose of this document is to make those who use hoods aware of some of the factors, which contribute to the effectiveness of a hood system.

3.1 Hood Basics

There are a wide variety of fume hoods on campus and some of these suggestions may not be applicable to all systems. The basic structure of a fume hood is not unlike a conventional fireplace and chimney combination. They usually have dampers, which permit ventilation of the laboratory when the hood is not in use. In some cases, hoods with vertical sashes are designed to automatically exhaust about the same amount of air from the room even when the sash is closed. In other cases, the hoods have dampers, which change the ratio of room air, which goes through the hood, compared to that which bypasses the system.

As shown in Figure 4, most hoods have an arrangement of movable panels, called baffles, with openings or slots at their edges. Air exhausted from the hood is drawn out through the slots. The slots are always at the top and the bottom with some systems having a middle adjustable slot or slots on the vertical edges of the baffles. Repositioning the baffles can vary the ratio of air, which is drawn into the top and bottom slots. Hood manufacturers claim that the upper exhaust slot should be opened when working with lighter than air vapors and the lower exhaust slot should be used to collect heavier than air vapors. Experts dispute this claim as a useful concept, noting that, except in unusual circumstances, the amount of material mixing with the air has minimal effect on the density of the mixture. You should check the setting of the upper slot. This should be between one-half and three-quarters of an inch. If this setting is not fully open, efficiency can drop by a large factor due to turbulence in the upper portion of the hood. The bottom slot is usually open one to four inches depending upon the design of the hood.

3.2 Work Practices

3.2.1 Keep the Sash Down

For hoods that have a movable front sash, keeping the opening as small as reasonably possible usually increases the flow rate through the aperture and enhances effectiveness. The sash also operates as a safety shield. It is strongly recommended that the hood sash be closed to within one or two inches when not in use. In many cases, such a practice not only saves energy, but also can increase efficiency of other hoods on the same system.

3.2.2 Have an Airfoil Installed

A source of undesirable turbulence results when air entering the hood impacts on the front edge of the floor of the hood. This effect can be minimized by the installation of an airfoil along the front edge of the hood as shown in Figure 1. Experiments conducted have shown a significant decrease in turbulence when such devices were installed. These devices are relatively inexpensive (around $100) and can be purchased for existing hoods through fume hood suppliers. Contact the EH&S if your fume hood is not equipped with an airfoil.

3.2.3 Use an Airflow Indicator

It is possible that without the knowledge of the user, the fan motor may not be operating, with the result that the individual does not have the protection expected from the system. A simple telltale consisting of an eight-inch narrow length of light material will also serve this purpose well. Telltales are installed by EH&S, if yours are missing or damaged call EH&S at x8226.

3.2.4 Keep Laboratory Doors and Windows Closed

In closed buildings, ventilation and fume hood systems are usually designed on the assumption that doors to the laboratory and windows will be in the closed position. If the doors and windows are left open, unplanned airflow patterns may degrade the efficiency of a hood.

3.2.5 Limit Traffic

Pedestrian traffic in front of the hood induces turbulence and can overcome the capture of vapors and pull them back out of the hood and into the operator's breathing zone. A painted line or length of tape placed on the floor of the room two feet away from the hood will discourage traffic this close to the hood.

3.2.6 Reduce Clutter

The effectiveness of a hood system is increased by achieving even, laminar airflow across the deck or bench surface of the hood The presence of objects in the hood tends to increase turbulence, so the more cluttered the working surface, the lower the efficiency and the less protection you have. For this reason, the number of objects in a hood should be kept to a workable minimum. In particular, keep the number of chemicals stored in a hood as low as possible. Not only does such storage decrease hood efficiency, but it also increases the possibility and seriousness of accidental fires. Solvents should be placed in vented cabinets rather than wasting useful and expensive hood space. When circumstances dictate such storage of chemicals, they should not be placed near the exhaust slots or in the front six inches. Shelving constructed of noncombustible materials may be placed in a hood as long as the bottom shelf is several inches off the deck of the hood and as long as it is placed in a way that does not interfere with the flow of air through the hood.

3.2.7 Work Far Into the Hood

You can substantially increase your protection by putting experimental materials as far back into the hood practicable. By moving a fume source from the plane of the hood face back six inches into the hood's interior, the capture rate for volatile materials can be greatly improved. Operations should not be carried out within six inches from the plane of the sash and as a useful reminder, a safety-striped tape is installed at this six-inch limit. However, in attempting to work as far back in the hood as possible, you should realize that the concentration of escaping vapors falls off very rapidly from the plane of the sash outward. Therefore, one's face should not be within the plane of the sash.

3.2.8 Proper Sash Use

Do not remove sashes from sliding sash hoods except when necessary to set-up apparatus and be sure to replace the sash before operation.

3.3 Other Considerations

3.3.1 Explosions

The glass sash offers protection from accidents and, when possible, it is safest to keep the sash between your face and the experiment. But the glass face is not designed to protect against explosions. When an explosive hazard is present, rounded safety shields should be placed between the operator and the experiment and as close as possible to the plane of the hood sash. Full-face protection should also be used in such circumstances.

3.3.2 Exhaust

Care should be taken with the use of paper products, aluminum foil and other lightweight materials within the hood. If such a material was drawn into the exhaust ducts, it could cause a profound deterioration in the velocity of air flowing into the hood.

3.3.3 Drains

Run water in hood drains at least once a week if the drains are not normally used. This is to prevent the drain traps from drying out and possibly perturbing airflow in the system or causing the introduction of sewer gases.

3.3.4 Power Outages

In case of a loss of power, the hood sash should be lowered to within an inch or so of the closed position so the chimney effect will keep some air flowing into the hood. Electric powered devices in the hoods should be disconnected to minimize accidents when the power is restored.

3.4 Adjustments to the Hood System

3.4.1 Get Assistance for Mechanical Changes

Venting of laboratory apparatus (e.g., vacuum pumps and storage cabinets) into the face or side of a hood can disrupt the design flow and lower efficiency. When such venting is deemed necessary, the connection should be further along the exhaust ducts of the hood system rather than into the face of the hood. To avoid the possibility of disrupting the efficient operation of the system, such installations should not be undertaken without consultation with Facilities Engineering, EH&S and the appropriate technical shops.

Likewise, installation of a new fume hood cannot be undertaken without the possibility of seriously disrupting the existing ventilation system and at times making other hoods in the building much less efficient. You should never consider doing this work yourself.

3.4.2 Office of Environmental Health and Safety

Environmental Health and Safety performs annual testing of fume hoods on campus. If the existing inspection sticker on your fume hood indicates a year or more has passed since we last inspected that hood, please call us. If your fume hood doesn't have an inspection sticker or if you have questions concerning the hood's operation, contact Environmental Health and Safety at x8226 for air flow measurements or questions.

Please remember all fume hood purchase requests need prior review and approval through our office. We can also provide information regarding the selection; purchase and inspection requirements for laminar flow, bio-safety, and portable fume hoods.

3.4.3 Mechanical Problems

If your fume hood suddenly seems to stop working and you suspect mechanical problems, contact EH&S or Physical Plant to report the problem. If maintenance workers are going to be working on your hood system, you should remove all chemicals from the hood.

3.4.4 Points to Remember

Many advisory notices of this sort are read but forgotten over time. To emphasize the more important operating factors, remember the following:

1. Make sure the hood is working (telltale indicates airflow).
2. Keep the sash as low as practical--sash is a safety shield.
3. Keep lab equipment one inch off work surface.
4. Keep hood free from clutter--don't block baffle openings.

5. Work at least six inches into hood.
6. Minimize rapid movements in front of hood.

Training programs on the safe use of fume hoods are available from Environmental Health and Safety.

4.0 FUME HOOD EVALUATIONS

Certain items should be looked into when evaluating a fume hood.

4.1 Location

The location of the fume hood affects its efficiency. Ideally, fume hoods should be located in an area of minimal traffic. When a person walks by a fume hood turbulence can be created causing contaminants to be drawn outside the fume hood. Also, if the air diffuser is located directly above the fume hood, air turbulence may be created causing contaminants to escape into the room. The airflow into the room has an effect on the fume hood. All doors and windows should be closed to maintain the negative pressure of the lab with respect to the corridor. This ensures that any contaminants in the lab will be exhausted through the fume hood and not escape in the hallway.

4.2 Face Velocity

Face velocity is a measurement of the average velocity at which air is drawn through the face to the hood exhaust. This is checked on a semi-annual basis or when ever maintenance, repairs or modifications are made. The acceptable range is 100 feet per minute (fpm). The ideal average face velocity is 100 fpm for most operations. Hoods installed today are at 100 fpm as the industry norm. At velocities greater than 125 fpm, studies have demonstrated that the creation of turbulence causes contaminants to flow out of the hood and into the user's breathing zone.

5.0 FUME HOOD INSPECTIONS

5.1 Inspection

5.1.1 Preliminary Investigation

After identifying the fume hoods to be evaluated, obtain any past history from fume hood files. Take this information along for reference material as necessary. In most cases, it will not be necessary to have Physical Plant personnel present when the hood is tested. Verify with the lab personnel that the hood is not being used and can be tested. Make sure that lab personnel are present to move any equipment and answer questions regarding experiments being performed in the hood. **<u>Do not touch any lab equipment.</u>**

5.1.2 Physical examination

Upon entering the room, compare information on the room diagram (Appendix D4) to the present arrangement. Indicate any changes to the room layout that have4 occurred since the last evaluation. If a diagram of the room is not available draft one. This information may be useful in resolving any airflow problems found during the testing.

5.1.2.1 Room diagrams should include the location of:

- Fume hoods
- Ceiling diffusers;
- Open doors or windows;
- Lab walls;
- Refrigerators, autoclaves, or other equipment that can obstruct fume hoods;
- Other room activities;
- Exhaust ducts;
- HVAC supply/return air ducts.

5.1.2.2 Next, indicate on the fume hood inspection sheet:

- Class of chemicals and extremely hazardous chemicals used.
- External condition of hood and exhaust duct (e.g., rust, missing parts, holes).
- Internal condition of hood (e.g., rust missing parts, holes).
- If it is being used for a storage area (other than SAA).
- Amount of equipment in the hood.
- Placement of equipment in the hood.
- Type of work being performed.

5.1.2.3 Before testing the hood, check the following items and record this information on the inspection sheet.

1. The sash needs to move smoothly and easily, yet remain in place at any height wherever stopped. It should substantially close off the hood face. The glass should be free of cracks, clean and visually transparent.

2. Check the lighting. This does not effect the inspection but is an excellent opportunity to catch these types of discrepancies.

3. Airfoil (if installed) is missing or damaged. This may result in abnormal test patterns.

4. Check for any unauthorized modifications to the original design, such as:

- Airfoil removed or damaged.
- Homemade fume hoods.
- Blocking or disabling auxiliary air.
- Venting other equipment into the hood.
- Missing or improperly adjusted baffle.
- Holes in duct work or other items vented into it.
- If it is not already on turn on the hood and listen for any unusual noises:
- Squealing sound may indicate a loose belt.
- Grinding sound may indicate a worn bearing.
- Hissing sound may indicate a hole in the exhaust duct or an object lodged in the duct.
- Roaring sound may be indicating fan speed is too high.

5.1.3 Performance Airflow Pattern Test

Use a testing substance to obtain a preliminary indication of the airflow pattern at the face of the fume hood. Record the information of this test on the inspection sheet.

With the sash fully open introduce, the substance into the hood face. Movement into the hood indicates positive airflow. A reverse flow (outward movement or dead air space (no movement) indicates unacceptable performance; the hood fails inspection, is tagged as such and reported to maintenance for repair.

5.1.4 Air Velocity Test

A vanometer is used to check the velocity at the hood's face. Record the result in the inspection sheet.

With the sash open to the determined maximum safe working height, begin testing. Evenly space the readings across the face of the hood 6-11 spaces depending upon the face's width. Do this at the point on the plane. See figure 2.

After you have taken all the readings, find the average face velocity. 100 fpm is desired but an average of 90-120 is acceptable as long as all test readings are greater than 70.

6.0 FUME HOOD REPAIR

Repair is to be solely done by Physical Plant.

7.0 STANDARD SAFE WORK PRACTICES

Laboratory fume hoods are designed to protect the user from hazardous airborne contaminants that may be released in an experiment. It is important to understand and follow the procedures that can insure that the hoods are used properly.

7.1.1 A fume hood should be used when:

Handling chemicals with significant inhalation hazards such as toxic gases, toxic chemical vapors, volatile radioactive material and respirable toxic powders.

- Carrying out experimental procedures with strong exothermic reactions.
- Handling chemicals with significant vapor pressure.
- Chemical vapors generated could cause a fire hazard.
- Working with compounds that have an offensive odor.
- Conduct all operation, which may generate air contaminants inside a hood.
- Before using a fume hood, make sure your work area is clean and uncluttered.
- When using a fume hood, ensure that there is airflow in the proper direction by observing the telltales.
- Never put your head inside a fume hood.
- Adjust the fume hood sash to an appropriate level to the process. Do not exceed posted maximum sash heights.
- Electrical extension cords are not safe to use in a fume hood due to the danger of an explosion or fire.
- When hood is not in use it should be left on and slightly open.
- Keep all apparatus and reagents at least six inches from the face of the hood.
- Do not block the exhaust vent in the back of the hood.
- Do not store chemicals in the hood.
- Large equipment must be elevated on solid blocks to maintain an airflow space of 1 – 2 inches above the work surface.
- Avoid opening and closing the sash rapidly, and avoid swift arm and body movements in front of or inside the hood. These actions may increase turbulence and reduce the effectiveness of the fume hood.

- If you observe defective or overheating equipment, disconnect it, close the sash and contact EH&S or Physical Plant.
- Keep chemical containers closed at all times. Use condensers, traps or scrubbers to contain and collect waste solvents, vapors or dusts.
- Clean all spills immediately. Do not allow spilled liquid chemicals to evaporate.
- If a fire occurs inside the fume hood, immediately close the sash and activate the fire alarm, exit the room, close the door and from a safe area outside call Campus Security at x

8.0 TROUBLESHOOTING

The following factors may adversely affect the performance of the Fume Hoods:

8.1 Lack of Sufficient Exhaust

If the volume of air being exhausted from the Fume Hood does not meet the minimum requirements as, then the fume hood will not maintain containment.

The exhaust fan must be of adequate size to handle the required volume of air.

The calculations for the fan size must include other factors in order to yield the correct fan size.

These factors include, but are not limited to, the size and configuration of the ductwork and the number of fume hoods on the same fan.

8.2 Lack of Sufficient Supply Air

If the volume of air being supplied to the laboratory space is not sufficient to meet the Fume Hood's exhaust requirements, then the fume hood will not maintain containment.

8.3 Flexible Ducts

The use of flexible ductwork to connect the fume hood to the ventilation system will adversely affect the fume hood's performance. Hard ductwork should be used at all times to optimize the fume hood's performance.

8.4 Traffic in Front of the Fume Hood

When people walk in front of the hood, a vortex is formed behind that person, similar to the wake that forms on the water behind a boat. These vortices cause turbulence at the face of the fume hood and may cause containment to break down. Excessive traffic should be avoided in the aisles adjacent to fume hoods.

8.5 Location of Supply Air Diffusers

Air supply diffusers that are located adjacent to the fume hood can cause disturbances in the airflow at the face of the hood, thereby adversely affecting containment. Supply air diffusers should be located in such a way that they do not interfere with the airflow in front of the fume hood. Existing supply diffusers should be either relocated, replaced with another type that directs the air away from the fume hood or the supply air volumes should be rebalanced for the diffusers.

8.6 Fume Hood Proximity to Doors and Windows

Fume hoods that are located next to windows and/or doors may lose containment efficiency due to the turbulence caused by the opening and closing of these windows and doors. The opening and closing of windows and doors causes waves of air that can adversely affect the airflow into the fume hood. In addition, the pressure changes in the laboratory space caused by the opening and closing of doors can negatively affect the fume hood's performance.

9.0 FREQUENTLY ASKED QUESTIONS

9.1 Whom do I contact if my fume hood is not functioning properly?

If your fume hood is not functioning properly, contact either Physical Plant or EH&S to assist you. If the problem is that the hood has shut off, report the problem to Physical Plant, then contact EH&S. If the hood is suffering from poor performance or other problems, contact the EH&S at x786-8226. EH&S can work with Physical Plant in examining your fume hoods and determining what procedures need to be conducted to fix your fume hood.

9.2 Why are fume hoods inspected? How often are the fume hoods inspected? Who do I call if my fume hood is due for inspection?

Fume hoods are inspected on a semi-annual basis by EH&S personnel in order assure that fume hoods provide adequate ventilation to protect its users from inhalation exposures. Fume hoods are inspected with an instrument, which measures air velocity into the hood. If your fume hood is due for an inspection, you may call EH&S at x28226 to schedule an inspection appointment.

9.3 What are proper storage guidelines for chemicals within fume hoods?

Only minimal amounts of chemicals or equipment storage are allowed in fume hoods. Excessive storage blocks air passage through the hood and results in air turbulence, which allows contaminants to escape. Chemicals may be kept temporarily in fume hoods if needed frequently during an experiment. After using a chemical, personnel should store chemical bottles in appropriate cabinets.

Bates College
Fume Hood Safety Program

Appendix D1

Definitions

Definitions

Chemical Laboratory Fume Hood

A ventilating device located in a laboratory, which is enclosed on five sides and has a moveable sash, that is used to controls chemical exposures. A chemical fume hood draws air from the laboratory and prevents the escape of air contaminants into the lab.

Fume Hood Inspection Program

A program implemented by EH&S whereby every fume hood on campus is tested for airflow characteristics on an annual basis. Fume hoods that pass the inspection process are marked with a calibration label and a maximum safe sash height label.

Hazardous Chemical

A chemical for which there is statistically significant scientific evidence, based on at least one study, that acute or chronic health affect may occur in exposed individuals. Hazardous chemicals can be separated into classes by the type of detrimental effect observed. Classes of chemicals include carcinogens, toxins, reproductive toxins, irritants, corrosives, sensitizers, mutagens, teratogens, hepatoxins, nephrotoxins, neurotoxins, etc.

Baffle

Panel located in the back of the fume hood interior, which assist in controlling airflow moving within the hood. Facilities Management should adjust the baffles according to the specific gravity of the chemicals used in the hood. Once the baffles are set, they should not be re-adjusted by lab workers.

Sash

Sash is the term used to describe the movable glass panel that covers the face area of a fume hood, used to assist with protecting the worker from chemical vapors and splashes. Sashes can be vertical, horizontal, or a combination of the two. Sash stops should never be removed, overridden, or modified. It is recommended that all lab work in a properly functioning fume hood be performed at the lowest level possible

Face Velocity

The average velocity of air moving perpendicular to the hood face, usually expressed in feet per minute (fpm) or meter per second (m/s). (ANSI/ASHRAE 110, 1995)

Building Envelope

This is the three-dimensional space surrounding a building containing the building's makeup air

Downwash

Pollutants discharged from an exhaust stack that travels towards the ground due to insufficient discharge velocities, poor wind dispersion, and physical obstructions.

Exhaust air

The air that is removed from an enclosed space and discharged into atmosphere (ANSI/AIHA Z9.5, 1992).

Hood face

The plane of minimum area at the front portion of a laboratory fume hood through which air enters when the sash (es) is (are) fully opened, usually in the same plane as the sash (es) when sash (es) is (are) present (ANSI/ASHRAE 110, 1995)

Internal Condensation

Fumes and vapors that condense into liquids inside of the exhaust stack.

Laboratory Fume Hood

A box-like structure enclosing a source of potential air contamination, with one open or partially open side, into which air is moved for the purpose of containing and exhausting air contaminants, generally used for bench-scale laboratory operation but not necessarily involving the use of a bench or a table (ANSI/ASHRAE 110, 1995)

LPM

Liters per minute (ANSI/ASHRAE 110, 1995)

Makeup air

Outside air drawn into a ventilation system to replace exhaust air (ANSI/AIHA Z9.5, 1992). Makeup air **MUST** always be provided when any exhaust system is designed and installed.

Re-circulation

Air withdrawn from a space, passed through a ventilation system, and delivered again to an occupied space (ANSI/AIHA Z9.5, 1992).

Reentry

The flow of contaminated air that has been exhausted from a space back into the space through air intakes or openings in the walls of the space (ANSI/AIHA Z9.5, 1992).

Replacement Air

See makeup air

Return air

Air being returned from a space to the ventilation fan that supplies air to a space (ANSI/AIHA Z9.5, 1992).

Special purpose hood

An exhaust hood, not otherwise classified, for a special purpose such as- but not limited to - capturing gases from equipment such as atomic absorption, gas chromatographs, liquid pouring or mixing stations, and heat sources (ANSI/AIHA Z9.5, 1992).

Velocity

Speed and direction of motion (ANSI/AIHA Z9.5, 1992).

Flammable and corrosive material storage cabinets

Flammable and corrosive cabinets typically comprise the bottom supporting structure of the fume hood. They can be vented or non-vented enclosures used primarily for storage of flammable or corrosive materials. If vented, the flammable storage cabinet is connected to the hood exhaust. The corrosive storage cabinet should be designed with a protective lining and secondary containment to inhibit chemical corrosion. It is highly recommended that these storage cabinets be vented either through the hood or through their own dedicated exhaust.

Alarms, sensors, controls, and gauges

Many of the newer hoods are installed with alarms, sensors, controls, and gauges. These features are included to provide lab personnel with a constant reading of fume hood performance. If the face velocity falls below an acceptable work range the hood sensors will trigger an alarm to notify lab personnel. Hoods usually go into alarm mode either because the sash has been raised to a height at which the hood can no longer exhaust a sufficient amount of air, the building air exhaust system is not working properly, or there has been a power outage. When a hood alarms, no chemical work should be performed until the exhaust volume is increased. Additionally, lab workers should not attempt to stop or disable hood alarms. Bates College's Physical Plant office should be notified for adjustment of air handling system exhausts and fume hood maintenance.

Airfoil (Sill)

The airfoil or sill, located at the front of the hood beneath the sash, creates a smooth airflow, minimizing turbulence of the air entering the hood. The recessed work area is directly behind the sill. All work should be done at least six (6) inches into the recessed area.

Air jambs

The air jambs are vertical sills or side posts at the front of the hood. These are tapered to promote smooth airflow into the hood.

Bates College
Fume Hood Safety Program

Appendix D2

Laboratory Standards and Guidelines for Fume Hoods
Developed by
Phoenix Controls Corporation

Laboratory Standards and Guidelines

Phoenix Controls Corporation

Laboratory Standards and Guidelines Table of Contents

Performance Test may be used as a specification. The specified performance should be required of both the hood manufacturer and the designer of the room air supply system."

p. 10-41, Table 10.35.1. Laboratory Hood Ventilation Rates

Condition	cfm/ft² Open Hood Face
1. Ceiling panels properly located with average panel face velocity < 40 fpm. Horizontal sliding sash hoods. No equipment in hood closer than 12 inches to face of hood. Hoods located away from doors and trafficways.*	60
2. Same as 1 above; some traffic past hoods. No equipment in hoods closer than 6 inches to face of hood. Hoods located away from doors and trafficways.*	80
3. Ceiling panels properly located with average panel face velocity < 60 fpm or ceiling diffusers properly located; no diffuser immediately in front of hoods; quadrant facing hood blocked; terminal throw velocity < 60 fpm. No equipment in hood closer than 6 inches to face of hood. Hoods located away from doors or trafficways.*	80
4. Same as 3 above; some traffic past hood. No equipment in hood closer than 6 inches to face of hood.	100
5. Wall grilles are possible but not recommended for advance planning of new facilities.	

* Hoods near doors are acceptable if 1) there is a second safe egress from the room; 2) traffic past hood is low; and 3) door is normally closed.

NFPA 45

p. 45-12, section 6.4.6

"Laboratory hood face velocities and exhaust volumes shall be sufficient to contain contaminants generated within the hood and exhaust them outside of the laboratory building. The hood shall provide containment of the possible hazards and protection for personnel at all times when chemicals are present in the hood."

p. 45-28, section A.6.4.6

"Laboratory fume hood containment can be evaluated using the procedures contained in the ASHRAE 110, *Method of Testing Performance of Laboratory Fume Hoods.* Face velocities of 0.4 m/sec to 0.6 m/sec (80 ft/min to 120 ft/min) generally provide containment if the hood location requirements and laboratory ventilation criteria of this standard are met."

ANSI/AIHA Z9.5

p. 13, section 5.7

"Each hood shall maintain an average face velocity of 80-120 fpm with no face velocity measurement more than plus or minus 20% of the average."

SEFA 1.2

p. 7, section 5.2

"A fume hood face velocity of 100 fpm is considered acceptable in standard practice. In certain situations face velocity of up to 125 fpm or as low as 75 fpm may be acceptable to meet required capture velocity of the fume hood."

Fume Hood Monitoring

Federal Register—OSHA

p. 492

"(b) *Hoods*...each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use."

Prudent Practices

p. 180

"Make sure that a continuous monitoring device for adequate hood performance is present, and check it every time the hood is used."

Industrial Ventilation—ACGIH

p. 10-45

"13. Provide adequate maintenance for the hood exhaust system and the building supply system. Use static pressure gauges on the hood throat, across any filters in the exhaust system, or other appropriate indicators to ensure flow is appropriate."

NIH Reference Materials for Design Policy and Guidelines—Mechanical

pp. D-141 to D-142, section D.16.22

"Fume hoods in new laboratory facilities shall have a pressure-independent flow-monitoring device connected to a local audiovisual alarm within the laboratory area. For existing facilities the implementation of airflow devices for fume hoods occurs during the renovation phase. When the fume exhaust falls below a preset safety level, the alarm will sound and the alarm light will come on."

Fume Hood Use

Federal Register—OSHA

p. 495

"(n) *Use of hood*:...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...

"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'."

Prudent Practices

p. 179

"In addition to protecting the laboratory worker from toxic or unpleasant agents used in them, fume hoods can provide an effective containment device for accidental spills of chemicals. There should be at least one hood for every two workers in laboratories where most work involves hazardous chemicals, and the hoods should be large enough to provide each worker with at least 2.5 linear feet of working space at the face. If this amount of hood space is not available, other types of local ventilation should be provided, and special care should be exercised to monitor and restrict the use of hazardous substances."

ANSI/AIHA Z9.5

p. 4, section 4.3

"Adequate laboratory fume hoods, special purpose hoods, or other controls shall be used when there is a likelihood of employee overexposure to air contaminants generated by a laboratory activity."

Laboratory Air Recirculation

Federal Register—OSHA

p. 492

"4. *Ventilation*...ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day..."

Prudent Practices

p. 192

"All air from chemical laboratories should be exhausted outdoors and not recirculated. Thus, the air pressure in chemical laboratories should be negative with respect to the rest of the building unless the laboratory is also a clean room."

ASHRAE Handbook

p. 13.9

"Laboratories in which chemicals and compressed gases are used generally require nonrecirculating or 100% outside air supply systems. The selection of 100% outside air supply systems versus return air systems should be made as part of the hazard assessment process, which is discussed in the section on Hazard Assessment. A 100% outside air system must have a very wide range of heating and cooling capacity, which requires special design and control.

Supply air systems for laboratories include both constant volume and variable volume systems that incorporate either single-duct reheat or dual-duct configurations, with distribution through low-, medium- or high-pressure ductwork."

NFPA 45

p. 45-12, section 6.3.1

"Laboratory ventilation systems shall be designed to ensure that chemicals originating from the laboratory shall not be recirculated. The release of chemicals into the laboratory shall be controlled by enclosure(s) or captured to prevent any flammable and/or combustible concentrations of vapors from reaching any source of ignition."

p. 45-12, section 6.4.1

"Air exhausted from laboratory hoods and other special local exhaust systems shall not be recirculated."

Industrial Ventilation—ACGIH

pp. 7-20

"*Industrial Exhaust Recirculation:* Where large amounts of air are exhausted from a room or building in order to remove particulate, gases, fumes or vapors, an equivalent amount of fresh tempered replacement air must be supplied to the room. If the amount of replacement air is large, the cost of energy to condition the air can be very high. Recirculation of the exhaust air after thorough cleaning is one method that can reduce the amount of energy consumed. Acceptance of such recirculating systems will depend on the degree of health hazard associated with the particular contaminant being exhausted as well as other safety, technical, and economic factors."

ANSI/AIHA Z9.5

p. 6, section 4.10.2

"Air exhausted from the general laboratory space (as distinguished from exhaust hoods) shall not be recirculated unless one of the following sets of criteria is met:

1) Criteria A
   a) There are no extremely dangerous or life-threatening materials used in the laboratory;
   b) The concentration of air contaminants generated by the maximum credible accident will be lower than short-term exposure limits...;
   c) The system serving the exhaust hoods is provided with installed spares, emergency power, and other reliability features as necessary.
2) Criteria B
   a) Recirculated air is treated to reduce contaminant concentrations...;
   b) Recirculated air is monitored continuously for contaminant concentrations or provided with a secondary backup air cleaning device that also serves as a monitor (i.e., a HEPA filter in a series with a less efficient filter, for particulate contamination only);
   c) Air cleaning and monitoring equipment is maintained and calibrated under a preventive maintenance program;
   d) A bypass to divert the recirculated air to atmosphere is provided."

NIH Research Laboratory Design Policy and Guidelines

p. D-16, section D.7.6

"Laboratory HVAC systems shall utilize 100% outdoor air, conditioned by central station air-handling systems to offset exhaust air requirements. Laboratory supply air shall not be recirculated or reused for other ventilation needs."

Laboratory/Building Pressurization

Federal Register—OSHA

p. 492

"4. *Ventilation*...direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building."

Prudent Practices

p. 192

"In all cases, air should flow from the offices, corridors, and support spaces into the laboratories. All air from chemical laboratories should be exhausted outdoors and not recirculated. Thus, the air pressure in chemical laboratories should be negative with respect to the rest of the building unless the laboratory is also a clean room."

ASHRAE Handbook

p. 13.12

"For the laboratory to act as a secondary confinement barrier, the air pressure in the laboratory must be maintained slightly negative with respect to adjoining areas. Exceptions are sterile facilities or clean spaces that may need to be maintained at a positive pressure with respect to adjoining spaces."

NIH Research Laboratory Design Policy and Guidelines

p. D-17, section D.7.8

"Laboratory air shall flow from low-hazard to high-hazard use areas. In general, laboratories shall be maintained at 47 L/s per module negative relative to non-laboratoy spaces. Administrative areas in laboratory building (sic) must always be positive with respect to corridors and laboratories."

NFPA 45

p. 45-12, sections 6.3.3

"Laboratory units in which chemicals are present shall be continuously ventilated."

p. 45-12, sections 6.3.4

"The air pressure in the laboratory work areas shall be negative with respect to corridors and nonlaboratory areas.

"Exception No. 1: Where operations such as those requiring clean rooms preclude a negative pressure relative to surrounding areas, alternate means shall be provided to prevent escape of the atmosphere in the laboratory work area or unit to the surrounding spaces.

"Exception No. 2: The desired static pressure level with respect to corridors and non-laboratory areas shall be permitted to undergo momentary variations as the ventilation system components respond to door openings, changes in laboratory hood sash positions, and other activities that can for a short term affect the static pressure level and its negative relationship."

The direct pressure control systems are also hard to stabilize, and can cause building pressure problems and result in excessively large volume offsets in 'porous' rooms.

"The need to maintain directional airflow at every instant and the magnitude of airflow needed will depend on individual circumstances. For example, 'clean' rooms may have very strict requirements while teaching laboratories may only need to maintain directional airflow during certain activities or emergency conditions. In the later cases, one would simply use the appropriate offset to maintain directional airflow as needed and operational procedures during emergencies (i.e. close doors during a chemical spill)...

"The amount of offset should be based on two considerations:

(1) The airflow required to keep the room negative (or in some positive) with regard to surrounding air spaces. The 10% offset suggested in the comments may be appropriate in some cases, but has no general validity.

(2) The required 'stringency' of the requirement for direction of air flow, into or out of any openings in the walls. Is the requirement really stringent, 'we really mean it', or less stringent, 'most of the time' or 'except when a door is open'.

"If the requirement is stringent, two seldom considered factors become important. First, if there is any appreciable temperature difference between the lab and the adjoining space, when a door is opened there will be a thermal exchange of warmer air flowing in one direction at the top of the doorway, and cooler air flowing in an opposite direction near the floor. An airflow velocity of at least 50 fpm is required to inhibit this exchange under normal conditions, a flow rate of 100 fpm is more positive. For a typical 3 ft. x 7 ft. open doorway, this translates to 1050 to 2100 cfm. The volume is independent of the size of the room or the cfm of lab supply and exhaust; an arbitrary 10% 'offset' of the lab total ventilation rate is not the proper basis. If there is no airlock, and if there is a definite but not 'stringent' need for direction of airflow, this phenomenon should be made a design consideration...

"For situations less than those requiring stringent control, VAV systems should be adequate. The 'offset' volume should be based on the cfm needed to provide at least 50 fpm (100 fpm is better) through the doorway opening. The increased offset volume can be operated by a mechanical optical switch at or near the door. The volume of offset air required is not related to the ventilation rate of the laboratory.

"A secondary intent of this paragraph is to encourage the operation of laboratories with the doors closed. The 'note' was intended to demonstrate that a significant volume of air would be needed to maintain adequate directional airflow through an open door. This was not meant to be a design recommendation for airflow through open doors."

Laboratory Airflow Exchange Rates

Federal Register—OSHA

p. 492

"(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."

Prudent Practices

p. 192

"A general ventilation system that gives 6 to 12 room air changes per hour is normally adequate. More airflow may be required to cool laboratories with high internal heat loads, such as those with analytical equipment, or to service laboratories with large specific exhaust system requirements."

ASHRAE Handbook

p. 13.8

"The total airflow rate for a laboratory is dictated by one of the following:

1. Total amount of exhaust from containment and exhaust devices
2. Cooling required to offset internal heat gains
3. Minimum ventilation rate requirements...

"Minimum airflow rates are generally in the range of 6 to 10 air changes per hour when the space is occupied; however, some spaces (e.g., animal holding areas) may have minimum airflow rates established by specific standards or by internal facility policies...The maximum airflow rate for the laboratory should be reviewed to ensure that appropriate supply air delivery methods are chosen such that supply airflows do not impede the performance of the exhaust devices."

Industrial Ventilation—ACGIH

p. 7-16

"'Air changes per hour' or 'air changes per minute' is a poor basis for ventilation criteria where environmental control of hazards, heat, and/or odors is required. The required ventilation depends on the generation rate and toxicity of the contaminant not on the size of the room in which it occurs."

NFPA 45

p. 45-27, section A.6.3.3

"A minimum ventilation rate for unoccupied laboratories (e.g., nights and weekends) is four room air changes per hour. Occupied laboratories typically operate at rates of greater than eight room air changes per hour, consistent with the conditions of use for the laboratory."

NIH Research Laboratory Design Policy and Guidelines

p. D-18, section D.7.10

"The ventilation rate for laboratory HVAC systems is driven by three factors: fume hood demand, cooling loads, and removal of fumes and odors from the general laboratory work area. The minimum air-change rate for laboratory space is six air changes per hour regardless of space cooling load."

Manifolded Exhaust Systems

ASHRAE Handbook

p. 13.9

"Each fume hood may have its own exhaust fan, or fume hoods may be manifolded and connected to central exhaust fans...

"These can be classified as pressure-dependent or pressure-independent. Pressure-dependent systems are constant volume only and incorporate manually adjusted balancing dampers for each exhaust device. If an additional fume hood is added to a pressure-dependent exhaust system, the entire system must be rebalanced, and the speed of the exhaust fans may need to be adjusted. Because pressure-independent systems are more flexible, pressure-dependent systems are not common in current designs.

"A pressure-independent system can be constant volume, variable volume, or a mix of the two. It incorporates pressure-independent volume regulators with each device. The system offers two advantages: (1) the flexibility to add exhaust devices without having to rebalance the entire system and (2) variable volume control...

"Running many exhaust devices into the manifold of a common exhaust system offers the following benefits:

- Lower ductwork cost
- Fewer pieces of equipment to operate and maintain
- Fewer roof penetrations and exhaust stacks
- Opportunity for energy recovery
- Centralized locations for exhaust discharge
- Ability to take advantage of exhaust system diversity
- Ability to provide a redundant exhaust system by adding one spare fan per manifold"

ANSI/AIHA Z9.5

p. 21, section 7.1.1

"Exhaust ducts from two or more hoods may be connected to an exhaust manifold, frequently to avoid a multiplicity of small stacks on the roof of the building or to reduce the pipe chase space that would be required in a multi-story laboratory."

p. 21, section 7.1.4

"Unless the use of all laboratory exhaust hoods connected to a manifold can be stopped completely without creating a hazardous situation, provision should be made for continuous maintenance of adequate suction in the manifold. This requirement would be satisfied by providing

- an installed spare manifold exhaust fan that can be put into service rapidly by energizing its motor and switching a damper;
- emergency power to the manifold exhaust fans.

"Alternative methods of maintaining manifold suction, if acceptable to all parties involved, will satisfy this requirement."

Exhaust Stack Height

NFPA 45

p. 45-12, section 6.4.11

"Air exhausted from laboratory hoods and special exhaust systems shall be discharged above the roof at a location, height, and velocity sufficient to prevent re-entry of chemicals and to prevent exposures to personnel."

p. 45-28, section A.6.4.11

"Exhaust stacks should extend at least 3 m (10 ft) above the highest point on the roof to protect personnel on the roof. Exhaust stacks might need to be much higher to dissipate effluent effectively, and studies might be necessary to determine adequate design."

ASHRAE Handbook

p. 13.13

"Chapter 15 of the 1997 *ASHRAE Handbook—Fundamentals* describes a geometric method to determine the stack discharge height high enough above the turbulent zone around the building that little or no effluent gas impinges on air intakes of the emitting building. The technique is conservative and generally requires tall stacks that may be visually unacceptable or fail to meet building code or zoning requirements. Also, the technique does not ensure acceptable concentrations of effluents at air intakes (e.g., if there are large releases of hazardous materials or elevated intake locations on nearby buildings)...

"To increase the effective height of the exhaust stacks, both the volumetric flow and the discharge velocity can be increased to increase the discharge momentum (Momentum Flow = Density x Volumetric Flow x Velocity). The momentum of the large vertical flow in the emergent jet lifts the plume a substantial distance above the stack top, thereby reducing the physical height of the stack and making it easier to screen from view. This technique is particularly suitable when (1) many small exhaust streams can be clustered together or manifolded prior to the exhaust fan to provide the large volumetric flow and (2) outside air can be added through automatically controlled dampers to provide constant exhaust velocity under variable load. The drawbacks to the second arrangement are the amount of energy consumed to achieve the constant high velocity and the added complexity of the controls to maintain the constant flow rates. Dilution equations presented in Chapter 15 of the 1997 *ASHRAE Handbook—Fundamentals* or mathematical plume analysis (e.g., Halitsky 1989) can be used to predict the performance of this arrangement, or performance can be validated through wind tunnel testing. Current mathematical procedures tend to have a high degree of uncertainty, and the results should be judged accordingly."

ANSI/AIHA Z9.5

p. 5, section 4.8

"Exhaust discharge from stacks shall be in accordance with the latest applicable ASHRAE standards, and it shall

- be in a vertical-up direction at a minimum of 10 feet above the adjacent roof line and so located with respect to openings and air intakes of the laboratory or adjacent buildings to avoid reentry."

p. 6, section 4.9

"Two or more exhaust systems may be combined into a single manifold and stack..."

Exhaust Duct Velocity

Industrial Ventilation—ACGIH

p. 3-18, Table 3-2. (partial) Range of Minimum Duct Design Velocities

Nature of Contaminant	Examples	Design Velocity
Vapors, gases, smoke	All vapors, gases and smoke	Any desired velocity (economic optimum velocity usually 1000-2000 fpm)
Fumes	Welding	2000-2500
Very fine light dust	Cotton lint, wood flour, litho powder	2500-3000
Dry dusts & powders	Fine rubber dust, Bakelite molding powder dust, jute lint, cotton dust, shavings (light), soap dust, leather shavings	3000-4000

NFPA 45

p. 45-13, section 6.6

"Duct Velocities. Duct velocities of laboratory exhaust systems shall be high enough to minimize the deposition of liquids or condensable solids in the exhaust systems during normal operations in the laboratory hood."

ANSI/AIHA Z9.5

p. 5, section 4.8

"- have a discharge velocity of at least 3000 fpm for a stack without internal condensation; or

- have a discharge velocity of 2000 fpm or less if internal condensation might occur."

General Air Distribution Guidelines

ASHRAE Handbook

p. 13.5

"Caplan and Knutson (1977, 1978) conducted tests to determine the interactions between room air motion and fume hood capture velocities with respect to the spillage of contaminants into the room. Their tests indicated that the effect of room air currents is significant and of the same order of magnitude as the effect of the hood face velocity. Consequently, improper design and/or installation of the replacement supply air lowers the performance of the fume hood.

"Disturbance velocities at the face of the hood should be no more than one-half and preferably one-fifth the face velocity of the hood. This is an especially critical factor in designs that use low face velocities. For example, a fume hood with a face velocity of 100 fpm could tolerate a maximum disturbance velocity of 50 fpm. If the design face velocity were 60 fpm, the maximum disturbance velocity would be 30 fpm.

"To the extent possible, the fume hood should be located so that traffic flow past the hood is minimal. Also, the fume hood should be placed to avoid any air currents generated from the opening of windows and doors. To ensure the optimum placement of the fume hoods, the HVAC system designer must take an active role early in the design process."

NFPA 45

p. 45-12, section 6.3.5

"The location of air supply diffusion devices shall be chosen so as to avoid air currents that would adversely affect the performance of laboratory hoods, exhaust systems, and fire detection or extinguishing systems."

p. 45-28, section A.6.3.5

"Room air current velocities in the vicinity of fume hoods should be as low as possible, ideally less than 30 percent of the face velocity of the fume hood. Air supply diffusion devices should be as far away from fume hoods as possible and have low exit velocities."

Prudent Practices

p. 178

"Tracer gas containment testing of fume hoods has revealed that air currents impinging on the face of a hood at a velocity exceeding 30 to 50% of the hood face velocity will reduce the containment efficiency of the hood by causing turbulence and interfering with the laminar flow of the air entering the hood. Thirty to fifty percent of a hood face velocity of 100 fpm, for example, is 30 to 50 fpm, which represents a *very* low velocity that can be produced in many ways. The rate of 20 fpm is considered to be still air because that is the velocity at which most people first begin to sense air movement."

ANSI/AIHA Z9.5

p. 6, section 4.11.2

"Supply air distribution shall be provided to create air jet velocities less than half (preferably less than one-third) of the capture or face velocity of the exhaust hoods."

p. 12, section 5.4

"Hoods should be located more than 10 feet from any door or doorway (emergency exits excepted), and should not be located on a main traffic aisle."

Controls—Pressure-independent

ASHRAE Handbook

p. 13.9

"Airflow monitoring and pressure-independent control may be required even with constant volume systems...Because pressure-independent systems are more flexible, pressure-dependent systems are not common in current designs...(Pressure-independent) volume regulators can incorporate either direct measurement of the exhaust airflow rate or positioning of a calibrated pressure-independent air valve."

NIH Reference Materials for Design Policy and Guidelines—Mechanical

p. D-132, section D.16.17

"Exhaust air from laboratory equipment such as fume hoods and biosafety cabinets connected to a general central laboratory exhaust main is preferably connected through pressure-independent terminal units."

AIA

p. 33

"Chemical fume hood systems may be constant-volume or variable-volume types depending on user and facility management considerations of function, first cost, and life cycle cost issues. The exhaust of the hood should be provided with a pressure-independent flow-monitoring device connected to a local audiovisual alarm within the laboratory."

Controls—General

ASHRAE Handbook

p. 13.11

"Laboratory controls must regulate temperature and humidity, control and monitor laboratory safety devices that protect personnel, and control and monitor secondary safety barriers used to protect the environment outside the laboratory from laboratory operations (West 1978). Reliability, redundancy, accuracy, and monitoring are important factors in controlling the lab environment. Many laboratories require the precise control of temperature, humidity, and airflows; components of the control system must provide the necessary accuracy and corrosion resistance if they are exposed to corrosive environments.

"Laboratory controls should provide fail-safe operation, which should be defined jointly with the safety officer. A fault tree can be developed to evaluate the impact of the failure of a control system component and to ensure that safe conditions are maintained."

p. 13.12

"A true CAV (Constant Air Volume) system requires volume controls on the supply and exhaust systems."

p. 13.16

"Energy can be conserved in laboratories by reducing the exhaust air requirements. For example, the exhaust air requirements for fume hoods can be reduced by closing part of the hood opening during operation, thereby reducing the airflow needed to obtain the desired capture velocities (an exception is bypass hoods, which require similar quantities of exhaust air whether open or fully closed). The sash styles that may be adjusted are described in the section on Laboratory Exhaust and Containment Devices.

"Another way to reduce exhaust airflow is to use variable volume control of exhaust air through the fume hoods to reduce exhaust airflow when the fume hood sash is not fully open. A variation of this arrangement incorporates a user-initiated selection of the fume hood airflow from a minimum flow rate to a maximum flow rate when the hood is in use. Any airflow control must be integrated with the laboratory control system, described in the section on Control, and must not jeopardize the safety and function of the laboratory.

"A third energy conservation method uses night setback controls when the laboratory is unoccupied to reduce the exhaust volume to one-quarter to one-half the minimum volume required when the laboratory is occupied. Timing devices, sensors, manual override, or a combination of these can be used to set back the controls at night. If this strategy is considered, the safety and function of the laboratory must be considered, and appropriate safety officers should be consulted."

ANSI/AIHA Z9.5

p. 14, section 5.10

"Variable volume hoods also shall modulate supply air to maintain the design air balance between the laboratory and adjacent areas. The mechanism that controls the exhaust fan speed or control damper position to regulate hood exhaust volume should be designed so exhaust volume is not reduced until the sash is half-closed. Then, it is reduced in proportion with the sash closure to a minimum of 10% full-open face volume (i.e., if the exhaust volume is not reduced to zero by the control, a separate on-off switch is required)...

"If the maximum exhaust volume of variable volume hoods in one room exceeds 10% of the room air supply volume, and if the laboratory is designed for controlled airflow between laboratory and adjacent spaces, automatic flow control devices shall be provided to reduce the supply air volume by the same amount that hood exhaust volume is reduced."

ANSI/AIHA Z9.5 Clarification Letter

p. 3

"There is a statement in this section that suggests that it may be desirable to maintain constant volume through the hood with the sash at or above half opening. This enables the user to instantly attain twice the normal face velocity for unusual or more hazardous operations than normal, i.e. spills, etc. In some cases it may not be desirable. This is not intended to be a requirement.

"It may be more important to establish a minimum exhaust flow rate, i.e. as the sash is lowered below a specific sash height the hood becomes a constant volume by-pass hood. This will allow the exhaust to stay at or above the minimum desired for the space while not resulting in excessive face velocities as the sash continues to be lowered below this trigger point."

NFPA 45

p. 45-13, section 6.5.8

"Controls and dampers, where required for balancing or control of the exhaust system, shall be of a type that, in event of failure, will fail open to ensure continuous draft."

p. 45-14, section 6.10.4

"Laboratory hoods equipped with control systems that vary the hood exhaust airflow as the sash opening varies and/or in conjunction with whether the laboratory room is in use (occupied/unoccupied) shall be equipped with a user accessible means to attain maximum exhaust hood airflow regardless of sash position when necessary or desirable to ensure containment and removal of a potential hazard within the hood."

p. 45-14, section 6.10.3

"Automatic file dampers shall not be used in laboratory hood exhaust systems. Fire detection and alarm systems shall not be interlocked to automatically shut down laboratory hood exhaust fans. The design and installation of ducts from laboratory hoods shall be in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, except that specific requirements in NFPA 45 shall take precedence.

"Exception No. 1: Where a gaseous fire extinguishing system is used to protect a laboratory hood, the protected laboratory hood shall be independent of all other laboratory hoods, and its exhaust system shall be permitted to be interlocked to shut down upon actuation of the fire extinguishing system.

"Exception No. 2: Where a branch duct connects to an enclosed exhaust riser located inside a shaft, which has a required fire resistance rating of 1 hour or more and in which the airflow moves upward, protection of the opening into the fire resistance rated enclosure shall be made with a steel subduct turned upward a minimum of 0.6 m (22 in.) in length and of a minimum thickness of 22 gauge [0.76 mm (0.030 in.)]. The steel subduct shall be carried up inside the riser from each inlet duct penetration. This riser shall be appropriately sized to accommodate the flow restriction created by the subduct."

p. 45-14, section 6.10.1

"Automatic fire protection systems shall not be required in laboratory hoods or exhaust systems.

"Exception No. 1: Automatic fire protection shall be required for existing hoods having interiors with a flame spread index greater than 25 in which flammable liquids are handled.

"Exception No. 2: If a hazard assessment shows that an automatic extinguishing system is required for the laboratory hood, then the applicable automatic fire protection system standard shall be followed."

p. 45-13, section 6.7.5

"Motors and their controls shall be located outside the location where flammable or combustible vapors or combustible dusts are generated or conveyed, unless specifically approved for that location and use."

p. 45-10, section 3.6.1

"Electrical receptacles, switches, and controls shall be located so as not to be subject to liquid spills."

AIA

p. 69

"Fire dampers shall not be provided on any fume hood system."

Testing and Monitoring

Prudent Practices

p. 180

"All fume hoods should be tested, before they leave the manufacturer, by using ASHRAE/ANSI standard 110, Methods of Testing Performance of Laboratory Fume Hoods. The hood should pass the low- and high-volume smoke challenges with no leakage or flow reversals and have a control level of 0.05 parts per million (ppm) or less on the tracer gas test. ASHRAE/ANSI 110 testing of fume hoods after installation in their final location by trained personnel is highly recommended."

ANSI/AIHA Z9.5

p. 10, section 4.14.5

"If practical, the exhaust flow rate from hoods shall be tested by measuring the flow in the duct by the hood throat suction method (see the *Industrial Ventilation* manual, Section 9[6]) or by a flowmeter. If a flowmeter is used, care shall be taken to ensure that the sensing element has not been compromised by chemical action or deposition of solids...

"If flow measurement in the duct is not practical, velocity at the hood face or opening shall be measured at a sufficient number of points to obtain a realistic average velocity, and multiplied by the open area in the plane of the velocity measurements to obtain the flow rate.

"If the flow rate is more than 10% different from design, corrective action shall be taken."

pp. 10-11, section 4.14.6

"The proper direction and velocity of air movement between laboratory spaces will have different degrees of importance, varying from desirable to important to critical. The degree of importance will vary with many factors, among them the objective assessment of potential health hazard and whether the potential health effects are acute or chronic...

"The laboratory organization should establish the degree of importance of proper airflow balance as desirable, important, or critical...

"4.14.6.1 Critical air balance

"Monitoring devices shall be inspected and tested at intervals no longer than one week.

"4.14.6.2 Important air balance

"Direction and velocity of airflow shall be tested at intervals no longer than one month.

"4.14.6.3 Desirable air balance

"Direction and velocity of airflow should be tested at intervals not to exceed six months."

p. 13, section 5.6.1

"Specification and procurement of fume hoods shall be based on a performance test of the hood (or a prototype) demonstrating that the hood performance is adequate for the intended use. The recommended performance test is ANSI/ ASHRAE 110."

p. 13, section 5.6.2

"A routine performance test shall be conducted on every fume hood at least annually or whenever a significant change has been made to the operational characteristics of the system."

ASHRAE Handbook

p. 13.5

"Fume Hood Performance Criteria. ASHRAE *Standard* 110, Method of Testing Performance of Laboratory Fume Hoods, describes a quantitative method of determining the containment performance of a fume hood. The method requires the use of a tracer gas and instruments to measure the amount of tracer gas that enters the breathing zone of a mannequin; this simulates the containment capability of the fume hood as a researcher conducts operations in the hood.

"The following tests are commonly used to judge the performance of the fume hood: (1) face velocity test, (2) flow visualization test, (3) large volume flow visualization, (4) tracer gas test, and (5) sash movement test. These tests should be performed under the following conditions:

- Usual amount of research equipment in the hood; the room air balance set
- Doors and windows in their normal positions
- Fume hood sash set in varying positions to simulate both static and dynamic performance

"All fume hoods should be tested annually and their performance certified."

NFPA 45

p. 45-15, sections 6.13.1 to 6.13.6

"When installed or modified and at least annually thereafter, laboratory hoods, laboratory hood exhaust systems, and laboratory special exhaust systems shall be inspected and tested. The following inspections and tests, as applicable, shall be made:

(1) Visual inspection of the physical condition of the hood interior, sash, and ductwork...

(2) Measuring device for hood airflow

(3) Low airflow and loss-of-airflow alarms at each alarm location

(4) Face velocity

(5) Verification of inward airflow over the entire hood face

(6) Changes in work area conditions that might affect hood performance

"Deficiencies in hood performance shall be corrected or one of the following shall apply:

(1) The activity within the hood shall be restricted to the capability of the hood.

(2) The hood shall not be used.

"Laboratory hood face velocity profile or hood exhaust air quantity shall be checked after any adjustment to the ventilation system balance.

"**Detectors and Alarms.** Air system flow detectors, if installed, shall be inspected and tested annually. Where potentially corrosive or obstructive conditions exist, the inspection and test frequency shall be increased.

"**Fans and Motors.**

"Air supply and exhaust fans, motors, and components shall be inspected at least annually.

"Where airflow detectors are not provided or airflow-rate tests are not made, fan belts shall be inspected quarterly. Frayed or broken belts shall be replaced promptly. When double sheaves and belts are employed, the inspection frequency shall be permitted to be semiannual.

"Fixed fire extinguishing systems protecting filters shall be inspected quarterly for accumulation of deposits on nozzles. Nozzles shall be cleaned as necessary."

Work Practices

ANSI/AIHA Z9.5

pp. 12-13, section 5.5

"Many work practices might affect the overall safety and health situation in a laboratory. The following list concerns only those work practices related directly to hood performance and applies only when hazardous materials are to be used in the hood:

a) The worker shall not lean into the hood so that his/her head is inside the plane of the hood face without adequate respiratory and personal protection, except for setup work or hood maintenance;

b) Equipment in the hood should not block airflow to slots in the baffle;

c) Equipment that might be a source of emission (including in case of breakage) should not be placed closer than 6 inches from the plane of the hood face;

d) Flammable liquids should not be stored permanently in the cabinet under the hood unless that cabinet meets the requirements of ANSI/NFPA 30 and 45 for flammable liquid storage;

e) The hood sash or panels shall not be removed except for setup work without hazardous chemicals in the hood;

f) The hood sash or panels should be closed to the maximum position possible while still allowing comfortable working conditions;

g) A hood that is more than 10% below standard in exhaust volume shall not be used unless its condition is labeled and the maximum sash opening marked clearly.

"Each hood shall be posted with a notice giving the date of the last periodic field test. If the hood failed the performance test, it shall be taken out of service until repaired, or posted with a restricted use notice. The notice shall state the partially closed sash position necessary and any other requisite precautions concerning the type of work and materials permitted or prohibited."

Prudent Practices

p. 179

"Many factors can compromise the efficiency of a hood operation. Most of these are avoidable; thus, it is important to be aware of all behavior that can, in some way, modify the hood and its capabilities. The following should always be considered when using a hood:

- Keep fume hood exhaust fans on at all times.
- If possible, position the fume hood sash so that work is performed by extending the arms under or around the sash, placing the head in front of the sash, and keeping the glass between the worker and the chemical source. The worker views the procedure through the glass, which will act as a primary barrier if a spill, splash, or explosion should occur.
- Avoid opening and closing the fume hood sash rapidly, and avoid swift arm and body movements in front of or inside the hood. These actions may increase turbulence and reduce the effectiveness of fume hood containment.
- Place chemical sources and apparatus at least 6 inches behind the face of the hood. In some laboratories, a colored stripe is painted on, or tape applied

to, the hood work surface 6 inches back from the face to serve as a reminder. Quantitative fume hood containment tests reveal that the concentration of contaminant in the breathing zone can be 300 times higher from a source located at the front of the hood face than from a source placed at least 6 inches back. This concentration declines further as the source is moved farther toward the back of the hood.

- Place equipment as far to the back of the hood as practical without blocking the bottom baffle.
- Separate and elevate each instrument by using blocks or racks so that air can flow easily around all apparatus.
- Do not use large pieces of equipment in a hood, because they tend to cause dead spaces in the airflow and reduce the efficiency of the hood.
- If a large piece of equipment emits fumes or heat outside a fume hood, then have a special-purpose hood designed and installed to ventilate that particular device. This method of ventilation is much more efficient than placing the equipment in a fume hood, and it will consume much less air.
- Do not modify fume hoods in any way that adversely affects the hood performance. This includes adding, removing, or changing any of the fume hood components, such as baffles, sashes, airfoils, liners and exhaust connections."

Selection of Specialty Hoods

Prudent Practices

pp. 184-185

"*Auxiliary Air Hoods*

"Quantitative tracer gas testing of many auxiliary air fume hoods has revealed that, even when adjusted properly and with the supply air properly conditioned, significantly higher worker exposure to the materials used in the hood may occur than with conventional (non-auxiliary air) hoods. Auxiliary air hoods should not be purchased for new installations, and existing auxiliary air hoods should be replaced or modified to eliminate the supply air feature of the hood. This feature causes a disturbance of the velocity profile and leakage of fumes from the hood into the worker's breathing zone.

"The auxiliary air fume hood was developed in the 1970s primarily to reduce laboratory energy consumption. It is a combination of a bypass fume hood and a supply air diffuser located at the top of the sash. These hoods were intended to introduce unconditioned or tempered air, as much as 70% of the air exhausted from the hood, directly to the front of the hood. Ideally, this unconditioned air bypasses the laboratory and significantly reduces air conditioning and heating costs in the laboratory. In practice, however, many problems are caused by introducing unconditioned or slightly conditioned air above the sash, all of which may produce a loss of containment."

p. 187

"Radioisotope Hoods

"Hoods used for work with radioactive sources or materials should be designed so that they can be decontaminated completely on a regular basis. A usual feature is a one-piece, stainless steel, welded liner with smooth, coved corners, which can be cleaned easily and completely. The superstructure of radioisotope hoods is usually made stronger than that of a conventional hood in order to support lead bricks and other shielding that may be required in the hood. Special treatment of the exhaust from radioisotope hoods may be required by government agencies to prevent the release of radioactive material into the environment. This usually involves the use of high-efficiency particulate air (HEPA) filters."

ASHRAE Handbook

p. 13.4

"**Auxiliary Air** (approximately constant volume airflow with approximately constant face velocity). A plenum above the face receives air from a secondary air supply that provides partially conditioned or unconditioned outside air.

"Application: Research laboratories—frequent or continuous use. Moderate to highly hazardous processes; varying procedures.

"Note: Many organizations restrict the use of this type of hood...

"**Radioisotope.** Standard hood with special integral work surface, linings impermeable to radioactive materials, and structure strong enough to support lead shielding bricks. The interior must be constructed to prevent radioactive material buildup and allow complete cleaning. The ductwork should have flanged neoprene gasketed joints with quick disconnect fasteners that can be readily dismantled for decontamination. High-efficiency particulate air (HEPA) and/or charcoal filters may be needed in the exhaust dust.

"Application: Process and research laboratories using radioactive isotopes.

"**Perchloric Acid.** Standard hood with special integral work surfaces, coved corners, and nonorganic lining materials. Perchloric acid is an extremely active oxidizing agent. Its vapors can form unstable deposits in the ductwork that present a potential explosion hazard. To alleviate this hazard, the exhaust system must be equipped with an internal water washdown and drainage system, and the ductwork must be constructed of smooth, impervious, cleanable materials that are resistant to acid attack. The internal washdown system must completely flush the ductwork, exhaust fan, discharge stack, and fume hood inner surfaces. The ductwork should be kept as short as possible with minimum elbows. Perchloric acid exhaust systems with longer duct runs may need a zoned washdown system to avoid water flow rates in excess of the capacity to drain the water from the hood. Because perchloric acid is an extremely active oxidizing agent, organic materials should not be used in the exhaust system in places such as joints and gaskets. Ducts should be constructed of a stainless steel material, with a chromium and nickel content not less than that of 316 stainless steel, or of a suitable nonmetallic material. Joints should be welded and ground smooth. A perchloric acid exhaust system should only be used for work involving perchloric acid.

"*Application:* Process and research laboratories using perchloric acid. Mandatory use because of explosion hazard."

ANSI/AIHA Z9.5

p. 15, section 5.11.3

"Auxiliary supplied air hoods are not recommended unless special energy conditions or design circumstances require their use."

pp. 15-16, section 5.12

"Perchloric acid fume hoods shall meet the following provisions:

a) All surfaces of the hood shall be materials that will not react with the acid to form flammable or explosive compounds;
b) The interior surfaces of the entire hood, duct, fan, and stack surface must be equipped with water wash capabilities;
c) The ductwork shall be stainless steel with smooth-welded seams;
d) The system shall not be manifolded or joined to other nonperchloric acid exhaust systems;
e) Organic materials, including gaskets, shall not be used unless it is known they will not react with perchloric acid;
f) The hood shall be labeled 'Perchloric Acid Hood.'"

NFPA 45

p. 45-14, section 6.11.1

"Perchloric acid heated above ambient temperatures shall only be used in a laboratory hood specifically designed for its use and identified as follows:

FOR PERCHLORIC ACID OPERATIONS

"Exception: Hoods not specifically designed for use with perchloric acid shall be permitted to be used where the vapors and trapped and scrubbed before they are released into the hood."

Sound Levels in Rooms

ASHRAE Handbook

p. 46.25

"Table 34 lists design guidelines for HVAC-related background sound appropriate to various occupancies."

Table 34. (partial) Design Guidelines for HVAC-Related Background Sound in Rooms

Room Types	RC(N); QAI ≤5 dB Criterion[a,b]
Office Buildings	
Executive and private offices	25-35
Open-plan offices	30-40
Hospitals and Clinics	
Private rooms	25-35
Laboratories (with fume hoods)	
Testing/research, minimal speech communication	45-55
Research, extensive telephone use, speech communication	40-50
Group teaching	35-45

[a]The values and ranges are based on judgement and experience, not on quantitative evaluations of human reactions. They represent general limits of acceptability for typical building occupancies. Higher or lower values may be appropriate and should be based on a careful analysis of economics, space use, and user needs.
[b]When the quality of sound in the space is important, specify criteria in terms of RC(N). If the quality of sound in the space is secondary concern, the criteria may be specified in terms of NC or NCB levels of similar magnitude.

AIA

p. 37

"The typical maximum noise coefficient (NC) levels generated by HVAC systems in a laboratory is approximately NC 50 with hoods in an operating position and in the midpoint of the room. For laboratory hoods, noise levels should not exceed NC 60 at the face of the hood unless permitted by the facility safety personnel."

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Phoenix Controls
Corporation
55 Chapel Street, Newton MA 02458
Telephone 617-964-6670
Fax 617-965-4503
www.phoenixcontrols.com

Bates College
Fume Hood Safety Program

Appendix D3

Requirements

Requirements

OSHA Regulation 1910.1450 - Occupational Exposure to Hazardous Chemicals in Laboratories:

1. **Summary:**

   The Occupational Safety and Health Administration, recognizing the unique characteristics of the laboratory workplace, tailored a standard for occupational exposure to hazardous chemicals in laboratories to include industrial, clinical, and academic laboratories.

2. **Scope and Application:**

a. Covers all laboratories engaged in the laboratory use of chemicals defined as hazardous by this standard, generally, superseding provisions of all other health standards except in specific instances. The obligation to maintain employee exposures at or below the permissible exposure limits (PELs) specified in the air contaminants standard and in substance specific standards is retained.

b. Does not apply to uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer must comply with the relevant standard even though use occurs in a laboratory.

c. Does not apply for laboratory use of hazardous chemicals which provide no potential for employee exposure such as procedures using chemically-impregnated test media and commercially prepared test kits.

d. Employee Exposure Determination: The employer must measure the employee's exposure periodically 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). The employer must notify the employee of the results within 15 working days after receipt of the monitoring results.

3. **Chemical Hygiene Plan:**

   Where hazardous chemicals are used a laboratory covered by this standard the employer must develop and carry out the provisions of a written Chemical Hygiene Plan (CHP). The CHP must include the necessary work practices, procedures and policies to ensure that employees are protected from all potentially hazardous chemicals in use in their work area. The plan must be available to employees, to employee representatives, and to the Assistant Secretary for Occupational Safety and Health.

4. **Employee Training and Information:**

a. The employer must provide employees with information and training to ensure that they are aware of the hazards of the chemicals present in their work area. This information must 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.

b. Employees must be informed of:

- the contents of this standard and its appendices must be made available to them;
- the location and availability of the employer's Chemical Hygiene Plan;
- the permissible exposure limits for OSHA
- signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and
- 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 (MSDS) received from chemical suppliers.

c. Employee training must include:

- methods and observations that may be used to detect the presence or release of a hazardous chemical;
- The physical and health hazards of chemicals in the work area; and
- The measures they 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.
- The applicable details of the employer's written Chemical Hygiene Plan.

5. **Medical Consultation and Examinations:**

All employees who work with hazardous chemicals must be given the opportunity to receive medical attention, including any follow-up examinations, which the examining licensed physician determines to be necessary under certain circumstances. Medical examinations and consultants must be provided without cost to the employee, without loss of pay and at a reasonable time and place.

b. The employer must provide certain information to the physician, including the identity of the hazardous chemicals, a description of the conditions under which the exposure occurred, and a description of the signs and symptoms of exposure that the employee is experiencing.

6. **Hazard Identification:**

   Labels on incoming containers of hazardous chemicals must not be removed or defaced. MSDS's on incoming hazardous chemicals must be retained and made available to lab employees.

7. **Respirator Use:**

   Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer must provide, at no cost to the employee, the proper respirator equipment.

8. **Record keeping:**

   The employer must establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposure and any medical consultation and examination including tests or written opinions.

Bates College
Fume Hood Safety Program

Appendix D4

Fume Hood Inspection Form

Bates College Fume Hood Inspection Form

Building: ____________________
Room No: ____________________
Hood ID No: ________________

1. Visual inspection of the physical condition of the hood interior, sash and ductwork.
   Comments: ____
   ____
   ____
   ____

2. Flow Monitor (vanometer); condition and function:
   Comments: ____
   ____
   ____
   ____

3. Face velocity checked at three locations:

0in	8in	16in	24in	32in	40in	48in	56in	64in	72in	80in	88in

4. Check for the installation of telltales:
   Comments: ____
   ____
   ____
   ____

5. Check for unnecessary clutter or storage:
   Comments: ____
   ____

Inspector: ______________________________ Date: __________________________

Bates College

Chemical Hygiene Plan

Appendix E

Glove Selection Guide

GLOVE SELECTION GUIDE

The following guide was developed from information in several sources. The information presented here is believed to be accurate; however, we cannot guarantee its accuracy. Many factors affect the breakthrough times of glove materials including, but not limited to:

1. Thickness of glove material
2. Concentration of the chemical worked with
3. Amount of chemical the glove comes in contact with
4. Length of time which the glove is exposed to the chemical
5. Temperature at which the work is done
6. Possibility of abrasion or puncture.

This information is provided as a guide to proper glove material selection. Glove performance varies between manufactures, so always consult the manufacturer to make sure you will have the right glove for your application.

Selection Key:

4	Excellent, breakthrough times generally greater than 8 hours.
3	Good, breakthrough times generally greater than 4 hours.
2	Fair, breakthrough times generally greater than 1 hour.
1	Not Recommended, breakthrough times generally less than 1 hour.
?	Not Tested or No Information, check other references.

GLOVE SELECTION GUIDE

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton®
Organic Acids						
Acetic acid	2	3	4	2	1	4
Formic acid	2	3	4	3	2	2
Lactic Acid	4	4	4	3	4	4
Maleic acid	3	3	2	3	3	4
Oxalic acid	4	4	4	4	4	4
Inorganic acids						
Chromic acid up to 70%	1	1	4	3	3	4
Hydrochloric acid up to 37%	3	3	4	3	3	3
Hydrofluoric acid up to 70%	2	2	3	1	1	?
Nitric acid 70+ %	?	1	2	?	1	4
Perchloric acid up to 70%	4	4	3	4	4	4
Phosphoric acid 70+ %	4	4	4	4	4	4
Sulfuric acid 70+ %	1	2	4	2	1	2
Alkalis						
Ammonium hydroxide up to 70%	1	3	4	2	3	?
Potassium hydroxide up to 70%	4	4	4	4	4	4
Sodium hydroxide 70+ %	4	4	4	4	3	3
Salt Solutions						
Ammonium nitrate	4	4	4	4	4	4
Calcium hypochlorite	1	3	4	4	3	4
Ferric chloride	4	4	4	4	4	4
Mercuric chloride	3	3	4	3	3	4
Potassium cyanide	4	4	4	4	4	4
Potassium dichromate	4	4	4	4	4	4

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton®
Salt Solutions						
Potassium	4	4	?	4	4	?
Sodium cyanide	4	4	4	4	4	4
Sodium thiosulfate	4	4	4	4	4	4
Aromatic hydrocarbons						
Benzene	1	1	1	1	1	3
Gasoline	1	1	1	1	4	4
Naphthalene	1	1	1	1	4	4
Toluene	1	1	1	1	1	4
Xylene	1	1	1	1	1	4
Aliphatic hydrocarbons						
Diesel fuel	1	2	1	2	3	4
Hexanes	1	1	1	1	4	4
Kerosene	1	3	1	3	4	4
Naphtha	1	2	1	3	4	4
Pentane	1	1	1	1	3	4
Petroleum ether	1	1	1	2	3	4
Turpentine	1	1	1	1	2	4
Halogenated hydrocarbons						
Carbon tetrachloride	1	1	1	1	1	4
Chloroform	1	1	1	1	1	4
Methylene chloride	1	1	1	1	2	3
Polychlorinated biphenyls (PCB's)	1	4	4	?	2	4
Perchloroethylene	1	1	1	1	2	4
Trichloroethylene	1	1	1	1	1	4
Esters						
Ethyl acetate	1	1	3	1	1	1
Butyl acetate	1	1	2	1	1	1

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton®
Esters						
Methyl acetate	1	1	4	1	1	1
Isobutyl acrylate	1	1	4	1	1	1
Ethers/Glycols						
Diethyl ether	1	2	1	1	2	1
Ethylene glycol	1	2	4	1	2	4
Isopropyl ether	1	2	1	1	3	1
Propylene glycol	?	3	3	2	2	?
Tetrahydrofuran	1	1	2	1	1	1
Aldehydes						
Acetaldehyde	1	1	4	1	1	1
Acrolein	1	1	4	1	1	1
Benzaldehyde	1	1	4	1	1	3
Butyraldehyde	1	1	4	1	1	1
Formaldehyde	1	2	4	2	4	4
Glutaraldehyde	?	4	4	2	?	4
Ketones						
Acetone	1	1	4	1	1	1
Diisobutyl ketone	1	1	2	1	1	2
Methyl ethyl ketone	1	1	4	1	1	1
Alcohols						
Allyl alcohol	1	1	4	1	4	3
Butyl alcohol	1	3	4	2	3	4
Ethyl alcohol	1	2	4	1	3	4
Isopropyl alcohol	1	3	4	2	4	4
Methyl alcohol	1	1	4	1	1	4
Amines						
Aniline	1	1	4	1	1	2
Ethanolamine	2	4	4	3	4	4
Ethylamine	1	2	4	1	1	1
Methylamine	1	3	4	2	4	4

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton®
Amines						
Triethanolamine	1	1	4	1	4	4
Elements						
Bromine	1	2	1	?	1	4
Chlorine aqueous	?	1	2	?	1	4
Iodine	?	1	3	?	3	4
Mercury	?	4	4	?	4	4
Miscellaneous						
Acetic anhydride	1	2	4	1	1	1
Acetonitrile	1	1	4	1	1	1
Acrylamide	1	1	3	1	2	3
Carbon disulfide	1	1	1	1	1	4
Cresols	1	3	4	?	2	4
Cutting fluid	?	2	?	2	3	?
Dimethyl sulfoxide	1	4	4	1	1	1
Hydraulic oil	?	?	1	2	3	?
Hydrazine	2	4	4	4	4	1
Hydrogen Peroxide	4	2	4	3	4	4
Lubricating oil	3	3	?	?	4	3
Malathion	?	3	1	?	3	?
Nitrobenzene	1	1	4	1	1	4
Phenol	1	3	2	1	1	4
Photo solutions	3	4	?	3	4	?
Picric acid	1	2	3	1	2	4
Pyridine	1	1	4	1	1	1

Viton is a registered trademark of DuPont Dow Elastomers.

Bates College

Chemical Hygiene Plan

Appendix F

Standard Operating Procedure For Laboratories

Bates College

Standard Operating Procedure For Laboratories

Laboratory Supervisor:____________________________________Dept.:____________________

Building:________________________Room(s):____

Date of last revision:____

The individual responsible for the Chemical Hygiene Plan in this area is:____________________

Chemicals are stored in:____

Chemicals are safely transported by the following means:_________________________________

In the event of an accident or other emergency, the following shall be done:__________________

This is a list of our emergency equipment:____

The following are the spill control and decontamination procedures:_________________________

The following are the waste disposal procedures:_______________________________________

1. Standard Operating Procedure for the activity:____

____

2. Chemical(s) Used	3. Hazard Class	4. Health Hazards

5. Personal Protective Equipment required for this activity:

____

____

____

6. Engineering Controls required for this activity:

____

____

____

7. Other precautions required for this activity:

____

____

____

Approval for use of particularly hazardous substances provided by:

____ Date:__________________________

Designated work areas for this procedure will be: ______________________________________

____

____

____

Bates College

Chemical Hygiene Plan

Appendix G

List of Particularly Hazardous Substances

List of Particularly Hazardous Substances

EXAMPLES OF COMPOUNDS WITH A HIGH LEVEL OF ACUTE TOXICITY

Acrolein
Arsine
Chlorine
Diazomethane
Diborane (gas)
Hydrogen cyanide
Hydrogen fluoride
Methyl fluorosulfonate
Nickel carbonyl
Nitrogen dioxide
Osmium tetroxide
Ozone
Phosgene
Sodium azide
Sodium cyanide (and other cyanide salts)

EXAMPLES OF SELECT CARCINOGENS

2-Acetylaminofluorene
Acrylamide
Acryloitrile
Aflatoxins
4-Aminobiphenyl
Arsenic and certain arsenic compounds
Asbestos
Azathioprine
Barium chromate
Benzene
Benzidine
Bis(chloromethyl)ether
1,4-Butanediol dimethylsulfonate (myleran)
Chlorambucil
Chloromethyl methyl ether
Chromium and certain chromium compounds
Cyclophosphamide
1,2-Dibromo-3-chloropropane
3,3'-Dichlorobenzidine (and its salts)
Diethylstilbestol
4-Dimethylaminoazobenzene
Dimethyl sulfate
Ethylene dibromide
Ethylene oxide
Ethylenimine
Formaldehyde
Hexamethylphosphoramide
Hydrazine
Melphalan
4,4'-Methylene-bis(2-chloroaniline)
Mustard gas (bis(2-chloroethyl)sulfide)
N,N-Bis(2-chloroethyl)-2-naphthylamine
α-Naphthylamine
β-Naphthylamine
Nickel carbonyl
4-Nitrobiphenyl
N-Nitrosodimethylamine
β-Propiolactone
Thorium dioxide
Treosulfan
Vinyl chloride

EXAMPLES OF REPRODUCTIVE TOXINS

Arsenic and certain arsenic compounds
Benzene
Cadmium and certain cadmium compounds
Carbon disulfide
Ethylene glycol monomthyl and ethyl ethers
Ethylene oxide Lead compounds
Mercury compounds
Toluene
Vinyl Chloride
Xylene

List of Particularly Hazardous Substances

CLASSES OF CARCINOGENIC SUBSTANCES

Alkylating agents
α-Halo ethers
Bis(chloromythyl) ether
Methyl chloromethyl ether
Sulfonates
1,4-Butanedoil dimethanesulfonate (myleran)
Diethyl sulfate
Dimethyl sulfate
Ethyl methanesulfonate
Methyl methanesulfonate
Methyl triflouoromethanesulfonate
1,2-Propanesultone
Epoxides
Ethylene oxide
Diepoxybutane
Epichlorohydrin
Propylene oxide
Styrene oxide
Aziridines
Ethylenimine
2-methylaziridine
Diazo, azo, and azoxy compounds
4-Dimethylaminoazobenzene
Electrophilic alkenes and alkynes
Acrylonitrile
Acrolein
Ethyl acrylate

Acylating agents
β-Propiolactone
β-Butyrolactone
Dimethylcarbamyl chloride

Organohalogen coumpounds
1,2-Dibromo-3-chloropropane
Mustard gas (bis(2-chloroethyl)sulfide)
Vinyl chloride
Carbon tetrachloride
Chloroform
3-Chloro-2-methylpropene
1,2-Dibromoethane
1,4-Dichlorobenzene
1,2-Dichloroethane
2,2-Dichloroethane1,3-Dichloropropene
Hexachlorobenzene
Methyl iodide
Tetrachloroethylene
Trichloroethylene
2,4,6-Trichlorophenol

Hydrazines
Hydrazine (and hydrazine salts)
1,2-Diethylhydrazine
1,1-Dimethylhydrazine
1,2-Dimethylhydrazine

***N*-Nitroso compounds**
N-Nitrosodimethylamine
N-Nitroso-N-alkylureas

Aromatic amines
4-Aminobiphenyl
Benzidine (4,4'-diaminobiphenyl)
α-Napthylamine
β-Naphthylamine
Aniline
o-Anisidine (2-methoxyaniline)
2,4-Diaminotoluene
o-Toluidine

Aromatic hydrocarbons

Benzene
Benz[a]anthracene
Benzol[a]pyrene

Natural products (including antitumor drugs)
Adriamycin
Aflatoxins
Bleomycin
Cisplatin
Progesterone
Reserpine
Safrole

Miscellaneous organic compounds
Formaldehyde (gas)
Acetaldehyde
1,4-Dioxane
Ethyl carbamate (urethane)
Hexamethylphosphoramide
2-Nitropropane
Styrene
Thiourea
Thioacetamide

List of Particularly Hazardous Substances

Miscellaneous inorganic compounds
Arsenic and certain arsenic compounds
Chromium and certain chromium compounds
Thorium dioxide
Beryllium and certain beryllium compounds
Cadmium and certain cadmium compounds
Lead and certain lead compounds
Nickel and certain nickel compounds
Selenium sulfide

Bates College

Chemical Hygiene Plan

Appendix H

Incident Report Form

Bates College
Lewiston Campus
Incident Report Form

Employee Name: ______________________Date/Time of Accident:________________________

Department/Room No.: _____________________________ Work Phone No.: _______________

Nature of Injury: ____

____

Did the employee require immediate medical attention?, If yes, describe the actions that were

taken: ____

____

____

Describe the event and the cause of the injury: ____________________________________

____

____

____

____

Describe the actions that will be taken to prevent the event from reoccurring: ________________

____

____

____

Copies of completed Incident Report Forms should be kept in the Department files and the original sent to the Chemical Hygiene Officer in the EHS Department.

Bates College

Chemical Hygiene Plan

Appendix I

Equipment Inspection Checklist

Bates College
Lewiston Campus
Equipment Inspection Checklist
(to be completed monthly)

Inspector: ___________________________________ Date:_____________________________

Department/Room No.: ____

Equipment	**Yes/No**	**Comments** Proposed Corrective Action (If Necessary)
Is there an adequate supply of absorbents immediately available and has it been fully restocked?		
Is there a fire extinguisher located in the immediate area and has it been inspected within the past month?		
Does the room have a sufficient supply of personal protective equipment (safety goggles, protective gloves, aprons, etc.) for employees and students when conducting laboratory experiments?		
Are eye wash stations readily available, in good working condition and in close proximity to locations where chemicals are used and handled?		
Are all flammable and corrosive chemicals stored in the appropriate storage locations?		
Are all chemicals properly labeled?		
Are all chemicals marked with a purchase date and are expired chemicals discarded?		
Are incompatible chemicals stored safely away from each other?		
Have all fume hoods been inspected for proper air flow within the last six months?		

All Equipment Inspection Checklists are required to be maintained by the Laboratory Supervisor for at least five years.