

**MIDDLEBURY COLLEGE
CHEMICAL HYGIENE PLAN
FOR BICENTENNIAL HALL**

2006

Referencing 29 CFR 1910.1450

Occupational Exposure to Hazardous Chemicals in Laboratories

This plan revision was implemented on February 1, 2006

FOREWORD

It is the policy of Middlebury College to provide a safe and healthy workplace in compliance with applicable federal and state regulations, and to maintain its laboratory facilities, practices, and procedures in accordance with current knowledge regarding laboratory safety. This Plan has been developed in accordance with the requirements of the Occupational Safety and Health Administration (OSHA) in its rule for Occupational Exposure to Hazardous Chemicals in Laboratories, 29 CFR 1910.1450, as adopted by the Vermont Occupational Safety and Health Administration (VOSHA). Although VOSHA/OSHA regulations apply only to employees, in the interest of safety Middlebury College also requires its students to adhere to the requirements of its Chemical Hygiene Plan.

The purpose of this Chemical Hygiene Plan is to describe procedures, equipment, personal protective equipment, and work practices that are designed to protect employees and students from the health hazards presented by the various chemicals used in the laboratory. The Plan is available for inspection in the office of the Director of Sciences Support Services, as are a copy of the relevant regulations and supporting resources.

It is the responsibility of all faculty, staff, and students who work in a Bicentennial Hall laboratory environment to know and to follow the provisions of this Plan. All operations performed in the laboratory must be planned and executed in accordance with the included procedures. In addition, Middlebury College expects each employee and student to develop safe personal chemical hygiene practices and habits aimed at the reduction of chemical exposures to themselves and their coworkers.

This Chemical Hygiene Plan applies only to trained laboratory employees and students. Custodial, maintenance, and other personnel who enter the laboratory only on an incidental basis are covered by Middlebury College's standard Hazard Communication Program, a copy of which is on file in the Human Resources office.

This Plan will be reviewed, evaluated, and updated at least annually.

Timothy H. Wickland
Director, Sciences Support Services and Bicentennial Hall

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MIDDLEBURY COLLEGE
CHEMICAL HYGIENE PLAN FOR THE SCIENCES

1. Responsibility and Authority for Chemical Hygiene

1.1 Chief Executive Officer

The President of Middlebury College has ultimate responsibility for the safety and health of faculty, staff, and students working at the College, and is committed to providing ongoing support for chemical hygiene and for the policies and practices described in this Plan.

1.2 Safety Officer

The Safety Officer is Edmund Sullivan, Human Resources, Service Building, ext. 5465.

The Safety Officer is responsible for overseeing policies and practices related to safety and health at the College, and works with program administrators to ensure implementation of appropriate safety measures, including chemical hygiene and proper use of personal protective equipment.

1.3 Director, Sciences Support Services

The Director of Sciences Support Services is Timothy Wickland, Bicentennial Hall 333, ext. 5421.

The Director of Sciences Support Services has the responsibility and the authority to ensure that the Chemical Hygiene Plan is written, updated, and implemented in accordance with 29 CFR 1910.1450. The Director will either serve as or will appoint the Chemical Hygiene Officer in accordance with the requirements of this section.

1.4 Chemical Hygiene Officer

The Chemical Hygiene Officer (CHO) is an employee designated by the College who is qualified by training or experience to provide technical guidance in the development and implementation of the provisions of Chemical Hygiene Plan. The CHO shall:

- Work with administrators, faculty, and other employees to develop and implement appropriate chemical hygiene policies and practices;
- Monitor policies and procedures for procurement, use, and disposal of chemicals in the lab;
- Assist faculty and supervisors in determining that facilities, precautions, training programs, and personal protective equipment are adequate for the chemicals in use;
- Maintain current knowledge concerning the legal requirements of regulated substances in the laboratory; and
- Review and update the Chemical Hygiene Plan on an annual basis.

1.5 Sciences Safety Committee

The Sciences Safety Committee shall consist of one representative from each Bicentennial Hall department, plus the CHO, Director of Sciences Support Services, Associate Director for Laboratory Support, and the Laboratory Stores Manager. The College Safety Officer shall be a member *ex officio*. The Sciences Safety Committee shall:

- Meet periodically to discuss safety concerns; review any laboratory accidents, mishaps, and “near misses;” and continually reassess safety policies and procedures;
- Conduct periodic laboratory safety inspections and audits, as necessary;
- Serve as liaisons to their respective departments on safety matters;
- Act as a resource for the CHO, faculty, staff, and students regarding chemical and laboratory safety; and
- Work with the CHO to update and improve the Chemical Hygiene Plan.

1.6 Laboratory Employees and Students

Faculty, laboratory staff, and students are, with the training, education, and resources provided by their supervisor, individually responsible for planning and conducting each laboratory operation in accordance with the Chemical Hygiene Plan, and for developing good personal chemical hygiene habits to minimize personal and coworker exposure to hazardous materials. In this Plan, the word “employee” refers to paid employees of the College, including work-study students; the word “worker” refers to all laboratory personnel, including students. Also, for the purposes of this Plan, faculty are considered to be the supervisors of their students.

2. Standard Operating Procedures for Laboratory Chemicals

2.1 Chemical Procurement

- The decision to procure a chemical shall be a commitment to handle and use the chemical properly from initial receipt to ultimate disposal.
- New chemicals shall be obtained only if the faculty member has determined that the use of the new chemical is necessary and appropriate for the research or teaching procedure. The faculty member will ensure that information on proper handling, storage, and disposal is made known to all involved personnel, including students, prior to their use of the chemical.
- All chemicals will be received through the Laboratory Stores. The Laboratory Stores Manager will ensure that:
 - Chemical containers are accepted only when labeled and packaged in accordance with applicable regulations;
 - All chemical containers are dated when received;
 - A Material Safety Data Sheet (MSDS) has been obtained and properly filed for each new chemical received.

2.2 Chemical Transport

- Received chemicals are to be expeditiously moved to the designated storage area. Large glass containers of a size greater than or equal to 2.5 liters and containing concentrated acids, highly-toxic liquids, or Class 1A flammables are to be either of a safety-coated type, or else be placed inside enclosed carriers or shipping containers during transport.
- Whenever a highly-toxic chemical is taken from the storage area, it must be placed either on a cart or inside a carrier, bucket, or other enclosed container.
- Cylinder gases must be transported only while chained to a cylinder cart, and with all protective caps or guards securely in place.

- Any transport of chemicals that involves the use of a motor vehicle shall comply with all applicable Department of Transportation (DOT) requirements as described in 49 CFR Subchapter C, including those related to labeling the package, placarding the vehicle, and manifesting the shipment. For information on these requirements, consult the Laboratory Stores Manager.

2.3 Chemical Storage

- Each storage area shall be well-illuminated, and chemical storage should be maintained at or below eye level (approximately 5.5 feet). An effort should be made to store large bottles of acids and other hazardous substances on a shelf that is no more than three feet above floor level.
- Chemicals, including cylinder gases, shall be segregated by hazard classification and compatibility in a well-identified area, with local exhaust ventilation as necessary.
- Acid-resistant trays should be placed under bottles of mineral acids.
- Acid-reactive materials such as cyanides and sulfides must be separated from acids or otherwise protected from contact with acids.
- Highly toxic chemicals whose containers have been opened shall be stored in unbreakable secondary containers to prevent spills and contamination.
- The chemical storage area in the Laboratory Stores will be accessible during normal working hours, and is under the control of the Laboratory Stores Manager. Access to storage areas associated with individual laboratories shall be controlled, with specific access requirements to be determined by the department in charge.
- The faculty or staff member in charge of each lab or chemical storage area shall ensure that all chemical containers are examined at least annually to determine container integrity, the absence of deterioration of the contents, and whether the material should remain in inventory.

2.4 General Precautions for Chemical Handling

- For each chemical in use, all faculty, staff, and students shall make themselves aware of:
 - Chemical hazards and appropriate safety procedures as described in the Material Safety Data Sheet (MSDS), as specified by the supervisor, and through other suitable references;
 - The appropriate safety eyewear and other personal protective equipment to be used;
 - Symptoms of exposure for the chemicals with which they work and with the precautions necessary to prevent exposure;
 - Location and proper use of emergency equipment, including fire extinguishers, safety showers, and eyewash stations;
 - Proper storage for the chemical when it is no longer in use;
 - Appropriate personal work practices;
 - Proper waste disposal procedures; and
 - Emergency procedures, including spill clean-up methods and evacuation routes.
- Never block access to emergency showers, eyewashes, or exits.
- Skin contact with chemicals is to be avoided, and all personnel are to wash hands before leaving the laboratory.

- Mouth suction for the purposes of pipetting or starting a siphon is prohibited; use pipette bulbs or other pipetting aids.
- When working with flammable liquids, be certain that there are no sources of ignition nearby that might cause a fire or explosion.
- Storage, handling, and consumption of food or beverages, or the application of cosmetics, is not allowed in laboratories or chemical storage areas, nor in refrigerators, glassware, or utensils used for laboratory operations.
- Any chemical mixture should be assumed to be as toxic as its most toxic component, and substances of unknown toxicity should be assumed to be toxic.
- Any specific precautions based on the toxicological characteristics of individual chemicals shall be implemented as deemed necessary by the Chemical Hygiene Officer. These special precautions are listed in Section 5.

2.5 Procedures for Use of Cylinder Gases

- Gas cylinders must be chained or secured at all times while in use, storage, or transport.
- Gas cylinders must be transported only while chained to a cylinder cart, and with all protective caps or rings securely in place.
- When tapping a gas cylinder, use only a pressure regulator which has a CGA fitting designation identical to that of the cylinder in use. Use of adapters is not permitted without prior approval from the Chemical Hygiene Officer.
- If the regulator or associated valving shows any evidence of improper performance or operation, including the failure to read zero when disconnected from the supply cylinder, the regulator must immediately be tagged as defective and removed from service. Bring the defective regulator to the Laboratory Stores Manager.
- When working with corrosive or toxic gases:
 - All other provisions of this Plan regarding toxic chemicals must be met.
 - The cylinder, regulator, and associated plumbing must be situated inside a fume hood or other appropriate protective enclosure while in use.
 - The regulator *must* have been cleaned and serviced within the past six months, unless it has not been used since either its date of purchase or the date of its prior cleaning and servicing.
 - It is recommended that a cross-purge arrangement be set up using argon or nitrogen to flush the regulator and valving after use of the corrosive or toxic gas.

2.6 Chemical Waste Disposal

- Middlebury College is subject to various federal, state, and local requirements regarding disposal of chemical wastes. Specific information regarding these requirements is available from the Chemical Hygiene Officer or the Laboratory Stores Manager.
- In general, small quantities (a few mL) of most dilute aqueous solutions may be flushed to the sewer with plenty of water. Exceptions are solutions that contain heavy metals such as barium, cadmium, or mercury; that contain arsenic or selenium; or that contain certain organic constituents. For specifics, speak with the Chemical Hygiene Officer.
- All other chemicals must be accumulated as hazardous wastes. Before beginning to accumulate wastes, users must make themselves aware of the applicable requirements.

- Federal and state regulations define a “satellite accumulation area” as an area close to the point of waste generation where the waste is under the control of the person generating the waste. Such an area may be a portion of a fume hood, or other suitable location in the laboratory. Hazardous waste accumulation in laboratory satellite areas is subject to all of the requirements included in this section. Additionally, Middlebury College limits accumulation of hazardous wastes in each laboratory satellite area to a maximum of 1 quart of acutely-hazardous wastes, as are listed in 40 CFR 261.33(e) or Appendix IV of the Vermont Hazardous Waste Management Regulations, or to 30 gallons of other wastes.
- Each waste container must be labeled with the words “Hazardous Waste” and tagged with a listing of its contents.
- All wastes within a container must be compatible with the container and with each other.
- All containers being used to accumulate hazardous waste must be kept closed except when adding waste to the container.
- Whenever a satellite waste container of any size is filled, or when the accumulation limits listed above have been reached, or when the operation producing the waste has ceased, or when the person generating the waste will no longer be working in that laboratory, the waste must, within three days, be dated and moved to the designated short-term waste storage area located in room BIH 128, near the Laboratory Stores.
 - Obtain and fill out a Hazardous Waste Internal Manifest, listing all wastes and surplus chemicals you are disposing. The first section of this form is for describing wastes generated by laboratory processes. The second section to the form is for listing wastes that are surplus or off-spec laboratory chemicals which are still in their original labeled containers. This form is available from the Laboratory Stores Manager or the CHO.
 - Be sure that each waste container is properly labeled as to its contents.
 - Telephone the Laboratory Stores Manager or the Chemical Hygiene Officer to make arrangements for pickup or transport of your waste. Do not bring any wastes down to the storage area without making arrangements in advance.
- Evaporating organic solvents as a means of disposal or to reduce disposal volume is prohibited.

2.7 Housekeeping

Each laboratory worker is directly responsible for the cleanliness of his or her work space, and jointly responsible for common areas of the laboratory. Supervisors shall ensure the maintenance of appropriate housekeeping standards.

- All walkways, exits, fire extinguishers, eyewashes, emergency showers, electrical disconnect panels, first-aid kits, and any other emergency equipment must remain unobstructed at all times.
- All spills on lab benches or floors shall be immediately cleaned and properly disposed of. Small spills should be cleaned up by the user. For large spills, immediately contact the CHO, Laboratory Stores Manager, or the Director of Sciences Support Services.
- Each lab worker shall keep his or her work area clean and uncluttered, with lab benches kept clear of unnecessary equipment and chemicals.
- At the completion of each experiment or operation, the work area shall be thoroughly cleaned, with all equipment properly cleaned and stored, and chemicals returned to their assigned storage areas.

- All chemical containers shall be clean and properly labeled in accordance with Section 2.11, and should be stored with the labels facing frontwards.

2.8 Laboratory Equipment and Glassware

In addition, the following procedures shall apply to the use of laboratory equipment:

- All laboratory equipment is to be used only for its intended purpose.
- Any broken, cracked, or chipped glassware shall be immediately disposed in a labeled broken glass receptacle.
- All evacuated glass apparatus such as dewars or vacuum manifolds must be used in a hood, or otherwise shielded to contain chemicals and glass fragments in the event of an implosion.
- Waste receptacles shall be properly identified. Chemical waste containers shall be labeled with the words “Hazardous Waste,” and shall be kept closed except to add waste.
- Laboratory equipment should be inspected periodically, and repaired or replaced as necessary.

2.9 Personal Protective Equipment

- Appropriate eye protection is required for all employees, students, and visitors to the laboratory, and shall be worn at all times when in the laboratory.
 - Chemical splash goggles meeting ANSI Z87.1 are required to be worn by all laboratory workers in any laboratory where transfer and handling operations occur that involve use of the following materials:
 - Liquids capable of causing injury or disease if sprayed or splashed in the eye; or
 - Any highly-toxic chemicals.
 - Most chemistry laboratories and many biology laboratories will fall into this category.
 - Use of a face shield as supplementary protection in addition to the required goggles should be considered for particularly-hazardous operations.
 - In those laboratories and shops where there is no possibility of injury due to spray or splash of hazardous liquids, safety glasses with side shields meeting ANSI Z87.1 may be worn instead of splash goggles.
- Appropriate footwear is required in all laboratory areas and associated corridors; going barefoot is expressly prohibited.
- Appropriate gloves shall be worn whenever there is a possibility of skin contact with hazardous materials.
 - Ensure that the selected glove material and type of construction is suitable for the substance being handled and the procedure to be used. Glove materials differ widely in resistance to permeation by specific chemicals. The thickness of the glove material should be chosen on the basis of permeability as well as on any abrasion or other physical stress to which the glove will be subjected.
 - CAUTION: gloves made of latex are generally suitable for use only with mild aqueous solutions and substances of low toxicity.
 - Gloves are to be removed before handling objects that should not be contaminated by residues on the gloves, such as doorknobs, telephones, pens, and computer keyboards.

- Reusable gloves shall be washed with soap and water or other suitable solvent before being removed. Used gloves are to be inspected carefully prior to reuse; damaged or deteriorated gloves must be immediately replaced.
- Lab coats may be required to be worn in the laboratory, depending on the intended procedures. In general, coats should *not* be made of nylon or polyester, or other material that can melt; cotton is a better choice. Laboratory coats are to be commercially laundered on a periodic basis, not to exceed monthly, and shall be removed immediately upon discovery of significant contamination. Laundry services are available through the Laboratory Stores.
- Use of a fume hood is recommended for any work with volatile chemicals, and is generally *required* for all chemical operations involving substances which are appreciably volatile and which are capable of causing harm at low exposure levels. Laboratory fume hoods are discussed under Engineering Controls in Section 4.4.
- Any respirator usage shall comply with the OSHA Respiratory Protection Standard, 29 CFR 1910.134, and Middlebury College's Respirator Program. This program requires fit testing and medical evaluation before a respirator is worn. Employees may *not* decide on their own to don respirators without following the full procedure outlined in Middlebury College's Respirator Program, administered by the Safety Officer. In addition, the CHO shall be notified about any procedures in which respirators will be worn.

2.10 Personal Work Practices

- Inspect personal protective equipment prior to use, and wear appropriate protective equipment as procedures dictate and when necessary to avoid chemical exposure.
- Do not eat, drink, or apply cosmetics in the laboratory (smoking is prohibited anywhere in Bicentennial Hall).
- Do not smell or taste any chemicals, and avoid unnecessary chemical exposures by any route.
- Wash promptly and thoroughly anytime a chemical has contacted the skin.
- Wash hands well with soap and water before leaving the laboratory.
- Be aware of long hair or loose-fitting clothing, and confine these close to the body when there is the possibility of their getting caught on equipment.
- Encourage safe work practices by setting a proper example. Horseplay is strictly forbidden.
- Do not sit on lab benches, hood airfoils, or other work surfaces where hazardous materials may have been used; sit only on proper chairs or stools.
- All employees are to be vigilant about unsafe practices and conditions in the laboratory, and shall immediately report such problems to their supervisor, the Chemical Hygiene Officer, or the Director of Sciences Support Services. The supervisor must ensure that unsafe practices or conditions are corrected promptly.
- Seek information and advice from knowledgeable persons, as well as applicable standards and codes, about the hazards present in the laboratory. Plan operations, equipment choices, and protective measures accordingly.
- Supervisors must ensure that each laboratory employee or student knows and follows the rules and procedures established in this Plan.

2.11 Labeling

- All chemical and waste containers in the laboratory shall be labeled.
- Chemical containers are to be provided with a durable label that clearly identifies in English the contents and any relevant hazard. Do not label with just the chemical formula! Except for containers holding transferred bulk solvents, the label should also include the date of acquisition and the source (manufacturer or experimental procedure) of the chemical.
- Waste containers also must be labeled with the words “Hazardous Waste” in addition to a description of the contents. Waste containers must remain closed except when adding waste.
- Portable, unmarked containers, including such items as wash bottles, must be labeled by the individual using the container.
- An exemption from labeling requirements is made for transferring a chemical from a labeled container into another container, such as a beaker or Erlenmeyer flask, where the chemical is solely for the immediate use of the worker who performed the transfer.
- Labels should be periodically inspected by the faculty or staff member in charge of the lab to ensure that labels have not been damaged, defaced, or removed.

3. Implementation of Control Measures

3.1 Air Sampling

Air sampling to evaluate exposure of laboratory personnel to chemical substances shall be conducted as may be required by specific codes or regulations, or whenever there is reason to believe that the exposure level for a regulated substance that requires sampling routinely exceeds the ACGIH TLV or other action level, or in the absence of an action level, the Permissible Exposure Limit (PEL). If sampling indicates that such levels have been exceeded, remedial measures must be taken, in consultation with the CHO. In general, preference is to be given to adjusting the design or implementation of the experimental procedures, and/or utilizing additional engineering controls, before relying on respirators. If a decision is made to use respirators, their use shall be governed by the requirements of Section 2.9, Personal Protective Equipment.

3.2 Spill Response

All spills on lab benches or floors shall be immediately cleaned and properly disposed of. Small spills should be cleaned up by the user. For large spills, immediately contact the Chemical Hygiene Officer, Laboratory Stores Manager, or the Director of Sciences Support Services, who will then call in a contracted Hazmat Response team. All chemical wastes must be disposed of in accordance with Section 2.6.

3.3 Safety and Emergency Equipment

- The faculty or staff member in charge of each laboratory area shall ensure that telephone numbers of personnel to be contacted in an emergency are posted. These listings are to include supervisors and other workers, as appropriate.
- All laboratory personnel should familiarize themselves with the location and proper use of fire extinguishers. Specific training in the use of fire extinguishers will be made available by the College’s Safety Officer.

- Prior to the procurement of new chemicals, the supervisor needs to verify that existing extinguishers and other emergency equipment are appropriate for use with those chemicals.
- All laboratory workers shall be instructed by their supervisors in the location and proper usage of emergency showers and eyewashes. Eyewashes and emergency showers are to be inspected weekly by the laboratory employees. Eyewashes will be tested regularly (generally weekly) by the Laboratory Stores Manager, and safety showers will be tested at least quarterly by Facilities Management.
- Location signs for safety and emergency equipment will be posted.

4. Engineering Controls

4.1 Purpose

Engineering controls are devices and equipment installed in the laboratory that are intended to minimize worker exposure to chemical and physical hazards. These controls must be maintained in proper working order for this goal to be realized. Faculty, staff, and students are to familiarize themselves with the use of the engineering controls in their labs, and to follow proper work practices when using these controls.

4.2 Modifications

No modification of engineering controls by Facilities Management or laboratory personnel is permissible unless testing indicates that worker protection will continue to be satisfactory.

4.3 Improper Function

Any failure or improper function of an engineering control must be reported immediately to the Chemical Hygiene Officer or the Director of Sciences Support Services. The system will then be taken out of service until proper repairs have been performed.

4.4 Laboratory Fume Hoods

Use of a laboratory fume hood is recommended for any work with volatile chemicals. A fume hood is to be utilized for all chemical procedures which might result in release of hazardous chemical vapors, mists, or dusts. As a general rule, the hood shall be used for all chemical procedures involving substances which are appreciably volatile and have a Permissible Exposure Limit (PEL) less than 50 ppm, or where exposure by inhalation is likely to routinely exceed the ACGIH Threshold Limit Value (TLV) or other action level for that chemical.

The following work practices apply to the use of fume hoods:

- The user must confirm adequate hood ventilation performance prior to opening chemical containers inside the hood:
 - The hood's face velocity monitor will display a green light, and the numerical display will indicate a face velocity of between 80 and 150 linear feet per minute.
 - Under some circumstances, it is possible that the numerical display may simply indicate "FLO." As long as the green light is also displayed, this means that a suitable minimum flow rate, as determined by Siemens Building Systems, has been achieved.
 - As an additional check, an inward flow of air may also be confirmed by holding a strip of paper at the hood face opening and observing the movement of the paper; however,

the controller display must also indicate one of the two safe operating conditions described above.

- If the above conditions are not met, or if there are any other indications of a problem, *do not use the hood!* Instead, immediately notify the Chemical Hygiene Officer or the Director of Sciences Support Services about the problem.
- Keep the sash of the hood lowered at all times except when making adjustments to apparatus within the hood. This is to prevent vapors from spilling out of the hood, and also to provide containment in the event of a vigorous or runaway reaction.
- Hoods should not be used as a storage area for chemicals, apparatus, or other materials. Items inside the hood should always be kept to a minimum, and should be limited to the chemicals, apparatus, or other items being used in the immediate procedure.
- Minimize interference with the inward flow of air into the hood by keeping apparatus and reagent bottles at least 6 inches (15 cm) back from the hood face, and ensuring that the exhaust slots at the rear of the hood are not blocked.
- Hoods are *not* to be used as a means of disposal for volatile chemicals.
- Prior to the introduction of new chemicals, the supervisor will determine that the hood to be used will offer adequate protection to the user.
- The ventilation system shall be inspected regularly by Facilities Management. The hoods shall be inspected and tested at least annually to verify operation of the control system and to confirm that the face velocity is between 80 and 150 feet per minute. A copy of the records for all hood inspections shall be provided to the Director of Sciences Support Services.

4.5 Biological Safety Cabinets and Laminar Flow Hoods

The term “laminar flow hood” refers to any device designed to maintain a clean environment inside the cabinet. Many such devices offer no protection to the user from microorganisms or other pathogens. A laminar flow hood designed to contain pathogens within the unit, so as to minimize the chance of exposure from these agents to the user, is referred to as a biological safety cabinet (BSC). Important! Because these devices exhaust air directly into the room, they do not offer any protection from hazardous or toxic chemical vapors or gases.

- Biological safety cabinets are *not* to be used with flammable or volatile toxic chemicals. These types of materials are to be used only in a fume hood, if a hood is required.
- A laminar flow hood of a type other than a biological safety cabinet is to be used only with non-hazardous materials such as nutrient broths or media.
- The supervisor shall determine when and whether a biological safety cabinet or a fume hood is appropriate for the operation to be performed.

4.6 Glove Boxes

Glove boxes are typically used for work with air-sensitive materials.

- The exhaust gases from a glove box in which extremely hazardous substances have been used must be passed through scrubbers or receive other treatment as necessary before being released into the regular fume hood exhaust system.
- For other substances, the exhaust gases from a glove box shall be discharged directly into the fume hood exhaust system.

4.7 Storage Cabinets

- In the Laboratory Stores, flammable materials will be kept in one of the designated Flammable Materials Storage Areas.
- In individual laboratories, large quantities of flammable liquids are to be stored in an approved flammable materials storage cabinet.
- In individual laboratories, it is recommended that large quantities of corrosive substances be stored in a corrosive materials storage cabinet, taking care to separate acids and bases.

5. Special Precautions for Particularly Hazardous Materials

The use of certain chemicals and operations may pose unusual hazards. This includes work with highly toxic materials, reproductive toxins, and select carcinogens, as such materials are defined in 29 CFR 1910.1200 Appendices A and B, and in 29 CFR 1910.1450; and also would include such operations as high-pressure reactions. The degree of the hazard will depend on the quantities of substances involved as well as the duration for which personnel may be exposed, and determination of the actual level of hazard requires informed judgment on the part of the supervisor as well as the laboratory worker. Work of a particularly hazardous nature may be undertaken only with prior approval from the supervisor, and with written notice to the Chemical Hygiene Officer regarding the location and duration of the activity. The following conditions also apply:

5.1 General Procedures for Work with Chemicals of Moderate to High Toxicity

- Materials in this category include cyanides, acrylamide, and formaldehyde.
- All work with toxic chemicals that may expose the user to toxic vapors or respirable dusts shall be performed in an operating fume hood, glove box, vacuum line, or similar device, which shall be equipped as necessary with suitable filters and/or traps.
- Determination of appropriate containment devices and personal protective equipment shall be made by the supervisor after consulting appropriate references and the CHO.
- At a minimum, splash goggles, gloves suitable for the hazard involved, and a long-sleeved lab coat shall be worn. Hands and arms shall be washed immediately after working with such chemicals.
- Signs are to be posted at the work area identifying the hazardous material in use.
- The work area is to be thoroughly cleaned and/or decontaminated after use.

5.2 Work with Acrylamide

Acrylamide is defined as a select carcinogen and is also a neurotoxin.

- Wear splash goggles, gloves, and a long-sleeved lab coat.
- Use an underpad or matting in the work area.
- Handle unpolymerized solutions and acrylamide powder with caution.
- Acrylamide powder must be handled, dispensed, and mixed in a fume hood.
- Hands and arms shall be washed immediately after working with acrylamide.
- Clean the work area thoroughly after use.

5.3 Work with Formaldehyde

Formaldehyde is defined as a select carcinogen and is also an irritant and a sensitizer. The actual degree of hazard will depend on the concentration and length of time that the user is

exposed. The precautions below are based on work that may involve exposure to significant airborne or aqueous concentrations of formaldehyde.

- Personnel may only be exposed to airborne concentrations of formaldehyde that do not exceed 0.75 ppm calculated as an 8-hour time-weighted average (TWA) or 2 ppm calculated as a 15 minute short-term exposure limit (STEL). If airborne concentrations are likely to exceed 0.5 ppm calculated as an 8-hour TWA, actual concentrations must be monitored.
- The best way to reduce airborne concentrations is with appropriate exhaust ventilation; either a fume hood, or benchtop slot ventilation or other local exhaust ventilation.
- Work with formaldehyde gas or with formalin solutions at concentrations greater than 10% is to be performed in a fume hood or glove box.
- Wear splash goggles, gloves, a long-sleeved lab coat, and an apron.
- Post the work area with a sign indicating that formaldehyde is in use.
- Small quantities (a few mL) of formaldehyde waste solutions may be flushed to the sewer with large amounts of water. Larger amounts are to be accumulated as hazardous waste.

5.4 Work with Other Select Carcinogens, Reproductive Toxins, and Highly-Toxic Chemicals

- Prior approval from the supervisor must be obtained for work with these chemicals.
- The user will design the experiment such that the smallest amount of chemical that is consistent with the desired outcome is obtained and utilized.
- Written notice must be given to the Chemical Hygiene Officer that describes in detail the work to be performed, the chemicals to be used, any other hazards that may be involved, and the protective measures that will be taken.
- All work with toxic chemicals that may expose the user to toxic vapors or respirable dusts shall be performed in an operating fume hood, glove box, vacuum line, or similar device, which shall be equipped as necessary with HEPA or other suitable filters and traps.
- Determination of appropriate containment devices and personal protective equipment shall be made by the supervisor after consulting appropriate references and the CHO.
- At a minimum, splash goggles, gloves suitable for the hazard involved, and a long-sleeved lab coat shall be worn. Hands and arms shall be washed immediately after working with such chemicals.
- Two people must always be present during any work with highly-toxic chemicals.
- A designated work area, consisting of a hood, glove box, portion of a laboratory, or an entire laboratory room as necessary, shall be established for work with these substances.
- The designated work area shall be posted with signs identifying the hazardous material in use, and the boundaries of the work area shall be clearly marked.
- Only those persons trained to work with the chemicals may be allowed in the designated area.
- The work area is to be thoroughly cleaned and/or decontaminated after use.

5.5 Prior Approval for Hazardous Operations

Certain operations may also pose unusual hazards, such as high-pressure reactions; work with highly-reactive materials; and the like. Requests to perform such work require the

supervisor's approval, and the Chemical Hygiene Officer must be notified in writing or via e-mail about the scope and duration of the operation.

6. Unattended Operations

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

- The Chemical Hygiene Officer shall be notified in writing or via e-mail about the scope and duration of the operation.
- The supervisor, in consultation with the Chemical Hygiene Officer, will review work procedures to ensure the safe completion of the operation.
- A sign is to be posted at all entrances to the laboratory describing the operation, chemicals in use, and any associated hazards; and will include the telephone numbers of the supervisor and other laboratory personnel, with the assurance that at least one responsible individual will always be reachable via one of the numbers.
- Provision will be made for the safe automatic shutdown of the operation in the event of any interruption to utility services (loss of water pressure, electricity, etc.) or other foreseeable disruption that may occur during the unattended operation.

7. Employee Information and Training

7.1 Hazard Information

Information on the general principles of chemical hygiene and Middlebury College's Chemical Hygiene Plan will be disseminated annually by the Chemical Hygiene Officer. Each employee will be given a copy of the Chemical Hygiene Plan whenever the Plan is revised.

7.2 Training

Training on the safe use of laboratory chemicals shall include methods of detecting the presence of a hazardous chemical, physical and health hazards of chemicals in the lab, and measures lab personnel can take to protect themselves from these hazards.

- All laboratory personnel will be instructed by their supervisors on the hazards presented by the specific chemicals in use in the laboratory in which they work. Each person is to receive training at the time of initial assignment to the laboratory and prior to any assignments that involve new exposure situations. Training for students shall be conducted by faculty.
- The training shall present the details of the Chemical Hygiene Plan, and shall include, to the degree that is relevant, discussion of:
 - The contents of the OSHA Laboratory Standard, 29 CFR 1910.1450;
 - The location and availability of the Chemical Hygiene Plan;
 - Signs and symptoms associated with exposure to the chemicals present in the laboratory;
 - The permissible exposure limits for OSHA-regulated substances or recommended exposure values for other hazardous chemicals not regulated by OSHA which are present in the lab;
 - Location and availability of reference materials on chemical hygiene.

8. Medical Consultations and Examinations

8.1 Opportunity to Receive Medical Attention

An opportunity to receive medical attention is available to all employees who work with hazardous chemicals in the laboratory, under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory;
- Whenever an event takes place in the laboratory such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure the employee will be provided an opportunity for medical consultation for the purpose of determining the need for a medical examination; and/or
- When a medical surveillance program is established after exposure monitoring reveals an exposure level routinely above the action level for an OSHA-regulated substance which has exposure-monitoring and medical surveillance requirements.

8.2 Cost of Required Medical Consultations and Examinations

Cost of any required medical consultations and examinations will be borne by Middlebury College.

8.3 Administration of Medical Consultations and Examinations

All required medical consultations and examinations shall be administered by or under the direct supervision of a licensed physician.

8.4 Information Provided to Physician

The College will provide the physician with the identity of the chemical(s) to which the employee may have been exposed, including, upon request, a copy of the MSDS; the conditions under which the exposure occurred; and any symptoms of exposure that the employee is experiencing.

8.5 Physician's Written Opinion

The College shall obtain a written opinion from the examining physician that includes the results of the examination, recommendations for further medical follow-up, identification of any medical condition which may place the employee at increased risk due to exposure to a hazardous chemical in the workplace, and a statement that the employee has been informed of the results and of any further required examination or treatment.

9. Recordkeeping

9.1 Accident Investigations

Accident investigations will be conducted by the immediate supervisor with assistance from other personnel as necessary.

9.2 Accident Reports

Accident reports will be written by the supervisor and retained in Human Resources.

9.3 Exposure Records

Exposure records for hazardous chemicals and harmful physical agents will be maintained for 30 years per 29 CFR 1910.20.

9.4 Medical Records

Medical records for employees exposed to hazardous chemicals and harmful physical agents will be maintained for the duration of employment plus 30 years per 29 CFR 1910.20.

9.5 Material Safety Data Sheets

- The College will retain a copy of each Material Safety Data Sheet (MSDS) for a laboratory chemical that is sent by the manufacturer, and will make a reasonable effort to obtain an appropriate MSDS for all other commercial laboratory chemicals.
- MSDSes for substances used in laboratories will be filed in a central file in the Laboratory Stores. It is intended that an electronic version of these MSDSes will eventually be made available over the College's network.
- Individual laboratories will maintain a file of MSDSes for chemicals in use in the laboratory that is available for inspection at all times the laboratory is open. As an alternative to paper copies, these MSDSes may instead be made available electronically.
- MSDSes for substances used in laboratories will be retained for 30 years after the material is no longer in use or on site.

9.6 Records of Employee Training

Records of employee training will be maintained for the duration of employment.

10. Annual Chemical Hygiene Plan Audit

The Chemical Hygiene Officer will conduct a review of the Chemical Hygiene Plan each year. Results of the review and any modifications to the Plan will be provided to the appropriate College officials and to each Bicentennial Hall department chair. Supervisors, including faculty, are responsible for taking corrective action to bring all of their operations and procedures into compliance with the new plan.

11. References and Resources

The following books and other resource materials have either been referenced in this Chemical Hygiene Plan, or are considered to be excellent sources of information on laboratory safety issues. A copy of each listed reference is available in the office of the Director of Sciences Support Services, as are additional materials on more specific areas of interest, including ventilation, safety showers/eyewashes, and laboratory fire protection. Copies of certain of the listed materials are also available in Starr Library (Government Documents) or the Armstrong Library.

Regulatory Documents

29 CFR 1910 — Occupational Safety and Health Standards.

Contains the referenced OSHA standards, including 29 CFR 1910.1450 — Occupational Exposure to Hazardous Chemicals in Laboratories (“The Laboratory Standard”).

VOSHA 29 CFR 1910.1450 and 1910.1450A — Occupational Exposure to Hazardous Chemicals in Laboratories. The Vermont extract of the federal OSHA standard.

49 CFR 171–180 — Hazardous Materials Regulations.

Contains Department of Transportation (DOT) standards regarding packaging and transporting or shipping chemicals, chemical wastes, and other hazardous materials.

General Laboratory and Chemical Safety

- American Chemical Society (ACS). 1995. *Safety in Academic Chemistry Laboratories, 6th ed.* Committee on Chemical Safety. Washington, DC: ACS.
- American Chemical Society (ACS). *Chemical Health and Safety*. Bimonthly journal of the American Chemical Society. Washington, DC: ACS. Current and back copies are on file.
- American National Standards Institute (ANSI). 1989. *Practices for Occupational and Educational Eye and Face Protection: ANSI Z87.1-1989*. New York: ANSI.
- Compressed Gas Association. 1990. *Handbook of Compressed Gases, 3rd ed.* New York: CGA. A useful guide to cylinder gases and cryogenes.
- Furr, A. Keith. 1995. *CRC Handbook of Laboratory Safety, 4th ed.* Boca Raton, FL: CRC Press. A good general resource.
- National Research Council. 1995. *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*. Washington, DC: National Academy of Sciences. The bible on the use of laboratory chemicals, extracts from the 1981 edition are incorporated in the appendix of the OSHA Laboratory Standard as recommended procedures.
- Young, Jay A., Ed. 1991. *Improving Safety in the Chemical Laboratory, 2nd ed.* New York: John Wiley & Sons.

Chemical Exposure Information and Standards

- American Conference of Governmental Industrial Hygienists (ACGIH). 1998. *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, 1998-99*. Cincinnati, OH: ACGIH.
- U.S. Department of Health and Human Services (DHHS), Public Health Service (PHS), Center for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH). 1994. *NIOSH Pocket Guide to Chemical Hazards*. DHHS (NIOSH) Publication No. 94-116. Washington, DC: U.S. Government Printing Office. Not copyrighted, this publication may be freely copied for lab use.

Chemical Storage and Disposal

- Armour, Margaret-Ann. 1996. *Hazardous Laboratory Chemicals Disposal Guide, 2nd ed.* Boca Raton, FL: CRC Press.
- Pipitone, David. 1991. *Safe Storage of Laboratory Chemicals, 2nd ed.* New York: John Wiley & Sons.

Biosafety

- National Research Council. 1989. *Biosafety in the Laboratory: Prudent Practices for the Handling and Disposal of Infectious Materials*. Washington, DC: National Academy of Sciences.
- U.S. Department of Health and Human Services (DHHS), Public Health Service (PHS), Center for Disease Control and Prevention (CDC), and National Institutes of Health (NIH). 1993. *Biosafety in Microbiological and Biomedical Laboratories, 3rd ed.* Jonathan Richmond and Robert McKinney, Eds. Washington, DC: U.S. Government Printing Office.

Videos

A small library of videos on a variety of topics in laboratory safety is available. Of particular interest are the videos produced for the Howard Hughes Medical Institute (HHMI), including *Practicing Safe Science* (1992, 29 minutes), and the 9-part series, *Safety in the Research Laboratory* (1995–97, 9–12 minutes each) that covers topics including chemical safety, x-ray diffraction hazards, radionuclides, cell culture, centrifugation, and glassware washing.