Middlebury College

McCardell Bicentennial Hall

CHEMICAL HYGIENE PLAN

In accordance with 29 CFR 1910.1450

Updated November 2020

Middlebury College Chemical Hygiene Plan

Persons Having Responsibility and Authority for Chemical Hygiene

College President: Laurie L. Patton

Executive Vice President & Provost: Jeffrey Cason

Vice President for Academic Affairs & Dean of Faculty: Sujata Moorti

Associate Dean of the Sciences: Rick Bunt

Vice President for HR and Chief Risk Officer: Karen Miller

Director, Sciences Support Services: Tim Wickland

Chemical Hygiene Officer: Caitlin Carr

Laboratory Stores & Safety Manager: Caitlin Carr

Environmental Health and Safety Coordinator: Jennifer Kazmierczak

Laboratory Safety Committee:

- Tim Wickland, Director of Sciences Support Services
- Caitlin Carr, Chemical Hygiene Officer/Laboratory Stores & Safety Manager, co-Chair
- Eric Moody, Biology Dept. faculty representative
- Lindsay Repka, Chemistry Dept. faculty representative
- Jeff Byers, Chemistry Dept. faculty representative
- Dave West, Geology Dept. faculty representative, co-Chair
- Mike Durst, Physics Dept. faculty representative
- Jennifer Kazmierczak, Environmental Health and Safety Office representative
- Jody Smith, Sciences Technical Support Services representative

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Statement of Purpose/Introduction

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. The **Middlebury College Chemical Hygiene Plan for McCardell Bicentennial Hall** 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 (also referred to as the *Laboratory Standard*), as adopted by the Vermont Occupational Safety and Health Administration (VOSHA).

The Chemical Hygiene Plan (CHP) applies to all laboratories that use, store, or handle potentially hazardous chemicals and to all personnel who work in these facilities. The CHP also addresses other potential laboratory hazards, such as physical and electrical hazards. The CHP does not apply to research involving exclusively radiological or biological materials. Research involving more than one type of hazard must comply with all applicable regulatory requirements and follow guidance outlined in all the relevant safety manuals.

The CHP establishes safety procedures and rules for handling chemicals in the laboratory. The CHP includes guidance and requirements for the use of laboratory equipment and personal protective equipment (PPE) such as gloves, laboratory coats, safety eyewear, and respirators. The CHP also establishes safe work practices, known as standard operating procedures (SOPs), for the use of hazardous chemicals in laboratories. Chemicals that are identified as "particularly hazardous substances" will often need special stringent procedures, including such workplace control methods as chemical fume hoods, glove boxes, and designated work areas.

The purpose of this Plan is to describe policies, procedures, and responsibilities designed to develop an awareness of potentially hazardous chemicals in the work place, to protect employees and students from the health hazards presented by the various chemicals used in the laboratory, and to ensure safe working conditions.

It is the responsibility of all faculty, staff, and students who work in a McCardell Bicentennial Hall laboratory environment to know and to follow the provisions of this CHP. 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.

Information on Middlebury College's Chemical Hygiene Plan will be disseminated annually by the Chemical Hygiene Officer or the Laboratory Stores and Safety Manager. The latest version of the Chemical Hygiene Plan will be posted on the College's website, with hard copies made available to users upon request.

This Plan will be reviewed, evaluated, and updated at least annually. The current Plan revision was implemented on 19 June 2019.

1. Responsibility and Authority for Chemical Hygiene

1.1 Executive Responsibility

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

1.2 Administration

The Provost will appoint a Chemical Hygiene Officer upon the recommendation of the Director of the Sciences. Faculty Council will appoint members of a Laboratory Safety Committee upon the recommendation of the Dean of Faculty and the Director of the Sciences.

1.3 Environmental Health & Safety Coordinator (EH&S)

The Environmental Health and Safety Coordinator 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.

1.4 Director, Sciences Support Services

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.

1.5 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 laboratories;
- Assist faculty and laboratory supervisors in determining that facilities, precautions, training programs, and personal protective equipment are adequate for the chemicals in use;
- See that appropriate chemical hygiene audits are performed and maintained;
- Maintain current knowledge concerning the legal requirements of regulated substances in the laboratory;
- Participate in review and updates of the Chemical Hygiene Plan on an annual basis and seek ways to improve the chemical hygiene program.

1.5 Laboratory Safety Committee

The Laboratory Safety Committee shall be constituted as follows:
Members *ex officio:*

- Director of Sciences Support Services
- Chemical Hygiene Officer
- Laboratory Stores and Safety Manager

Departmental members:

- One faculty representative from the Department of Biology
- One faculty representative from the Department of Chemistry
- One faculty representative from the Department of Geology
- One faculty representative from the Department of Physics
- One faculty representative from the Department of Psychology or the Program in Neuroscience
- One representative from the Office of Environmental Health and Safety
- One additional representative from the Sciences Technical Support Services Department

The Laboratory Safety Committee shall:

- Meet periodically to discuss safety concerns and reassess safety policies and procedures, as necessary;
- Serve as liaisons to their respective departments;
- Work with the Chemical Hygiene Officer to update and improve the Chemical Hygiene Plan.

1.6 Laboratory Supervisor or Principal Investigator

As Principal Investigators, faculty have primary responsibility for chemical hygiene in both teaching and research laboratories. For the purposes of this Plan, **faculty are considered to be the supervisors of the staff and students working in their laboratories**. Staff may be designated as the Laboratory Supervisor in specifically assigned support laboratories.

Laboratory Supervisors or Principal Investigators shall:

- Acquire the knowledge and information needed to recognize and control chemical hazards in their laboratories;
- Select and employ laboratory practices and engineering controls that reduce the potential for exposure to hazardous chemicals to the appropriate level;
- Ensure that workers know and follow the Chemical Hygiene Plan;
- Ensure that protective equipment (engineering controls and person protective equipment) is available and in working order;
- Ensure that students or employees in their laboratory attend required safety trainings;
- Inform those working in their laboratory of the potential hazards associated with the use of chemicals in the laboratory; the symptoms of exposure for the chemicals with which they work and with the controls and precautions necessary to prevent exposure;
- Inform those working in their laboratory of safe laboratory practices and procedures for dealing with accidents involving hazardous chemicals;
- Supervise the performance of workers in their laboratory to ensure the Chemical Hygiene Plan is adhered to in the laboratory;
- Obtain approval, when required, from the Chemical Hygiene Officer prior to using particularly hazardous substances;
- Understand and comply with the current legal requirements regulating hazardous substances used in his/her laboratory;
- Ensure that laboratory waste is collected, labeled and stored properly in accordance with Middlebury's Laboratory Management Plan;
- Inform visitors entering their laboratory of the potential hazards and safe laboratory practices;
- Participate in and/or conduct appropriate chemical hygiene and housekeeping audits;
- Understand emergency response protocols, handle laboratory incidents appropriately, and report all incidents immediately.

1.7 Laboratory Workers (Staff and Students)

Laboratory workers, which include staff and students, shall:

- Be aware of the hazards of the materials they are around or working with, and handle those chemicals in a safe manner;
- Plan and conduct laboratory procedures in accordance with the requirements contained in Middlebury College's Chemical Hygiene Plan;
- Develop good chemical hygiene habits (chemical safety practices and procedures);
- Immediately report unsafe conditions to their supervisor, the Chemical Hygiene Officer, or the Laboratory Stores and Safety Manager;
- Attend all required safety training;
- Collect, label and store laboratory waste properly;
- Inform visitors entering the laboratory of the potential hazards and safe laboratory practices.
- Understand emergency response protocols;
- Know how to handle laboratory incidents appropriately, and promptly report all incidents.

2. Definitions

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

Acutely Hazardous Material: Substance that can cause death, disability, or serious injury after a single, relatively low-level exposure; including substances defined by OSHA as *Highly Toxic Chemicals* in 29 CFR 1910.119 Appendix A.

Carcinogen: See **Select Carcinogen**

Chemical Hygiene Officer: 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 (CHP).

Combustible Liquid: Any liquid having a flashpoint at or above 100ºF (37.8ºC), but below 200ºF (93.3ºC), except any mixture having components with flashpoints of 200ºF (93.3ºC) or higher, the total volume of which makes up 99 percent or more of the total volume of the mixture.

Compressed Gas: A gas or mixture of gases having:

1. In a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C).
2. 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).
3. A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72.

Contact Hazard: Any chemical which fits any of the following:

1. Is identified or described as an allergen or sensitizer in the Safety Data Sheet (SDS) or on the label.
2. Is identified or described in the medical or industrial hygiene literature as an allergen or sensitizer.
3. In the experience of the Laboratory Supervisor or Principal Investigator is known to be an allergen or sensitizer.

Corrosive: Any chemical which fits any one of the following:

1. Is identified or described in the SDS or on the label as corrosive.
2. Is identified by the DOT (49 CFR 173) as corrosive. Meets the EPA (40 CFR 261.22) definition of corrosive.
3. An aqueous solution and has a pH less than or equal to 2 or greater than or equal to 12.5.
4. A liquid and corrodes steel at a rate greater than 6.35 mm per year at a test temperature of 55°C (130°F).
5. Meets the OSHA definition of corrosive: A chemical that causes visible destruction of, or irreversible alteration in living tissue by chemical action at the site of contact.
6. In the experience of the Laboratory Supervisor or Principal Investigator is known or found to be corrosive.

Engineering Control: Equipment installed in the laboratory intended to minimize worker exposure to chemical and physical hazards.

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

Flammable Aerosol: An aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.

Flammable Gas: A gas that, at ambient temperatures and pressures, forms a flammable mixture with air at a concentration of less than thirteen percent by volume; or forms a range of flammable mixtures with air wider than twelve percent by volume.

Flammable Liquid: Any liquid, as defined by 29 CFR 1910.106(a)(19) having a flashpoint at or below

199.4°F (93 °C). Flammable liquids are divided into four categories as follows:

Category 1 - liquids having flashpoints below 73.4°F (23°C) and having a boiling point at or below 95°F (35°C).
Category 2 - liquids having flashpoints below 73.4°F (23°C) and having a boiling point above 95°F (35°C).
Category 3 - liquids having flashpoints at or above 73.4°F (23°C) and at or below 140°F (60°C).
Category 4 - liquids having flashpoints above 140°F (60°C) and at or below 199.4°F (93°C).

Flammable Solid: A solid, other than a blasting agent or explosive as defined in 29 CFR 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.

Flash point: The minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. The flash point is normally an indication of susceptibility to ignition.

Hazardous: Any element, chemical compound, or mixture of elements and/or compounds which is classified as a health or physical hazard. The definition applies to all hazardous chemicals regardless of the quantity.

Hazardous Material: A product, waste or combination of substances which because of its quantity, concentration, physical, chemical, toxic, radioactive, or infectious characteristics, may reasonably pose a significant, actual or potential hazard to human health, safety, welfare, or the environment when improperly treated, stored, transported, used, disposed of, or otherwise managed. Hazardous materials include, without limitation, synthetic organic chemicals, petroleum products, heavy metals, radioactive or infectious materials, and all substances defined as "toxic" or "hazardous" as defined in this Plan.

Hazardous Waste: Materials that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possess at least one of four characteristics (ignitability, corrosiveness, reactivity or toxicity), or is listed by EPA in 40 CFR 261, by OSHA in 29 CFR, or by the Department of Transportation in 49 CFR.

Health Hazard: A chemical is a health hazard if it is classified as posing one of the following hazardous characteristics: Acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A of OSHA's Hazard Communication Standard (29 CFR 1910.1200 Appendix A) and 29 CFR 1910.1200(c).

Highly Toxic Chemical: Any chemical which fits any one of the following:

1. Is identified or described as highly toxic in the Safety Data Sheet or on the label.
2. Meets the following criteria:
    - The median lethal dose (LD50) is equal to or less than 50 mg/kg of body weight when administered orally to rats.
    - The median lethal dose (LD50) is equal to or less than 200 mg/kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of rabbits.
    - The median lethal concentration (LD 50) in air is equal to or less than 200 parts per million (ppm) by volume or less of gas or vapor, or equal to or less than 2 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to rats.
3. The Threshold Limit Value (TLV) or Permissible Exposure Level (PEL) is equal to or less than 5 ppm or 5 milligrams per m^3.
4. The median tolerance limit is equal to or less than 10 ppm by weight of material in water, or the median aquatic lethal concentration is equal to or less than 10 mg/L of material, when administered for 96 hours to a medium sensitivity warm-water or cold-water species of fish.
5. Is identified or described in the medical or industrial hygiene literature as being acutely toxic.

Laboratory: A facility in which hazardous chemicals are handled or manipulated in reactions, transfers, etc. in small quantities on a non-production basis. The containers used are designed to be easily and safely manipulated by one person.

Laboratory Waste: Unwanted laboratory chemicals and chemical waste; includes potentially hazardous materials and materials that are not regulated as hazardous waste.

Laboratory Supervisor: Principal Investigator/Faculty member responsible for the staff and students working in their laboratories and having primary responsibility for chemical hygiene in their teaching and research laboratories**.** Staff may be designated as the Laboratory Supervisor in specifically assigned support laboratories.

Occupational Safety and Health Administration (OSHA): The Federal Occupational Safety and Health Administration or the State agency responsible for the enforcement of occupational safety and health standards in that State. In Vermont, these regulations are enforced by The Vermont Occupational Safety and Health Administration (VOSHA).

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

Oxidizer: 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.

Permissible Exposure Limit (PEL): The permissible exposure limit (PEL or OSHA PEL) is a legal limit in the United States for exposure of an employee to a chemical substance or physical agent.

Physical Hazard: A chemical is a physical hazard if it poses one of the following characteristics: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self-reactive; pyrophoric (gas, liquid or solid); self-heating; an organic peroxide; corrosive to metal; gas under pressure; emits flammable gas in contact with water; or combustible dust. The criteria for determining whether a chemical is classified as a physical hazard are in Appendix B of OSHA's Hazard Communication Standard (29 CFR 1910.1200 Appendix B) and 1910.1200(c) (definitions of "combustible dust" and "pyrophoric gas").

Pyrophoric Gas: A chemical in a gaseous state that will ignite spontaneously in air at a temperature of 130 degrees F (54.4 degrees C) or below.

Pyrophoric Liquid: A liquid, which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

Pyrophoric Solid: A solid, which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

Reactive Hazards: Materials that can cause damage to the human body by the release of gases that will burn, explode, or produce high pressure that can inflict injury to a person nearby. In some cases, the reactive materials may release substances that are considerably more toxic than themselves. Reactive hazards include organic peroxides, unstable (reactive) materials, and water-reactive materials. However, in addition to these three categories there are other types of reactive hazards such as materials involved in slow decomposition processes that give rise to reactive materials or increased pressure in containment vessels.

Reproductive Toxin: Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Safety Data Sheet: A detailed information bulletin prepared by the manufacturer or importer of a chemical that describes the physical and chemical properties, physical and health hazards, routes of exposure, precautions for safe handling and use, emergency and first-aid procedures, and control measures. Information on the SDS aids in the selection of safe products and helps prepare employers and employees to respond effectively to daily exposure situations as well as to emergency situations.

Select Carcinogen: Any chemical which meets one of the following criteria:

1. Is regulated by OSHA as a carcinogen.
2. Is listed under the category known to be carcinogens or reasonably anticipated to be carcinogenic in the Annual Report of Carcinogens published by the National Toxicology Program (NTP).
3. Is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC)(latest editions); or
4. Is listed in either Group 2A ("probably carcinogenic to humans") or 2B ("possibly carcinogenic to humans") 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;
   c) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (Reactive): A chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure or temperature.

Vermont Occupational Safety and Health Administration (VOSHA): The State Agency responsible for administration and enforcement of regulations promulgated by the Federal Occupational Safety and Health Administration. VOSHA also enforces Vermont specific standards for Permissible Exposure Limits (PELs).

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

3. Standard Operating Procedures for Use of Laboratory Chemicals

3.1 General Procedures for Use of Chemicals

Laboratory work should not be performed after any consumption of alcohol or drugs, lack of sleep, or if one is in an unstable mental or emotional state. There have been many tragic accidents that illustrate this danger.

Before engaging in laboratory work, all faculty, staff and students must receive training appropriate to their activities, and comply with the following general precautions and procedures:

- Identify the location and be aware of the proper use of emergency equipment, including fire extinguishers, safety showers and eyewash stations, and evacuation routes;
- Verify clear access to emergency showers, eyewashes and exits;
- When working with flammable liquids, gases or solids, or with pyrophoric chemicals, be certain that there are no sources of ignition nearby that might cause a fire or explosion;
- Any chemical mixture should be assumed to be at least 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 may be deemed necessary by the Chemical Hygiene Officer or the Laboratory Safety Committee. These special precautions are listed in Section 5.

Prior to using chemicals all faculty, staff, and students **MUST**:

- Make themselves aware of symptoms of exposure for the chemicals with which they work and with the precautions necessary to prevent exposure;
- Review chemical hazards and appropriate safety procedures for each chemical as described in the Safety Data Sheet (SDS), laboratory specific protocols, and through other appropriate references, as may be necessary;
- Inspect personal protective equipment prior to use and wear appropriate protective equipment as

procedures dictate and when necessary to avoid chemical exposure;
- Ensure chemicals are properly stored during use and properly disposed of when no longer in use;
- Understand emergency procedures, including spill clean-up methods;
- Encourage safe work practices by setting a proper example. Horseplay is strictly forbidden;
- Be vigilant about unsafe practices and conditions in the laboratory, and shall immediately report such problems to their laboratory supervisor, the Chemical Hygiene Officer, or the Director of Sciences Support Services. The laboratory supervisor must ensure that unsafe practices or conditions are corrected;
- 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;
- Laboratory supervisors must ensure that each laboratory employee or student knows and follows the rules and procedures established in this Plan.

3.2 Working Alone/After Hours in the Laboratory

Working alone or after hours in a laboratory can be dangerous and should be avoided whenever possible, especially when hazardous materials or processes are being used. In some cases, such work may be prohibited. Accidents are unexpected by definition, and the presence of coworkers can help mitigate the consequences of accidents

Working alone is defined as performing work in a laboratory setting without other individuals present in the immediate vicinity. After-hours work is at any time outside of regular building hours. Whenever possible, workers should perform work during regular operational hours and should coordinate schedules when possible to avoid working alone or after hours. Hours of operation for McCardell Bicentennial Hall can be found at Bi Hall Hours of Operation and are updated as necessary to include college breaks and summer hours.

Prior to anyone working alone or after hours, the Laboratory Supervisor must conduct a risk assessment of the experimental procedure and the associated hazards. It is the responsibility of the Laboratory Supervisor to ensure that the Laboratory Worker has been trained on proper experimental procedures, emergency procedures, and steps to minimize risk in the laboratory. If the Laboratory Supervisor determines that the risk cannot be maintained at a safe level, the work should only be conducted when others are present in the laboratory and during regular building hours.

Laboratory Workers are not permitted to work alone without prior approval from the Laboratory Supervisor. In addition, students are not permitted to work after hours until the Laboratory Supervisor ensures that the student is qualified, has submitted the MBH Student Extended Access Request Form, and has received approval.

A means of communication to obtain assistance in an emergency should be made available in all areas where Laboratory Workers will be working alone or after hours. It is recommended that the Laboratory Worker notify the Laboratory Supervisor, a fellow lab member, friend, or family member of their anticipated work schedule, and establish a periodic check-in procedure with that person.

Campus Public Safety can be contacted 24 hours a day at 802-443-5911, in case of a non-emergency situation where outside response is not needed. Call 911 immediately when outside response is needed from the fire department, police, or medical responders. It is recommended that all Laboratory Workers program these contact numbers into their cellular device.

3.3 Personal Hygiene

Personal hygiene procedures are designed to protect laboratory workers from ingesting or otherwise being adversely exposed to hazardous chemicals, biological materials, or radioactive materials. The following personal hygiene procedures apply to all laboratory areas including desk areas in laboratories:
- Avoid skin contact with chemicals;
- Avoid sitting on laboratory benches, hood airfoils, and other work surfaces where hazardous materials may have been used; sit only on proper chairs or stools;
- Avoid contact with personal items (phones, backpacks, water bottles, etc.) while performing

laboratory work to avoid contamination of these items;

- Wash hands well with soap and water before leaving the laboratory, even if gloves and laboratory coat have been worn;
- Never wear or bring Personal Protective Equipment (laboratory coats, aprons, gloves, etc.) into areas where food is consumed, prepared, or stored, or into non-laboratory areas including bathrooms, elevators, and common areas;
- Remove contaminated gloves before entering non-laboratory areas, including hallways and elevators;
- Mouth suction for the purposes of pipetting or starting a siphon is prohibited; use pipette bulbs or other pipetting aids;
- Storage, handling, and consumption of food or beverages, the use of utensils, or the application of cosmetics, is not allowed in laboratories or chemical storage areas;
- Storage of food and beverages is not allowed in refrigerators used for laboratory operations;
- 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;
- Long hair should be tied back and loose-fitting clothing should not be worn when there is the possibility of getting caught on equipment, or when working with chemicals or flammable materials

3.4 Housekeeping

Laboratory supervisors and laboratory workers are directly responsible for the cleanliness of their workspaces, and jointly responsible for common areas of the laboratory.

- Access to walkways, exits, fire extinguishers, eyewashes, emergency showers, electrical disconnect panels, first-aid kits, and any other emergency equipment must remain unobstructed at all times. Access paths must not be used for storage of any kind, not even for carts or other portable items.
- Refrigerators used for chemical storage should be labeled on the outside with the words “Not for the Storage of Food for Human Consumption” or similar language.
- Keep floors clean and dry.
- All incidental spills on laboratory benches or floors shall be immediately cleaned and properly disposed of. Refer to Section 3.15.
- Each laboratory worker shall keep their work area clean and uncluttered, with laboratory 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 and waste containers shall be clean and properly labeled and should be stored with the labels readily visible.

3.5 Laboratory Attire

The laboratory attire restrictions described below apply to laboratory personnel (including students) performing work with hazardous materials or spending an appreciable amount of time in the laboratory, including desk areas in the laboratory. When working in the laboratory, even when there is no immediate danger to the skin from contact with a hazardous chemical it is still important to wear clothing that minimizes exposed skin and offers protection from other laboratory hazards, including physical hazards.

- Clothing and Hair
  Clothing worn while working in the laboratory should offer protection from chemical splashes and spills, and should be easily removable in case of an accident. It is recommended that laboratory workers wear pants or clothing that covers the legs; shorts and short skirts are discouraged. Loose or flowing clothing and clothing made of flammable polymeric fabrics should be avoided.

  Clothing that completely covers the hands, arms and legs should be worn when working with any hazardous material that may cause skin irritation, burns, allergic reactions or has the ability to penetrate skin. Long hair should be secured while working to avoid unintended contact with chemicals or unguarded equipment.

- Footwear
  Appropriate footwear is required in laboratories at all times. The use of closed-toe, closed-heel, solid top shoes is strongly encouraged. Some laboratories may require closed-toe footwear in order to enter. High-heeled shoes, and shoes made of woven or porous material are not recommended while working in the laboratory, particularly if working with hazardous material that may cause skin irritation, burns, allergic reactions, or has the ability to penetrate the skin. Sandals, flip-flops and bare feet are expressly forbidden.

3.6 Personal Protective Equipment

- Eye and Face Protection
  Eye and face protection is required by VOSHA anytime there is potential exposure to flying particles, liquid chemicals, acids and caustic liquids, hazardous chemical gases or vapors, or potentially hazardous light radiation (welding flash, burning flame, UV lights, lasers). Eye and face protection for a particular laboratory process should be selected based on the potential for exposure or damage to the eyes and face.

  Appropriate eye protection is required for all employees, students, and visitors to the laboratory, and shall be worn at all times when there is potential exposure to hazards.

  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;
  - Highly-toxic chemicals.

  Use of a face shield as supplementary protection in addition to the required goggles should be considered for particularly hazardous operations.

  In laboratories and shops where there is no possibility of injury due to spray or splash of hazardous liquids, safety glasses meeting ANSI Z87.1 may be worn instead of splash goggles.

  Certain chemicals for which OSHA has developed regulations have specific regulatory requirements for eye protection based on exposure levels. For example, performing experiments with exposure to formaldehyde above the OSHA Permissible Exposure Limit requires the use of a full-face respirator or a half-mask respirator with gas-tight goggles. See Section 6.3 *Work with Formaldehyde*.

  Special eye protection should be used when working with lasers, ultraviolet light, welding and brazing or intense light sources. Consult the Middlebury Environmental Health and Safety Coordinator or the Chemical Hygiene Officer for selecting appropriate eye protection for operations involving these hazards.

- Hand Protection
  Appropriate gloves shall be worn whenever there is a possibility of skin contact with chemicals or exposure to other hazards.

  Laboratory Supervisors should 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. Refer to chemical Safety Data Sheets for recommended glove materials. Chemical glove manufacturers also publish permeation tables or compatibility charts for common chemicals with projected breakthrough times. Common latex gloves offer little or no protection against most hazardous chemicals.

  Potentially-contaminated gloves must be removed before handling or contacting any objects in the laboratory that should not be contaminated, such as doors, telephones, pens, and computer keyboards. All gloves must be removed before leaving the laboratory and entering public areas and

hallways. Disposable gloves (nitrile and latex) should never be reused. Reusable gloves shall be rinsed, washed, or otherwise cleaned as necessary to remove hazardous residues before the gloves are taken off, so they will be ready for their next use. Used gloves are to be inspected carefully prior to reuse; damaged or deteriorated gloves must be immediately replaced.

- Laboratory Coats & Aprons
  Laboratory coats are recommended, and may be required when working in the laboratory, depending on the intended procedures. Chemical-resistant laboratory aprons should be worn in addition to laboratory coats when handing concentrated acids or bases or highly toxic chemicals that may be absorbed through the skin.

  Where flames or other heat sources are in use, coats should *not* be made of nylon, polyester, or other material that can melt; cotton or fire-retardant material laboratory coats are recommended.

  Laboratory coats should be buttoned at all times and removed immediately if they become contaminated. Laboratory coats are to be commercially laundered on a periodic basis, or upon discovery of significant contamination. Users must not launder laboratory coats at home, nor in a coin-operated laundry or similar facility. Laboratory coats and laundry services are available at no cost from Laboratory Stores.

- Respirators
  Respiratory protection in laboratories is typically provided by engineering controls in the form of chemical fume hoods and other local exhaust devices. Laboratory personnel should protect themselves from inhalation hazards by using product substitution, engineering controls, or process modifications whenever possible. The use of respirators for protection against inhalation hazards should be the last option. 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 Environmental Health and Safety Coordinator. In addition, the Chemical Hygiene Officer shall be notified about any procedures in which respirators will be worn.

3.7 Laboratory Equipment and Glassware

The following procedures shall apply to the use of laboratory equipment and glassware:

- All laboratory equipment is to be used only for its intended purpose;
- Broken, cracked, or chipped glassware shall be immediately disposed in a labeled broken glass receptacle;
- All evacuated glass apparatus such as vacuum manifolds should be used in a hood, or otherwise protected or shielded to contain chemicals and glass fragments in the event of an implosion;
- Laboratory equipment should be inspected periodically and repaired or replaced as necessary.

3.8 Chemical Procurement

- The decision to purchase or procure a chemical shall be a commitment by faculty 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 and Safety Manager will ensure that:
  - Chemical containers are accepted only when labeled and packaged in accordance with applicable regulations;
  - All chemical containers are logged into chemical inventory;
  - A Safety Data Sheet (SDS) has been obtained and properly filed.

3.9 Chemical Inventory List

- Prudent management of chemicals in any laboratory is greatly facilitated by keeping an accurate inventory of the chemicals stored. Each laboratory, with assistance from the Chemical Hygiene Officer, is responsible for developing and maintaining a list of chemicals used. It is recommended that this list shall be updated annually, and that unneeded items be discarded or returned to the stockroom.
- The Chemical Hygiene Officer will make a reasonable effort to maintain an electronic inventory of chemicals used and their storage locations.

3.10 Chemical Transport

- Once received and inventoried chemicals are to be expeditiously moved to designated storage areas. 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 placed inside enclosed carriers or shipping containers during transport.
- Whenever a highly toxic chemical is transported via a corridor, elevator, or other public space, its container must be placed either on a cart or inside a safety bottle carrier, bucket, or other secondary container, regardless of its size.
- Use caution when transporting chemicals. Never pick up containers by their caps.
- Cylinder gases must be transported only by trained staff and while chained to a cylinder cart, and with all protective caps and 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, including those related to labeling the package, placarding the vehicle, and manifesting the shipment. For information on these requirements, consult the Laboratory Stores and Safety Manager.

3.11 Chemical Storage

The quantities of hazardous chemicals stored in a laboratory should be kept to a minimum. Hazardous chemicals must be stored properly, and should be separated and stored according to hazard category and compatibility. In addition:

- Storage areas shall be well-illuminated and ventilated appropriately;
- The faculty or staff member in charge of each laboratory or chemical storage area shall ensure that chemical containers retain their integrity and that appropriate labels are maintained and contents are not deteriorated. Containers should be physically examined at least annually to confirm condition and determine whether the material should remain in inventory;
- Container types and maximum capacities for flammable liquids stored in laboratories and prep rooms shall comply with National Fire Protection Association (NFPA) standards as outlined in NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.
- Potentially hazardous chemicals should be stored at or below eye level (approximately 5.5 feet). An effort should be made to store large bottles of acids and other liquid or hazardous substances no more than three feet above floor level;
- Whenever possible, flammable materials should be stored in flammables cabinets, and organic and inorganic acids should be separated and stored in their respective acid cabinets.

The chemical storage area in the Laboratory Stores will be accessible during normal working hours, and is under the control of the Laboratory Stores and Safety Manager. Access to storage areas associated with individual laboratories shall be limited, with the specific access requirements to be determined by the department in charge.

3.12 Chemical and Waste Labeling

All chemical containers in the laboratory must be properly labeled. All waste containers shall be labeled in accordance with Middlebury College's Laboratory Management Plan, developed per 40 CFR 262 Subpart K, and located at http://www.middlebury.edu/academics/resources/stss/mbhhazwst/lmp. Labels should be periodically inspected by the Laboratory Supervisor to ensure that the labels have not been damaged, defaced, or removed.

Dispensing of chemicals into approved, compatible secondary containers requires that the secondary

containers be labeled with the full name of the chemical.

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 and the container is in the control of the user at all times.

Chemical container labeling should be assessed in the routine inspections of laboratory storage areas by the Laboratory Supervisor. Questions on the use and type of containers shall be referred to the Chemical Hygiene Officer or Laboratory Stores and Safety Manager.

The contents of chemical containers must be disposed of in accordance with the requirements of the Vermont Department of Environmental Conservation. Generators of laboratory chemical waste should use the standard Middlebury College Chemical Waste Tags for this purpose unless an alternate labeling method has been approved by the Chemical Hygiene Officer. Labels are available from the Laboratory Stores and Safety Manager and Chemical Hygiene Officer. Unlabeled chemical containers and unlabeled chemical waste containers require costly analysis prior to disposal, which can be avoided if labels are properly maintained. Chemicals having to be identified by analysis will be paid for by the department from which the container was obtained.

3.13 Chemical Waste Disposal

Middlebury College is subject to 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 and Safety Manager.

Generally, materials suitable for drain disposal in limited quantities must meet the following physical and chemical criteria:

- They are liquid and readily water soluble (soluble at 3% concentration);
- Easily biodegradable;
- Simple salt solutions of low toxicity inorganic substances;
- Dilute organic substances of low aquatic toxicity and concentration of 5% or less.

A listing of chemicals approved for drain disposal is included in Appendix A. If a waste is being generated that you believe can go down a lab drain but it is NOT listed in Appendix A please consult with the Chemical Hygiene Officer to obtain approval.

The following materials should never be poured down drains or placed in regular trash as a method of disposal:

- Oil, grease, petroleum or other water insoluble chemicals;
- Compounds that could result in the presence of toxic gases or vapors;
- Infectious substances;
- Halogenated hydrocarbons;
- Water reactive materials;
- Water soluble polymers that could form gels in the sewer system;
- Malodorous compounds or volatile organic chemicals that can cause exposures or obnoxious odors;
- Any waste that could impart color that cannot be removed by the Town of Middlebury Wastewater Treatment Facility (i.e. dye wastes and stains);
- Toxic chemicals such as carcinogens, mutagens, teratogens;
- Flammable materials (flashpoints less than 140°F) unless sufficiently diluted in water as part of the laboratory process such that the solution has a residual flashpoint greater than 140°F;
- Heavy metal compounds;
- Phosphoric acid or phosphates;
- Waste listed by the Environmental Protection Agency in 40 CFR 261 and in the Vermont Hazardous Waste Management Regulations (effective March 15, 2013) that carry a characteristic waste code (ignitable, corrosive, reactive, toxic) or are listed with an F, P or U code.

In addition to the list above, the Town of Middlebury's Sewer Ordinance prohibits the discharge of "any liquids, solids, or gases, which may by reason of their nature or quantity are, or may be, sufficient either alone or by interaction with other substances to cause fire or explosion, constitute a hazard to humans or

animals, or be injurious in any other way to the sewage works or to the operation of the sewage treatment plant." Consult with the Chemical Hygiene Officer prior to discharging any substance that may violate the Town's Sewer Ordinance.

All materials not suitable for drain disposal or disposal as ordinary waste must be accumulated in accordance with Middlebury College's Laboratory Management Plan, developed per 40 CFR 262 Subpart K, and located at http://www.middlebury.edu/academics/resources/stss/mbhhazwst/lmp. Generators of laboratory chemical waste should use the standard Middlebury College Chemical Waste Tags for this purpose unless an alternate labeling method has been approved by the Chemical Hygiene Officer. Labels are available from the Laboratory Stores and Safety Manager and Chemical Hygiene Officer.

3.14 Disposal of Empty Chemical Containers

Empty containers must be properly and safely managed to prevent injury and environmental contamination due to improper disposal. Containers include plastic and glass bottles, plastic bags and bladders, metal and plastic pails or drums.

The Federal Environmental Protection Agency (EPA) regulations define an empty container as a container in which all materials have been removed using practices commonly employed to remove materials from that type of container, e.g. pouring, pumping or aspirating.

- Containers that held biohazardous material must be disinfected and rinsed. Aerosols are considered empty when all contents have been used to the maximum extent feasible under normal use and the propellant approaches atmospheric pressure.
- Empty containers of diethyl ether or other potential peroxide formers should be triple rinsed with water before disposal.
- Containers that held extremely hazardous or acutely toxic hazardous material (EPA "P-Listed" chemicals, or if the oral LD50 is less than 50mg/kg) must be managed as hazardous waste using Middlebury College Chemical Waste Tags. Do not rinse out containers that held acutely toxic hazardous materials, this will create more waste and increase disposal costs.

All containers that have been certified empty using the practices above must have the manufacturer's label or any other markings identifying the previous contents completely removed or defaced and the word "empty" written on the container. Covering or defacing original labels and labeling as "empty" will help Facilities personnel and other personnel know the container is empty and has been properly managed. Sealed containers may become pressurized during compaction so be sure to remove all lids and bottle caps prior to disposal. Do not place glass containers into trash receptacles as they may break and become a puncture hazard for the custodians when managing the wastes in the trash receptacles.

Chemical reagent containers should not be recycled; please do not place these containers in or near recycling collection areas.

Reuse of empty containers is highly recommended when appropriate. They can be used to store and dispose of spill clean-up residues or used for hazardous waste collection and disposal. It is important to use a container made of a material that is compatible with the chemical/hazardous waste to be stored in it and that it be cleaned of any residues to eliminate chances of chemical reactions resulting from combinations of incompatible chemicals. Make sure all original markings have been removed or defaced and the current contents are clearly labeled.

Questions regarding management of empty chemical containers should be directed to the Laboratory Stores and Safety Manager or Chemical Hygiene Officer.

3.15 Chemical Spill Response

It is essential that laboratory personnel understand appropriate procedures for adequately containing and cleaning a chemical spill.

Incidental spills are small spills that do not pose a significant safety or health hazard to lab workers in the immediate vicinity or to the worker cleaning it up. Incidental spills do not require an emergency response

and may be cleaned up by employees working in the area if it can be done safely and easily and spill response materials are available. Any incidental spill shall be immediately cleaned up and cleanup materials properly disposed. Appropriate personal protective equipment (PPE) must be worn while cleaning up incidental spills.

For a spill that meets one or more of the following criteria:

1. The volume is large, cannot be contained, or exceeds the capacity of cleanup materials available in the laboratory;
2. May result in chemical exposure or injury;
3. Presents an immediate hazard (fire, explosion, chemical exposure, etc.);
4. Involves a highly dangerous chemical, including acutely hazardous or toxic materials; or
5. Is a spill of an unknown material,

personnel shall immediately contact the Chemical Hygiene Officer, Laboratory Stores and Safety Manager, or the Director of Sciences Support Services, who will direct clean-up operations and approve reentry to the lab. If necessary, a contracted Hazmat Response team will be called in if the spill cannot safely be cleaned up by in-house personnel.

All chemical wastes from spill cleanup must be disposed in accordance with the requirements of Middlebury College's Laboratory Management Plan.

3.16 Safety and Emergency Equipment

Safety and emergency equipment is provided in or near all laboratories. Pathways to and access to this equipment must never be blocked or obstructed.

Laboratory personnel should familiarize themselves with the location and proper use of safety and emergency equipment, including fire extinguishers, gas shutoff valves, emergency showers, and eyewash stations. Specific training in the use of fire extinguishers is available through the College's Environmental Health and Safety Office. Prior to the procurement of new chemicals, the Laboratory Supervisor shall verify that existing extinguishers and other emergency equipment are appropriate for use with those chemicals.

Location signs for safety and emergency equipment will be posted in each laboratory.

Eyewash Stations

Emergency eyewash stations are provided in or near all laboratories where hazardous materials may be used. Eyewashes are tested regularly (generally weekly) by Laboratory Stores; and should be checked regularly by the laboratory employees. For maintenance issues contact the Director of Sciences Support Services.

Safety Showers

Emergency showers are provided in or near all laboratories. Safety showers are tested at least quarterly by Facilities Services. For maintenance issues contact Director of Sciences Support Services.

Fire Extinguishers

Fire Extinguishers are located in or near all laboratories. Fire extinguishers in laboratories are generally BC type, which are suitable for fires caused by flammable liquid fires such as grease or gasoline, and electrical fires. These extinguishers are not appropriate for fires involving metals such as magnesium, sodium or potassium. Laboratories that work with these metals should work with the Chemical Hygiene Officer to provide appropriate extinguishing agents. For maintenance issues contact the Director of Sciences Support Services.

Chemical Spill Response Kits

Chemical spill response kits and sorbent materials are available from Laboratory Stores. Laboratory Supervisors should determine if it is also appropriate to maintain a Chemical Spill Response Kit in his or her laboratory. Laboratory Stores maintains Chemical Spill Response kits in

or near chemical storage and hazardous waste storage areas.

First Aid Kits

Laboratories are equipped with a basic first aid kit containing bandages and disinfectant wipes to treat minor cuts, scrapes, abrasions and burns. First aid kits are checked twice per year by Laboratory Stores.

Automated External Defibrillator

In the event of a medical emergency, an automated external defibrillator (AED) is located in the Great Hall on the second floor of Bicentennial Hall. If an AED is needed, 911 should be called directly for immediate medical assistance.

3.17 Procedures for 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 Laboratory Supervisor shall review work procedures to ensure the safe completion of the operation;
- If the operation involves flammable or other hazardous materials, or a hazardous process, 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 must be made for the safe automatic shutdown of any hazardous 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.

An unattended operations form is available from Laboratory Stores. It is recommended that this form is posted whenever an operation is left unattended, regardless of whether it involves hazardous processes or those involving flammable materials.

3.18 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 by trained staff and while chained to a cylinder cart, with all protective caps or rings securely in place.
- When tapping a gas cylinder, use only a pressure regulator that 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 or the Laboratory Stores and Safety Manager.
- 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 and Safety Manager.
- Gas cylinders should be stored according to type and compatibility.
- When working with corrosive or toxic gases:
    - All 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, both to prevent damage to the equipment and to avoid spillage of residual gas when the equipment is removed from the hood.

3.19 Procedures for Use of Flammable Liquids

- Designate a storage area for flammable and combustible liquids such as a flammable storage cabinet. Only small amounts of flammable liquid is permitted to be stored outside of a flammable storage cabinet.
- All personnel working in the laboratory should review SDSs for the specific flammable/combustible liquids being used.
- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin, eyes, and inhalation.
- Keep away from sources of ignition.
- Keep containers tightly closed. Store in a cool, dry, and well-ventilated area away from incompatible substances such as oxidizers.
- Follow laboratory supervisor's instructions for PPE, which may differ depending on the type and/or quantity of flammable/combustible liquid being used.
- Use in the smallest practical quantities for the experiment being performed. Perform work in a chemical fume hood whenever possible.
- Keep containers closed when not in use. This is to prevent accumulation of flammable vapor concentrations and accidental ignition.
- Label containers appropriately. Label should indicate the name of the chemical(s) in the container. Avoid using chemical abbreviations and formulae.
- When not in use, store in flammable storage cabinets if possible.
- Containers must be in good condition and compatible with the material.
- Avoid using ignition sources (flame burners or any open flame source, hot plates, electrical equipment with frayed or cracked wiring, etc.) and/or creating static electricity in areas where flammable/combustible chemicals are being used.
- Transport all flammable/combustible liquids in secondary containment, such as a safety bottle carrier.
- Segregate flammable/combustible liquids from incompatible materials such as oxidizers (e.g., hydrogen peroxide, nitric acid). Incompatibilities will be noted in Section 10 of the SDS, "Stability and Reactivity".
- If flammable liquids will be stored in refrigerators or freezers, they should be stored in "flammable-safe" refrigerators and freezers which have no internal sources of ignition posed by an internal light or thermostat circuit.

3.20 Procedures for the Use of Cryogenics (Liquid Nitrogen/Liquid Helium)

- Read the SDS for each cryogenic liquid prior to use.
- Avoid eye or skin contact. Wear appropriate clothing (long pants and closed-toe shoes) and PPE (lab coat, cryogenic gloves, safety glasses, and face shield).
- Work in a well-ventilated location.
- Never use a container that has defects.
- Carefully select working materials and equipment used with cryogenic liquids. Cryogenic liquids may alter the physical characteristics of many materials, making them brittle and leading to failure.
- Handle all objects that are in contact with cryogenic materials with tongs or proper gloves.
- Transfers or pouring of cryogenic liquids should be done carefully to avoid splashing.

4.0 Implementation of Control Measures

4.1 Air Sampling

Air sampling to evaluate exposure of laboratory personnel to chemical substances shall be conducted in consultation with EH&S to ensure sampling is performed as 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 American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (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 EH&S Coordinator and the Chemical Hygiene Officer. 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 this Plan.

5. Engineering Controls

5.1 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.

5.2 Modifications

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

5.3 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.

5.4 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 that 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.
    - If an alarm continues, stop using the hood and notify the Lab Supervisor, Chemical Hygiene Officer, or Director of Support Services.
- In the event of a spill, smoke, or other unintended vapors, press the emergency purge button to increase to maximum fan speed.
- 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.
- KEEP FACE AND HEAD OUTSIDE OF THE FUME HOODS when chemicals are in use or chemical processes are occurring.
- 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. Working hoods should not be used as a storage area for chemicals or waste unless designated for that purpose

- 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.
- Facilities Services shall inspect the ventilation system regularly. 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, and maintained by, the Director of Sciences Support Services.

5.5 Biological Safety Cabinets and Clean Benches

Biological safety cabinets and clean benches (laminar flow hoods) are devices designed to maintain a clean environment inside the cabinet. A clean bench is intended to protect the items in use and offers no protection to the user from microorganisms or other pathogens within the clean bench. A device designed also to contain pathogens within the unit is referred to as a biological safety cabinet.

The Laboratory Supervisor shall determine when and whether a clean bench or biological safety cabinet is appropriate for the operation to be performed.

Because these devices exhaust air directly into the room, they do not offer any protection from hazardous or toxic chemical vapors or gases and should only be used with non-hazardous materials such as nutrient broths or growth media.
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.

5.6 Glove Boxes

Glove boxes are typically used for work with air-sensitive materials. Exhaust gases from a glove box shall be discharged directly into the fume hood exhaust system unless extremely hazardous substances have been used. Exhaust gases from extremely hazardous substances must be passed through scrubbers or receive other treatment as necessary before being released into the regular fume hood exhaust system. Consultation should be done with the Director of Science and Technology Support Services or the CHO before this type of work is conducted.

5.7 Storage Cabinets

In individual laboratories, large quantities of flammable liquids are to be stored in an approved flammable materials storage cabinets. It is recommended that large quantities of corrosive substances be stored in a corrosive materials storage cabinet, taking care to separate acids and bases.

6. Special Precautions for Particularly Hazardous Chemicals.

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 Appendix A (Health Hazard Criteria) and Appendix B (Physical Hazard Criteria), and in 29 CFR 1910.1450, and includes such operations as high-pressure reactions.

OSHA provides a list of toxic and hazardous substances in 29 CFR 1910 Subpart Z, Toxic and Hazardous Substances.

The degree of the hazard will depend on the quantities of substances involved as well as the duration for which personnel may be exposed. Determination of the actual level of hazard requires informed judgment on the part of the Laboratory Supervisor as well as the laboratory worker. Work of a particularly hazardous nature may be undertaken only with prior approval from the supervisor. The supervisor must provide written or e-mail notice to the Chemical Hygiene Officer regarding the location and duration of the activity. The conditions outlined in the following sections also apply:

6.1 Prior Approval for Hazardous Operations

Certain operations may pose unusual hazards, such as high-pressure reactions; work with highly reactive materials; and acutely hazardous or highly toxic chemicals. Requests to perform such work require the Laboratory 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.

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

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, with a snorkel, or similar device, which shall be equipped as necessary with HEPA or other suitable filters and/or traps.

The Laboratory Supervisor, in consultation with appropriate reference materials and the Chemical Hygiene Officer, shall determine appropriate containment devices and personal protective equipment. At a minimum, splash goggles, gloves suitable for the hazard involved, and a long-sleeved laboratory 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.

6.3 Work with Formaldehyde

Formaldehyde is a select carcinogen and is also an irritant and a sensitizer. The actual degree of hazard will depend on the vapor 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. OSHA regulates laboratory use of formaldehyde in 29 CFR 1910.1048 (the Formaldehyde Standard).

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. Work areas exceeding these concentrations shall be posted with a sign indicating that formaldehyde is in use per the Formaldehyde Standard.

The recommended procedure for reducing airborne concentrations of formaldehyde is using appropriate exhaust ventilation; either a fume hood or 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.

Personnel working with formaldehyde shall wear splash goggles, gloves, and a long-sleeved laboratory coat and Safety Data Sheets for formaldehyde must be readily accessible in areas formaldehyde is actively 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.

6.4 Work with Acutely Hazardous or Highly-Toxic Chemicals

Approval from the Laboratory Supervisor, in consultation with the Chemical Hygiene Officer and EH&S must be obtained prior to working with acutely hazardous or highly toxic chemicals. OSHA provides a list of Highly Hazardous Chemical, Toxics and Reactives at 29 CFR 1910.119 Appendix A.

The Laboratory Supervisor shall ensure that a written protocol is in place 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 or other individuals to toxic vapors or respirable dusts shall be performed in an operating fume hood, glove box, with a snorkel vent, or similar device, which shall be equipped as necessary with HEPA or other suitable filters and traps.

The user shall design the experiment such that the smallest amount of chemical that is consistent with the desired outcome is obtained and utilized.

The Laboratory Supervisor shall make determination of appropriate containment devices and personal protective equipment after consulting appropriate references and the Chemical Hygiene Officer.

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.

7. Hazard Identification

A hazardous material is any substance or compound that has the capability of producing adverse effects on the health and safety of humans. Each laboratory must identify the hazardous chemicals that will be encountered by laboratory workers.

If you are not sure a chemical you are using is hazardous, review the chemical label, the Safety Data Sheet for the substance, or contact the Laboratory Supervisor, Chemical Hygiene Officer, or Laboratory Stores and Safety Manager for assistance.

7.1 Chemical Labels

In most cases, a chemical container's original label will indicate if the chemical is hazardous. OSHA has updated its hazard communication standard to require chemical labels to be uniform and consistent with global regulations. Starting in 2015, all chemical container labels comply with this regulation. There will be signal words (Warning, Danger), hazard statements, precautionary statements, and pictograms based on the hazard classification of the chemical. Note that containers of hazardous chemicals acquired or manufactured before 2015 may not contain this standardized information, but will still indicate the contents and hazard warnings. Look for key words like caution, hazardous, toxic, dangerous, corrosive, irritant, carcinogen, etc.

All chemical containers must be clearly labeled, and no hazardous substances may be used or stored if the container does not meet the requirements of OSHA's Hazard Communication Standard (29 CFR 1910.1200). Labels on chemical containers must not be removed or defaced unless containers will be reused.

7.2 Safety Data Sheets

Safety Data Sheets (SDS) provide standardized information for chemicals. SDS are required to be supplied for each shipment of a chemical. SDS include chemical names, hazardous ingredients, physical and chemical characteristics, fire and explosion hazard data, reactivity data, health hazard data, precautions for safe handling and use; and control measures.

A copy of any required SDS shall be readily accessible in the laboratory where the chemical is used. SDS sheets shall be available 24 hours a day, in case of an emergency.

Middlebury College will retain a copy of each Safety Data Sheet (SDS) for laboratory chemicals sent by the manufacturer, and will make a reasonable effort to obtain an appropriate SDS for all other commercial laboratory chemicals. SDSs for substances used in Bicentennial Hall laboratories will be maintained in a central file in the Laboratory Stores or electronically. An electronic file of SDSs is available at https://msdsmanagement.msdsonline.com. SDSs for substances used in laboratories will be retained for 30 years after the material is no longer in use or on site.

8. Safety Training

As required by OSHA, Middlebury College must provide each employee working with chemicals in a laboratory with the health and safety information appropriate for the type of work being performed. The training must be provided at the time of the employee's initial introduction into the facility and/or program where work involving chemicals will be performed.

All faculty, laboratory workers and students that perform research involving chemicals, or that supervise others that perform work in chemical laboratories, must undergo general laboratory safety training that includes the contents of this Chemical Hygiene Plan. General training shall include discussion of:

- The provisions of the OSHA Laboratory Standard, 29 CFR 1910.1450.
- The location and availability of the Chemical Hygiene Plan.
- The location and availability of Safety Data Sheets.
- Standard operating procedures from the Chemical Hygiene Plan and other sources that are relevant to each individual's work in the laboratory.
- Location and availability of appropriate reference materials on chemical hygiene and laboratory safety.
- Measures laboratory personnel can take to protect themselves from these hazards, including location, availability and use of personal protective equipment and emergency response equipment.
- Appropriate storage and labeling of laboratory chemical and waste containers.
- Emergency procedures.
- Appropriate methods of disposal of laboratory waste.

The Chemical Hygiene Officer will maintain records of general training for the duration of employment or enrollment.

Additionally, Laboratory Supervisors must ensure that all workers performing research work under their supervision have received training on laboratory specific procedures and safety rules, including permissible exposure limits and signs and symptoms associated with exposure to the chemicals present in the laboratory.

Training should be conducted at the time of initial assignment to the laboratory and prior to assignments involving new exposure situations. The Laboratory Supervisor, Chemical Hygiene Officer, or Laboratory Stores and Safety Manager shall conduct training for students. Laboratory Supervisors are encouraged to document this training with at least a sign-off sheet.

Additional training may be required for special laboratory processes or work with certain equipment or hazardous materials. Examples include working with radioactive materials or equipment, animals, biological materials, lasers, and fieldwork.

9. Medical Consultations and Examinations

OSHA has established permissible exposure limits (PELs) as specified in 29 CFR 1910 Subpart Z, for many chemical substances. Other agencies and organizations have developed and updated recommended occupational exposure limits and action levels for chemicals regulated by OSHA as well as for chemicals not regulated by OSHA. State specific (Vermont OSHA) standards are specified in 1910.1000.

Employers are required to assure that employee exposures are kept below the listed PELs. To determine and document employee exposures, employees may need to conduct air monitoring of employees' exposures whenever there is a reasonable possibility that exposure levels for a particular substance may exceed the PEL.

The Chemical Hygiene Officer, in consultation with the Environmental Health and Safety Coordinator, will determine the requirements for exposure monitoring and coordinate the assessment. A combination of factors are used to determine the need for an exposure assessment, including chemicals involved, protective measures in place, and employee input on odors and health symptoms.

The Environmental Health and Safety Office will maintain all exposure monitoring records.

Employees will be notified of the results of any exposure monitoring after receipt of sampling results and may have access to the results of their personal monitoring by contacting the Environmental Health and Safety Office.

9.1 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.

9.2 Cost of Required Medical Consultations and Examinations

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

9.3 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.

9.4 Information Provided to Physician

Middlebury 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 SDS; the conditions under which the exposure occurred; and any symptoms of exposure that the employee is experiencing.

9.5 Physician's Written Opinion

Middlebury 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.

9.6 Medical Records

Medical records for employees exposed to hazardous chemicals and harmful physical agents will be maintained by Human Resources for the duration of employment plus 30 years per 29 CFR 1910.1020.

10. Emergency Response and Reporting

Middlebury College has emergency response protocols available at: http://www.middlebury.edu/er.

10.1 Medical Emergencies and Injuries

If immediate medical attention is required, 911 should be called directly. All medical emergencies should also be reported to the Department of Public Safety at 802.443.5911. Employee injuries should be reported to the supervisor immediately and to the Department of Human Resources within 24 hours.

10.2 Fire and Fire Alarms

In the event of fire in the laboratory evacuate the laboratory, activate the nearest fire alarm, and notify Public Safety.

If an alarm sounds while working in the laboratory, turn off all services on your bench if possible (water, gas, electricity, and vacuum) and leave by the nearest fire exit.

Do not attempt to use elevators in the event of a fire.

10.3 Chemical Spills

Safe work procedures should always be followed after a chemical spill has been detected. Spill response procedures are detailed in Section 3.15.

Incidental spills do not require an emergency response and may be cleaned up by employees working in the area if it can be done safely and easily and spill response materials are available. Incident reporting (Section 10.5) is required for all spills, regardless of size.

For a spill that meets one or more of the following criteria:

1. The volume is large, cannot be contained, or exceed the capacity of cleanup materials available in the laboratory,
2. May result in chemical exposure or injury,
3. Presents an immediate hazard (fire, explosion, chemical exposure, etc.),
4. Involves a highly dangerous chemical, including acutely hazardous or toxic materials, or
5. Is a spill of an unknown material,

personnel shall immediately contact the Chemical Hygiene Officer, Laboratory Stores and Safety Manager, or the Director of Sciences Support Services, who will direct clean-up operations and approve reentry to the lab. If necessary, a contracted Hazmat Response team will be called in if the spill cannot safelybe cleaned up by in-house personnel.

10.4 Chemical Exposure

If chemical exposure occurs the first aid measures provided on Safety Data Sheets should be followed. Immediate measures may include removal of exposed clothing, flushing with water (in the event of direct skin or eye contact), and evacuation of the laboratory. In addition to immediate first aid measures Middlebury College's standard emergency response protocols (http://www.middlebury.edu/er) should be followed

10.5 Reporting

All incidents (i.e. injuries, fires, chemical spills or chemical exposures) that occur in a laboratory should be reported to the Laboratory Supervisor who is responsible for ensuring that standard Middlebury College emergency response protocols are followed and that a Middlebury Sciences incident report is completed

11. Annual Chemical Hygiene Plan Audit

The Chemical Hygiene Officer, in conjunction with the Laboratory Safety Committee will conduct an annual review of the Chemical Hygiene Plan. The occupants of McCardell Bicentennial Hall and College Administration will be notified of the annual review, as well as informed of any major modifications to the Plan. Laboratory Supervisors shall be responsible for taking corrective action to bring all of their operations and procedures into compliance with the new Plan, as may be necessary.

12. References & 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. Copies of listed references are available electronically, in the office of the Director of Sciences Support Services or the Environmental Health and Safety Coordinator. Additional materials on more specific areas of interest, including ventilation, safety showers/eyewashes, and laboratory fire protection are also available. Copies of certain of the listed materials are also available in the Main Library (Government Documents) or in Armstrong Library.

12.1 Regulatory Documents

29 CFR 1910 — Occupational Safety and Health Standards.

https://www.gpo.gov/fdsys/granule/CFR- 2013-title29-vol5/CFR-2013-title29-vol5-part1910
Contains the referenced OSHA standards, including:

- 29 CFR 1910.1450 — Occupational Exposure to Hazardous Chemicals in Laboratories ("The Laboratory Standard").

https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450

- 29 CFR 1910.1450 Appendix A - National Research Council Recommendations Concerning Chemical Hygiene in Laboratories.

https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450AppA

- 49 CFR 171–177 — Hazardous Materials Regulations. Contains Department of Transportation (DOT) standards regarding packaging and transporting or shipping chemicals, chemical wastes, and other hazardous materials.

https://www.govinfo.gov/content/pkg/CFR-2012-title49-vol2/pdf/CFR-2012-title49-vol2.pdf

OSHA Fact Sheets

- Autoclave/Sterilizers: https://www.osha.gov/Publications/laboratory/OSHAquickfacts-lab-safety-autoclaves-sterilizers.pdf
- Biological Safety Cabinets: https://www.osha.gov/Publications/laboratory/OSHAfactsheet-laboratory-safety-biosafety-cabinets.pdf
- Centrifuges: https://www.osha.gov/Publications/laboratory/OSHAquickfacts-lab-safety-centrifuges.pdf
- Chemical Fume Hoods: https://www.osha.gov/Publications/laboratory/OSHAquickfacts-lab-safety-chemical-fume-hoods.pdf
- Chemical Hygiene Plan: https://www.osha.gov/Publications/laboratory/OSHAfactsheet-laboratory-safety-chemical-hygiene-plan.pdf
- Cryogens & Dry Ice: https://www.osha.gov/Publications/laboratory/OSHAquickfacts-lab-safety-cryogens-dryice.pdf
- Formaldehyde: https://www.osha.gov/OshDoc/data_General_Facts/formaldehyde-factsheet.pdf
- Hazard Communication – Safety Data Sheets: https://www.osha.gov/Publications/OSHA3514.pdf
- Hazard Communications – Labels and Pictograms: https://www.osha.gov/Publications/OSHA3636.pdf
- Labeling and Transfer of Chemicals: https://www.osha.gov/Publications/laboratory/OSHAquickfacts-lab-safety-labeling-chemical-transfer.pdf
- Methylene Chloride: https://www.osha.gov/Publications/osha3144.pdf
- Noise: https://www.osha.gov/Publications/laboratory/OSHAfactsheet-laboratory-safety-noise.pdf
- Personal Protective Equipment: https://www.osha.gov/OshDoc/data_General_Facts/ppe-factsheet.pdf

12.2 General Laboratory and Chemical Safety

American Chemical Society (ACS). 2003. *Safety in Academic Chemistry Laboratories. Volume 1: Accident Prevention for College and University Students*, *7th ed*. Committee on Chemical Safety. Washington, DC: ACS.
http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/safety-in-academic-chemistry-laboratories-students.pdf

American Chemical Society (ACS). 2003. *Safety in Academic Chemistry Laboratories. Volume 2: Accident Prevention for Faculty and Administrators*, *7th ed*. Committee on Chemical Safety. Washington, DC: ACS.
http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/safety-in-academic-chemistry-laboratories-faculty.pdf

American Chemical Society (ACS). 2012. *Creating Safety Cultures in Academic Institutions: A Report of the Safety Culture Task Force of the ACS Committee on Chemical* Safety. Washington, DC: ACS.
http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/academic-safety-culture-report-final-v2.pdf

American Chemical Society (ACS). Journal of *Chemical Health and Safety*. Bimonthly journal of the American Chemical Society. Washington, DC: ACS. Current and back copies are available through Middlebury College library. http://www.sciencedirect.com/science/journal/18715532

American National Standards Institute (ANSI). 2015. ***American National Standard for Occupational and Educational Personal Eye and Face Protection Devices****: ANSI Z87.1-2015* New York: ANSI.

Compressed Gas Association. 2013. *Handbook of Compressed Gases, 5th ed*. New York: CGA. A useful guide to cylinder gases and cryogens.

Furr, A. Keith. 2000. *CRC Handbook of Laboratory Safety, 5th ed*. Boca Raton, FL: CRC Press. A good general resource.

National Fire Protection Association (NFPA). 2015. *NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals. Quincy, MA.*

National Research Council. 2011. *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards*. Washington, DC: National Academy of Sciences. https://www.nap.edu/login.php?record_id=12654&page=http%3A%2F%2Fwww.nap.edu%2Fdownload.php%3Frecord_id%3D12654. 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.

American Conference of Governmental Industrial Hygienists (ACGIH). 2016. *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*. 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). 2007. *NIOSH Pocket Guide to Chemical Hazards*. http://www.cdc.gov/niosh/docs/2005-149/pdfs/2005- 149.pdf

12.3 Chemical Storage and Disposal

American Chemical Society Task Force on Laboratory Chemical and Waste Management. 2012. *Laboratory Waste Management, A Guidebook*, 2nd ed. Washington, DC: Oxford University Press.

Armour, Margaret-Ann. 2003. *Hazardous Laboratory Chemicals Disposal Guide, 3rd ed.* Boca Raton, FL: CRC Press.

Pipitone, David. 1991. *Safe Storage of Laboratory Chemicals, 2nd ed*. New York: John Wiley & Sons.

12.4 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). 2009. *Biosafety in Microbiological and Biomedical Laboratories, 5th ed*. L. Casey Chosewood, MD and Deborah E. Wilson, DrPH, CBSP, eds. http://www.cdc.gov/biosafety/publications/bmbl5/bmbl.pdf

APPENDIX A: LIST OF CHEMICALS APPROVED FOR DRAIN DISPOSAL

Research and other operations in McCardell Bicentennial Hall generate chemical waste requiring disposal. Some of these chemicals can be recycled, while other chemicals are classified as hazardous waste and specific rules must be followed, prior to disposal, to be in compliance with federal, state and local regulations.

This appendix supplements Section 3.13 and provides additional information regarding disposal of chemicals into the Bicentennial Hall laboratory drain systems. Any questions regarding the disposal of chemicals generated in Bicentennial Hall should be directed to the Laboratory Stores and Safety Manager or Chemical Hygiene Officer. The following information is helpful to provide:

1. Constituents of the waste solution to be drain disposed
2. Volume of the waste chemical to be disposed, e.g. one liter, 50 ml etc.
3. Concentrations of each constituent in the waste
4. Process from which the waste was generated
5. Frequency of discharges
6. SDS of constituents, or product name and manufacturer

The following list identifies chemicals that can be disposed of down the drain, providing the solution does not contain materials otherwise prohibited.

Acceptable Chemicals for Drain Disposal

- Aqueous solutions such as salts and buffer solutions that do not contain heavy metals.
- Chemicals that are water-soluble and are non-hazardous by way of definition.
- Naturally occurring Amino Acids and Salts.
- Enzymes
- Sugars
- Proteins
- Citric acid and its Na, K, Mg, Ca, and Ammonium Salts
- Lactic acid and its Na, K, Mg, Ca and Ammonium Salts
- Small quantities of acids and bases, except for phosphoric acid.
- Biological liquids that have been treated with disinfectant or autoclaved.
- Materials listed below in quantities up to about **10g or 100ml** at a time are suitable for disposal down the drain while flushing with excess water. These materials are soluble to at least 3 percent; present low toxicity hazards and are readily biodegradable. Larger volumes should be collected and disposed of according to Middlebury's Laboratory Management Plan.

    - ethanol
    - propanols