CHEMICAL HYGIENE PLAN

Biology Department
James Madison University
Harrisonburg, VA 22807

Approved by the Biology Department, Spring 2006

I. Authorship Purpose

This document was composed by adapting existing plans (used by the Department of Chemistry and Integrated Science and Technology Program, James Madison University) for the particular needs and circumstances of the Biology Department of JMU. Authored by Robert Walters (Biology Department, Chemical Hygiene Officer), the Chemical Hygiene Plan (CHP) is the property of the Biology Department. The Department of Chemistry and ISAT program will assume no liability resulting from the adaptation of their plans by the Biology Department Chemical Hygiene Officer.

The purpose of the Biology Department's Chemical Hygiene Plan is to establish procedures, equipment, personal protective equipment and work practices that will protect employees, students, and visitors to Biology Department laboratories from health hazards presented by hazardous chemicals and laboratory equipment. All laboratory workers-faculty, staff and students should be given ready access to this plan. This plan is intended to comply with OSHA Standard 29 CFR 1910.1450. A copy of the standard is attached to this plan (Attachment 1).

Governmental Regulation

The Biology Department Chemical Hygiene & Laboratory Equipment Safety Plan was written to comply with OSHA Standard 29 CFR 1910.1200 with Appendices A, B, and E, and OSHA Standard 29 CFR 1910.1450 with Appendices A and B.

An additional source for this document-addressing both chemical and equipment safety-was Prudent Practices for Handling Hazardous Chemicals in Laboratories: Handling and Disposal of Chemicals, published by the National Research Council (1995). An earlier (1981) publication of Prudent Practices was cited in the OSHA Laboratory Standard, specifically in Appendix A of Standard 29 CFR 1910.1450, because of "its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council."

The OSHA Hazard Communication Standard (OSHA Standard 29 CFR 1910.1200) requires employers with hazardous chemicals in the workplace to provide information about those chemicals and safety training for their employees. Pertinent safety information will be provided to any outside contractors performing work onsite, and other visitors, to any Biology Department laboratory as requested.

II. Scope, Content, Application

According to Prudent Practices for Handling Hazardous Chemicals in Laboratories: Handling and Disposal of Chemicals, a chemical hygiene plan should contain these elements:

- employee information and training about the hazards of chemicals in the work area, including how to detect their presence or release, work practices and how to use protective equipment, and emergency response procedures;
- the circumstances under which a particular laboratory operation requires prior approval from the employer (administrator, director, manager);
- standard operating procedures for work with hazardous chemicals;
- criteria for use of control measures, such as engineering controls or personal protection equipment;
- measures to ensure proper operation of fume hoods and other protective equipment;
- provisions for additional employee protection for work with "select carcinogens" (as defined below) and for reproductive toxins or substances that have a high degree of acute toxicity; provisions for medical consultations and examinations for employees; and,
- designation of a chemical hygiene officer.

In addition, this plan contains safety information regarding laboratory equipment commonly found in biology laboratories. This plan applies to all JMU Biology department employees and students, as well as onsite outside contractors and visitors, whose work or activities inside a biology department laboratory may expose them to hazards associated with biological laboratories.

III. Safety Committee

The committee will address laboratory safety issues and be composed of the Biology department Chemical Hygiene Officer, the Laboratory Coordinators (BIO 114, BIO 124, BIO 214, and BIO 224), and one or more members of the Biology department faculty and will be established for the purpose of

- approving all Biology department safety documents, making recommendations for changes to be made when deemed necessary for OSHA compliance;
- approving the overall Biology department safety program, as established by the Chemical Hygiene Officer;
- discussing departmental safety and waste disposal issues; and
- analyzing any incidents that occurred since the last meeting, such as accidents that may or may not have resulted from violations of the safety regulations, or issues of neglect or enforcement on the part of faculty, staff, or students.

In addition, the overall chemical hygiene and safety program, as represented in this document, will be reviewed by the University Safety Director and Engineer. Though the Director / Engineer will not be a standing member of the Safety Committee, he/she may be asked to join the committee for selected meetings.
This committee will meet formally at least once during each semester of the JMU academic year.

IV. Definitions

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

Chemical Hygiene and Safety Officer: employee who is designated by the department, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Biology Department Chemical Hygiene Plan.

Designated Area: area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Employee/Student: an individual employed in a laboratory workplace, or a student of the Biology department, who may be exposed to the hazards associated with working with chemicals in the course of his/her assignments, classroom or research duties.

Hazardous Chemical: chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute and chronic health effects may occur in exposed persons. The term **Health Hazard** includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers (allergens), hepatoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. **Hazardous Waste** may be defined as substances which meet the EPA RCRA (1976) proposal which meets criteria of toxicity, ignitability, corrosiveness, or reactivity.

High Acute Toxicity Chemical: chemical which may be fatal or cause damage to target organs as a result of a single exposure or exposures of short duration.

Laboratory: workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory Fume Hood: five-sided enclosure with a moveable sash or fixed partial enclosed on the remaining side. It is constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory. It allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the body other than hands and arms.

Laboratory Scale: work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily manipulated by one person.

Medical Consultation: a consultation which takes place between an employee (or student, or visitor to a Biology department laboratory) and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Oxidizer: a chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

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

Select Carcinogen: substance which meets one of these criteria:

1. Regulated by OSHA as a carcinogen.

2. Listed under the category "known to be a carcinogen" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP).

3. Listed under Group 1 (carcinogenic to humans) by the International Agency for Research on Cancer Monographs (IARC).

4. Listed in either Group 2A or 2B in IARC or under the category "reasonably anticipated to be carcinogens" by the NTP and causes statistically significant tumor incidence in experimental animals.

Visitor: a guest person, not employed by the biology department and not a student of the biology program, who enters a biology laboratory.

V. Responsibilities

Dean of the College of Science and Mathematics (CSM)

- Oversees and administers all aspects of the college, which includes the Department of Biology.

Biology Department Head:

- Ultimately responsible for chemical hygiene and safety for the department, and must, with other administrators, provide continuing support for departmental chemical hygiene and safety.

- Appoints the Chemical Hygiene Officer (CHO).

Chemical Hygiene and Safety Officer:

- Works with administrators and other employees, as well as students, to develop and implement appropriate chemical hygiene policies and practices.

- Maintains volumes of current MSDS sheets for the Biology Department chemical inventory in a centrally accessible location.

- Insures that regular, formal chemical hygiene and housekeeping inspections, including routine inspections, and sees that appropriate audits are maintained.

- Helps faculty and students develop precautions and adequate facilities for work anticipated to be done in all laboratories, and informs students, faculty and staff, and the Biology Department Head of safety infractions and other laboratory chemical and equipment problems.

- Seeks ways continually to improve the Biology Department Chemical Hygiene Plan.

Departmental Safety Committee:

- Works with the chemical hygiene officer, administrators, and other employees to develop and implement appropriate chemical hygiene policies and practices.

Faculty Members/Laboratory Coordinators/Laboratory Instructors/Research Advisers:

- Responsible for chemical hygiene and safety in the particular laboratory under his/her jurisdiction at a particular time. Such times include

  - meetings of formal laboratory classes
  - instructional sessions for lab supervisors and instructors
  - lab exercise set-up periods
  - faculty-student research sessions

  Ensure that laboratory workers know and follow the chemical hygiene and safety rules, that protective equipment is available and is in working order, and that appropriate training has been provided.

- Know the current legal requirements for regulated substances used in the laboratory.

- Determine the required levels of protective apparel and equipment by personnel occupying a laboratory at any time.

- Ensures that the facilities for, and proper training needed for, the use of hazardous equipment and materials being used in the laboratory are adequate.

Laboratory Workers and Students:

- Responsible for planning and conducting all operations in accordance with the Biology Department Chemical Hygiene Plan, as directed by those persons in charge of the laboratory.

- Develop good personal chemical hygiene and safety habits as stated in the Safety Training Manual (we need to create?) given to new Biology Department faculty, graduate assistants, and student laboratory assistants; as well as in the safety document issued to students as part of their course syllabi.

VI. Information & Training

Information: Each laboratory instructor/coordinator or research adviser is responsible for ensuring that this information is communicated to his/her employees and students under his/her direction:

1. The location and availability of the OSHA Laboratory Standard (29 CFR 1910.1450) with Appendices A, B and E (Attachment 1)

2. The location and availability of the Biology Department Chemical Hygiene Plan

3. The availability of MSDS for all chemicals used in the laboratories

4. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory

5. Location and availability of known reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals; reference materials may include, but not be limited to, material safety data sheets available in Burruss 243.

Training: Each laboratory instructor/coordinator or research adviser is responsible for ensuring that laboratory employees, e.g., student laboratory assistants, state-classified full time employees, part-time employees, receive adequate training. This training should include

1. physical and health hazards of chemicals in the work area

2. measures employees and students can take to protect themselves from such hazards, including specific procedures that have been implemented to protect laboratory employees from exposure to hazard chemicals, including appropriate work practices, emergency response procedures and personal protective equipment to be used

3. applicable details of the Biology Department Chemical Hygiene Plan

The frequency of refresher information and training may be determined by the laboratory supervisor/coordinator, research advisor, or the Chemical Hygiene Officer.

A copy of the biology safety training form, (Standard Laboratory Practices and Safety Rules" (Attachment 5) containing safety information concerning chemical safety issues, will be provided during safety training sessions held at the beginning of each semester, to

- all persons (students, employees) directed to oversee any section of Biology Department laboratory courses

- any student/employee involved in laboratory preparations

- any student/employee involved in laboratory-related project
- any student enrolled in a laboratory course

VII. Permissible Exposure Limits

For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits (PEL) specified in 29 CFR part 1910, Z tables (Attachment 2).

Employee Exposure Detemination

Initial Monitoring: Initial employee exposure monitoring should be conducted when there is reason to believe that exposure levels for OSHA-regulated substances routinely exceed the action level (or in the absence of an action level, the PEL).

Periodic Monitoring: If the initial monitoring discloses employee exposure over the action level (or PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

Termination of Monitoring: Monitoring may be terminated in accordance with the relevant standard.

Employee Notification of Results: The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing by posting results in the departmental office.

Records: Records of exposure monitoring results should be maintained by employer for 30 years and be accessible to employees or their representatives.

VIII. Control Measures & Safety Equipment

Laboratory Design: Each laboratory should have

1. an appropriate general ventilation system with air intakes and exhausts
2. adequate, well-ventilated storage areas;
3. where applicable, laboratory fume hoods and sinks; and
4. where applicable, safety equipment, including eyewash fountains, safety showers, readily accessible fire extinguishers, a readily accessible fire alarm and telephone for emergency use.

Laboratory Ventilation: Laboratory ventilation should

1. provide a source of air for breathing and for input to local ventilation devices;
2. not be relied on for protection from toxic substances released into the laboratory; and

Laboratory Fume Hoods: Laboratory fume hoods should

1. be used for work with hazardous chemicals, especially toxic chemicals that have low air concentration limits, or that have high vapor pressures;
2. provide 2.5 linear feet of space per person for every 2 workers who spend most of their time working directly with hazardous chemicals;
3. provide a face velocity-with sash fully open-of 80 to 100 feet per minute (fpm)-100 to 120 fpm for substances of very high toxicity or where outside influences adversely affect hood performance;
4. not be used as storage areas for chemicals, apparatus or other materials; and
5. not be used to evaporate solvents (except small quantities of volatile materials).

   Also pertaining to fume hoods: provide four to twelve room air exchanges per hour.
6.
   - Work inside the hood should be conducted at least six inches from the front edge of the hood.
   - Hood sashes should be lowered at all times except when necessary to raise them to adjust apparatus inside the hood.
   - The hood fan should be kept "on" whenever a chemical is inside the hood, whether or not any work is being done in the hood.
   - Solid objects must not be allowed to enter the exhaust duct of the hood.
   - Hood ducts and fans should be inspected (1) every three months to be sure the ducts are clean and clear of obstructions and the fans are operational, and that hood performance is maintained, or (2) whenever a change in local ventilation devices is made. **Any hood with inadequate performance should be repaired immediately.**

Exhaust air from vacuum pumps and glove boxes should be vented directly into the building exhaust system.

Cold rooms should have provisions for rapid escape in the event of electrical failure.

Safety Equipment:

Most laboratories are equipped with, or have readily accessible, an eyewash fountaina safety shower

- protective apparel compatible with the required degree of protection for substances being handled
- a fire extinguisher
- a fire blanket
- a first-aid kit

- a portable safety shield, for certain chemical manipulations
- spill control kits, if appropriate

Each safety apparatus should be located so that they can be reached readily, and access must not be restricted or blocked in any way. In addition, respiratory protection, fire alarms and telephones for emergency use should be available nearby.
Eyewash fountains and safety showers should be tested routinely every six months and flushed once a month to see that they are functioning properly. The water flow for each eyewash should be 6 - 9 gallons/minute. Any eyewash that does not meet the water flow requirements should be repaired promptly.
Fire extinguishers will be type tri-class ABC, and will be inspected routinely every 6 months by JMU Facilities Management personnel .

IX. Chemical-Specific Safety Procedures

Reproductive Toxins:
Reproductive toxins should be handled only in a hood, using appropriate protective apparel (especially suitable gloves) to prevent skin contact.

Reproductive toxins should be properly labeled and stored in well-ventilated areas in unbreakable secondary containers, if possible.

Notify supervisor/instructor of all incidents of exposure or spills.

High Acute Toxicity Chemicals (Supplemental rules to be followed in addition to those mentioned above):
Use and store these chemicals in areas of "RESTRICTED ACCESS" that are posted with special warning signs. These areas should include a hood (with a face velocity of at least 60 linear feet/minute) or other containment device for procedures that may generate aerosols or vapors containing the substance.

Use gloves, long sleeves and other protective apparel as needed to avoid skin contact. Always wash hands after working with these chemicals.

Maintain records of the amounts of these materials on hand, amounts used and the names of the workers involved.

Assure that at least two people are present at all times if a compound in use is highly toxic or of unknown toxicity.

Be prepared for accidents and spills. Store breakable containers of these substances in chemically resistant trays. Cover work and storage surfaces with removable, absorbent, plastic backed paper.

If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment.

Thoroughly decontaminate or incinerate contaminated clothing or shoes. If possibly, chemically decontaminate by chemical conversion.

Store contaminated waste in closed, suitably labeled, secondary containers (for liquids, plastic bottles half-filled with vermiculite).

The laboratory supervisor/instructor, as well as the Chemical Hygiene and Safety Officer, must be notified of all incidents of exposure or spills.

The controlled work area, including any equipment, including glassware, should be decontaminated before normal work in that area is resumed.

NO CONTAMINATED WASTE MATERIALS SHOULD BE PLACED IN STANDARD LABORATORY TRASH RECEPTACLES.

Select Carcinogens (Further supplemental rules to be followed, in addition to all these mentioned above):
Conduct all transfers and work with these substances in a designated area--a restricted access hood, glove box or portion of a lab designated for use of highly toxic substances, for which all people with access are aware of the substance being used and necessary precautions. The designated area should be conspicuously marked with warning and restricted access signs.

Each laboratory supervisor or instructor must prepare a plan for use and disposal of these materials.

All containers of carcinogenic substances should be properly labeled with identity and warning labels.

Store containers of these chemicals in ventilated, limited access areas in appropriately labeled, unbreakable, chemically resistant, secondary containers.

If using toxicologically significant quantities of a select carcinogen on a regular basis (3 times per week or more), consult a physician concerning desirability of regular medical surveillance.

When cleaning a spill, use a wet mop instead of dry sweeping if the toxic substance is a dry powder.

When using a positive pressure glove box, thoroughly check for leaks before each use. Trap exit gases or filter them through a HEPA filter and then release into the hood.

Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in secondary container under the supervision of the laboratory supervisor/instructor.

Decontaminate any equipment, including glassware, in the hood before removing them from the controlled area. Decontaminate the controlled area before resuming normal work there.

On leaving the area, remove protective apparel and wash hands, forearms, face and neck.

Flammables:

Never heat flammable liquids with an open flame or hot plate. Use a heating mantle, steam bath or hot water bath.

Never use or store flammable chemicals near any source of ignition, spark or open flame.

Handle solvents in an exhaust hood or a well-ventilated area.

Ground containers when transferring from one container to another if the potential for sparking exists.

Do not store large quantities of flammable reagents in the laboratory.

Store flammable liquids in appropriate safety cabinets and/or safety cans.

Corrosives/irritants:

Concentrated acids will be stored in appropriate acid safety storage cabinets. Inorganic acids, as sulfuric, nitric and hydrochloric, should be stored separately from organic acids, such as acetic.

Acids and bases (including strong alkaline solutions) should not be stored in close proximity.
Since corrosive chemicals are highly reactive, dissolving and corroding (naturally) many different materials, and because some give off dangerous fumes,

- acids and bases are to be handled in an exhaust hood or a well-ventilated area, and
- large quantities of acids and bases should not be stored in the laboratories; instead, they will be stored in the ground-floor acid safety cabinets.

Because corrosives give off heat when diluted with water, one should always add acid to water. Doing so allows the heat to spread through the water instead of being concentrated in a small volume.
Mixing strong acids with strong bases is dangerous, and must be done slowly and with caution in a fume hood.

Since strong acids react with metals to generate explosive hydrogen gas, care much be used in dissolving metals in acids. Also, because mixing acids with solvents may lead to explosions, appropriate caution must be taken when strong oxidizers-such as nitric acid-and solvents are in proximity.

Compressed gases, liquefied gases, and cryogenic liquids:
All gas lines leading from a compressed gas supply should be labeled clearly to identify the gas. Labels should be color-coded to distinguish hazardous gases from those that are inert.
Cylinders should be transported carefully, not dragged, rolled, slid, or allowed to strike each other forcefully. They should be transported on wheeled cylinder carts with retaining straps or chains.
Once in place, cylinders should be secured firmly, individually, by means of clamp and belt or chain, to a wall or lab bench. The valve handle at the top should be accessible at all times.
The cylinder valve should be opened slowly, only when a proper regulator is in place.
Leak-testing should be performed when a problem with a cylinder is suspected. To check for leaks, a flammable gas leak detector or soapy water, or a 50% glycerin/water solution, may be used. If a leak at the cylinder valve handle cannot be remedied by tightening a valve gland or a packing nut, emergency action should be taken and the supplier should be notified.
All sources of ignition should be kept away from cylinders of flammable gases, e.g., oxygen, hydrogen, methane and acetylene.
Cylinders should not be emptied to a pressure lower than 172 kPa (25 psi) because the residual contents may become contaminated with air if the valve is left open.
Because of the special risk of eye and skin contact of personnel who work with cryogenic liquids (e.g., liquid nitrogen, helium and argon),

- eye protection-preferably a face shield-should be worn,
- gloves, impervious of the fluid, must be worn, and
- the area must be well-ventilated.

Special precautions with gas cylinders:

- Cylinders should be labeled as to its contents. Reliance on the manufacturer's color code is not advised.
- Gas cylinders should be strapped or chained to a wall or bench top.
- When a cylinder is no longer in use, the tank valve should be closed; pressure in gas regulator, released; the regulator, removed; and the tank valve should be capped. Empty cylinders should be segregated from full (or partially full) ones. They should be strapped or chained properly until they are returned to the supplier.

- Gas cylinders stored should be kept away from other stored chemicals.
- Incompatible gases should be stored separately. Flammable gases should be stored away from reactives, including oxidizers and corrosives.
- Signs should be posted conspicuously in areas in which flammable compressed gases are stored. For example,

  ACETYLENE-FLAMMABLE GAS
  NO SMOKING-NO OPEN FLAMES

X. Emergency Procedures

Accidents:
Eye contact: promptly flush eyes with water for 15 minutes and seek medical attention. Skin contact: promptly remove any contaminated clothing and flush area with water for 15 minutes. Seek medical attention if necessary. If medical attention is needed, notify campus security (6-911) to call the rescue squad. Report all accidents/injuries to your supervisor or the CHO. Complete the Accident Report form (Appendix).

Fires:
For small fires, try to suffocate the fire or use a fire extinguisher.
In cases of large fires, evacuate the area and activate the manual pull alarm. Call campus security (86911) to report the fire. Evacuate the building.

Spills:
Promptly clean up all chemical spills and properly dispose of spilled chemical and cleanup material. Consult Hazards in the Chemical Laboratory or Prudent Practices in the Laboratory: Handling and Disposal of Chemicals for specific cleanup recommendations. For large chemical spills of volatile or toxic material, immediately evacuate the area. Call campus security (86911) to report the spill.

Evacuation:
When the building fire alarm sounds, turn off all sources of heat, electricity and gas, and stabilize any reaction processes. Evacuate the building immediately.
Evacuate by the stairwell, not the elevator.
Laboratory workers should become familiar with evacuation routes before an emergency occurs. Supervisors/instructors/research advisers should arrange a place to meet with students in case of emergency evacuation. After evacuation, supervisors/instructors/research advisers should meet at the designated place and make sure all students are accounted for.

XI. Chemical Procurement, Distribution, Storage & Inventory

Procurement:
Before a chemical is ordered, the person who intends to use it should know the proper handling, storage and disposal procedures for it. To minimize storage space problems and waste disposal costs, only quantities anticipated for particular experiments planned, or those anticipated for ongoing laboratory courses, should be purchased.
All chemicals should be received in Burruss 243. No container should be accepted without an adequate identifying label. The "date received" should be written on the container label at the time of inspection of the package containing the chemical ordered.

Distribution:
Chemicals that are to be transported from the receiving area should be put onto a cart and transported via the elevator. Highly volatile liquids (as common lab solvents) and concentrated acids should be transported in appropriate containers that minimize the likelihood of bottle breakage. Items originally taken from appropriate storage area within any laboratory preparation room, should be discarded or returned to its storage when no longer needed in the laboratory itself.

Storage:
The major quantity of most chemicals should be stored in acid cabinets, flammables cabinets, or in appropriate storage areas in laboratory preparation rooms. (Only small quantities of chemicals should be transferred to secondary containers, properly labeled, and stored in the laboratories.)
Chemicals should not be stored on bench tops, under hoods, or atop cabinets. Any item-chemical or apparatus-must be stored with a clearance of at least 18 inches from a sprinkler head to allow proper functioning of the sprinkler system. Heavy materials should not be stored on high surfaces or shelves. Exits, passageways, areas under tables or benches, and emergency equipment areas must be free of stored equipment and materials.
Hazardous chemicals should be segregated in a well-identified area with proper ventilation.
Chemicals that are highly toxic should be kept in unbreakable secondary containers.
Stored chemicals should be examined annually for deterioration and container integrity.
Exposure of chemicals to heat or direct sunlight should be avoided.
Flammable liquids should be stored in approved flammable liquid storage cabinets.
Chemical storage areas must be established, so that storing incompatible reagents can be avoided.
Refrigerators used for chemical storage must be labeled "NO FOOD-CHEMICAL STORAGE ONLY." This refrigerator must then be used to store chemicals only. All materials stored inside must be labeled with (1) contents, (2) owner, (3) date of acquisition or preparation, and (4) nature of any potential hazard. **Flammable liquids**

must not be stored in any laboratory refrigerator unless that appliance is approved for such storage.

Inventory:
The chemical inventory will contain these data fields:

- Name, as printed on the container
- Molecular formula, for further identification and to provide a simple means of searching
- Chemical Abstract Service (CAS) registry number, for unambiguous identification of chemicals despite the use of different naming conventions
- Source
- Size of container
- Hazard classification, as a guide to safe storage, handling and disposal
- Date of acquisition, to ensure that unstable chemicals are not stored beyond their useful life
- Storage location, in laboratories where multiple locations exist

The chemical inventory will be checked and updated annually by each laboratory supervisor prior to the anticipated annual waste disposal. At this time, quantities of holdings will be estimated for each chemical, and decisions will be made concerning needed disposal of any holding which is deemed "out of date."

Storage:
Hazardous chemicals should be stored in an area with proper ventilation.
Chemicals that are highly toxic should be in unbreakable secondary containers.
Stored chemicals should be examined annually for deterioration, container integrity and possible replacement.
Do not store incompatible reagents together.
Laboratory Storage:
The amount of chemicals stored in laboratory areas should be small as possible.
Chemicals should not be stored on bench tops or hoods in order to avoid inadvertent spills or breakage.
Exposure of chemicals to heat or direct sunlight should be avoided.
Unneeded items should be discarded or returned to chemical storeroom.

XII. Waste Disposal

The waste disposal program will be maintained by the chemical hygiene officer, who will coordinate the waste disposal protocol for the biology department with that of the department of chemistry.

Waste for "commercial" disposal should be put into a suitable container (preferably glass, if possible). A departmental waste label should be filled out and attached to the container. The labeled waste container will be stored in a designated area.
See Hazards in the Chemical Laboratory or Prudent Practices for Handling Hazardous Chemicals in Laboratories for specific disposal procedures.
The chemistry department will periodically contract with a chemical disposal company to dispose of unwanted and waste chemicals.
Before a worker's employment ends, chemicals for which that person was responsible should be discarded.

XIII. Records

The University Safety Officer shall maintain an accurate record of any measurements taken to monitor employee exposures and any medical consultations/examinations including tests or written opinions required by this plan. He/she will assure that such records are kept, transferred and made available in accordance with 29 CFR 1910.20.

XIV. Medical Consultation and Medical Examinations

Laboratory employees who work with hazardous chemicals should be given an opportunity to receive medical attention, including any follow-up examination that the examining physician determines to be necessary, under the following circumstances:

1. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.
2. Where exposure monitoring reveals an exposure level routinely above the action level (or PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirement, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
3. Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.
The employer should provide the following information to the physician:

1. identity of the hazardous chemical(s) to which the employee may have been exposed.
2. description of the conditions under which the exposure occurred including quantitative exposure data, if available.

3. description of the signs and symptoms of exposure that the employee is experiencing, if any.

For medical consultations required under OSHA Laboratory Standard 29 CFR 1910.1450, the employer shall obtain a written opinion from the examining physician which should include the following:

1. any recommendation for further medical follow-up.
2. results of the medical examination and any associated tests.
3. any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace.
4. a statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

XV. Standard Operation Procedures

A copy of the standard operating procedures (SOP's) is to be given to each employee who is involved with any laboratory-based course or research project as part of the safety training. Students should receive an abbreviated version, appropriate for their particular lab course, as part of the course syllabus.

GENERAL GUIDELINES

1. **Responsible behavior in the laboratory is essential.** The dangers of spilled acids and other chemicals, as well as broken glassware created by thoughtless actions, are too great for irresponsible behavior to be tolerated.

2. **Perform no unauthorized experiments.** Use only the quantities of reagents as instructed in written procedures, and no more. Consult your instructor if you have any doubts about the instructions in the laboratory manual or written procedure. Prior approval should be obtained from the supervisor/instructor whenever a new laboratory procedure, test or experiment is carried out, or there is a change in an existing procedure, test or experiment. Also, when planning laboratory experiments or procedures involving chemicals, consult this plan to acquire information about specific hazardous substances used in biology laboratories. Additional information concerning all chemicals-as potential hazards, safety issues when handling and disposing of them, and steps to take in case of accidental release (e.g., spill, leak)-is contained in the MSDS collection for the biology department. Knowledge of this type of information should be in hand BEFORE the experiment is started.

3. **Working alone in the laboratory is not permitted.** At least one other person should be present in the same room, and an instructor should be readily available.

4. **Think about what you are doing in the laboratory.** Plan ahead; do not "cookbook." If you give no thought to what you are doing, you predispose yourself to an accident.

LAB APPAREL

1. **Wear approved eye protection** - that which meets the requirements of ANSI Z87.1-at all times in all biology laboratories where and when chemicals are handled or there is a possibility of injury to the eyes because of ongoing laboratory procedures (e.g., from projectiles, from boiling water.)

    a. Eye protection should protect against impact and chemical splashes. Goggles, or other special eye protection, must be worn by those who already wear prescription glasses.

    b. If your eyes come into contact with an acid, alkali, abrasive or otherwise irritating substance, wash your eyes with flowing water from a sink or eyewash station for at least 15 minutes. Seek medical attention immediately.

2. **Footwear that completely covers the feet is required**, because of the danger of broken glass and the possibility of chemical spills.

3. **A lab apron or coat should be worn**

    - when you are wearing easily combustible clothing, such as synthetic and light fabrics
    - when working with and/or transporting hazardous chemicals
    -

4. **Gloves should be worn when working with hazardous chemicals.** These gloves should be made of material known to be resistant to permeation by that chemical. Inspect gloves before each use, wash them before removal, and replace them periodically (Attachment 3).

BIOLOGY LAB POLICIES

1. As part of the **safety orientation** to the lab, you will be shown the location of fire extinguishers, fire blankets, safety showers and fire alarms. In addition, you will be informed of the location of MSDS, and shown how to use them. <u>All laboratory workers and students should know</u>

- the hazards of a chemical as stated in the MSDS and other appropriate references pertaining to that chemical
- the location and proper use of emergency equipment
- how and where to properly store chemicals when not in use
- the proper method for transporting chemicals within the department
- the appropriate procedures for emergencies, including evacuation routes, spill cleanup procedures and proper waste disposal

2. **Promptly clean** all chemical spills and **properly dispose** of spilled chemical and cleanup material

3. **Properly label and store all chemicals and equipment**. All chemicals (including solutions and chemicals transferred from their original containers) should be labeled with their names, concentrations and hazards.

4. **Do not eat or drink anything, do not chew gum, do not smoke, and do not apply cosmetics** in the laboratory. In addition, since many chemicals are absorbed through the skin, avoid direct skin contact. If you suspect skin contact with chemical substances, such as bottled reagents, wash off these substances with large quantities of water. Wash your hands thoroughly with soap and water before leaving the laboratory. In addition, do not store or handle food or beverages in laboratory areas, including refrigerators used for chemical storage.

5. **Report all injuries to your instructor at once**. Except for very superficial injuries, you will be required to get medical treatment for cuts, burns, or fume inhalation. Complete accident report form (Attachment 6).

6. **Avoid deliberately and directly breathing fumes of any kind.**

    a. To test the smell of a vapor, with your instructor's permission, collect some of the vapor in a cupped hand.

    b. Work in a chemical fume hood if there is the possibility that noxious or poisonous vapors may be produced.

7. **Do not use mouth suction to fill pipettes** with water or chemical reagents, aqueous or organic. Always use a suction device provided.

8. **Confine long hair and loose clothing** in the lab, since either can catch fire or be chemically contaminated.

9. **Keep your work area neat at all times.** Clean up spills and broken glass immediately. Clutter not only will slow your work, but it leads to accidents. Clean

your workspace, including wiping the surface and putting away all chemicals and equipment, at the end of the laboratory preparation, course laboratory period or student project session.

10. **Always carefully and slowly pour** acids into water when mixing to avoid spattering.

11. **Discuss with the instructor about disposing** of excess reagents. Dispose of solids in approved containers. DO NOT RETURN REAGENTS TO THEIR ORIGINAL CONTAINERS.

12. **Properly label and store all chemicals and equipment.** All chemicals (including solutions and chemicals transferred from their original containers) should be labeled with their names, concentrations and hazards.

13. Do not block access to emergency equipment or exits.

14. All chemicals and wastes should be placed in their proper storage area at the end of the day.

15. All working surfaces and floors should be cleaned regularly.

16. Laboratory doors leading to hallways are to be closed during any laboratory activity.

17. **Glassware:**

    - Do not use broken, chipped, starred or cracked glassware.
    - Clean all glassware after use.
    - Do not pick up broken glassware with bare hands. Use gloves or sweep it up. Deposit broken glass in a "Broken Glass Safety Toss Box."
    - Handle hot glassware with proper size and type of tongs or hot mitts.

18. **Vacuum and pressurizing equipment and materials:**

    - Use a safety shield whenever an implosion might occur when working with vacuum equipment**.** Shield or wrap Dewar flasks or other evacuated glass apparatus.
    - Relieve vacuum in all parts of system before opening apparatus. Relieve vacuum slowly. Avoid sudden pressure changes which could cause breakage or spattering of contents. Do not relieve vacuum on heated apparatus until apparatus has cooled.

- Use a safety shield whenever an explosion might occur when working with pressurizing equipment.
- Do not apply pressure to glassware.
- Vent pressure in all parts of the system before opening.

19. **Compressed gases:**

- Store and transport compressed gas cylinders with the safety caps on.
- Transport large cylinders on a hand truck to which the cylinder is secured.
- Cylinders should be clamped securely to a wall or other firm support with an appropriate cylinder clamp or chains.
- Always use a reducing valve with gas cylinders.
- Do not lubricate, modify or tamper with a cylinder valve.
- Do not heat cylinders or store them near a heat source.

20. **Syringes:**

Syringes are intended for dispensing reactive and/or hazardous chemicals that cannot be safely handled in any other manner. Following use, syringes are to be placed intact in a puncture-resistant, leak-proof container specified for sharps disposal.

XVI. Equipment Safety

At the start of the introductory section pertaining to "Laboratory Equipment" in Prudent Practices (1995) is this statement: "Proper use of laboratory equipment is required to work safety with hazardous chemicals. Maintenance and regular inspection of laboratory equipment are an essential part of this activity. Many of the accidents that occur in the laboratory can be attributed to improper use or maintenance of laboratory equipment." Requirements and recommendations concerning safety with equipment commonly located in chemical laboratories appear below.

Water-cooled equipment (e.g., distillation apparatus):

The major problem with cooling water is localized flooding due to the disconnection of tubing supplying water to the condenser. Tubing connections should be checked frequently, and the entire apparatus should be operated when the laboratory is occupied.

Electrically-powered equipment (including fluid and vacuum pumps, lasers, power supplies, both electrophoresis and electrochemical apparatus, stirrers, hot plates, water baths, heating mantles, microwave ovens and ultrasonicators):

The major hazard is electrical, as a shock hazard and as a source for flammable or explosive vapors. All electrical equipment must be installed and maintained according to the provisions of the National Electric Code (NEC) of the National Fire Protection Association (NFPA, 1991a).
All repair and calibration work must be carried out by properly trained and qualified personnel. Before modification, installation, or even minor repairs of electrical equipment are carried out, the devices must be deenergized, and all capacitors, discharged safely.
All 110-volt (V) outlet receptacles should be of the standard design that accepts a three-prong plug and provides a ground connection. **The use of two-pronged adapters to connect equipment with three-pronged grounded plugs to two-wire outlets is prohibited.** Ground fault circuit interrupter circuits should be located where appropriate, i.e., receptacles less than 6 feet from sinks.
Receptacles that provide electric power for operations in hoods should be located outside the hood, a step which prevent the production of electric sparks inside the hood. In addition, cords should not dangle outside the hood in such a way that they accidentally can be pulled out of their receptacles or tripped over.
Equipment plugged into an electrical receptacle should include a fuse or other overload protection device to disconnect the circuit if the apparatus fails or is overloaded.
General precautions for working with electrical equipment:

1. All equipment must be insulated properly. During equipment use, if frayed or damaged cords are found, they must be replaced before further use of the equipment is permitted. The complete electrical isolation of electrical equipment and power supplies must be ensured to prevent the possibility of accidental contact with electrical circuits.

2. The isolation of electrical equipment which may generate sparks from volatile solvents must be ensured.

3. To minimize the possibility of electrical shock, adequate grounding will be provided for all electrical equipment.

4. Pieces of equipment should be unplugged prior to adjusting, modifying or repairing them. If it is necessary to power this equipment, hands must be dry and, if feasible, nonconductive gloves and shoes with insulated soles should be worn.

5. Lab supervisors and students must be made aware of the location and operation of power shutoffs (i.e., main switches and circuit breaker boxes) for areas in which they work.

Personal safety techniques for use with electrical equipment:

1. Contact with energized electrical circuits must be avoided. Electrical equipment should be serviced by only qualified individuals, and only after power has been disrupted and capacitors are discharged. Before electrical equipment is reconnected to power after servicing, it must be tested to ensure proper grounding.

2. If a circuit breaker "trips," steps must be taken to assure that the overload or short-circuit which caused the failure is corrected.

3. Ground-fault circuit interrupters must be in place where required, particularly if an electrical device is hand-held during a lab operation.

4. If a person contacts a live electrical conductor, the power source first must be disconnected before the person is removed from the contact and first-aid is administered.

XVII. Electrical equipment used in BIOLOGY laboratories requiring special precautions:

Ultrasonicators:

- When ultrasonic equipment is operated in the laboratory, the apparatus must be enclosed in a 2-cm-thick wooden box or in a box lined with acoustically absorbing foam or tiles to substantially reduce acoustic emissions.

- Direct contact of the body with liquids or solids subjected to high-intensity ultrasound should be avoided.

Centrifuges:

- Centrifuges should be properly installed and must be operated by only trained personnel.

- The load must be balanced each time the centrifuge is used, and the lid must be closed while the rotor is moving.

Electrical Instruments and Appliances (e.g., circuit testing equipment, electrophoresis power supplies, microscopes, ovens, water baths, hot plates and stirring devices, top-loading and analytical balances, microwave ovens, pH and specific ion meters, vacuum pumps, refrigerators and freezers):

- For all equipment, a chassis ground must be in place.

- Special precautions should be taken to avoid the possibility that water or other chemicals could be spilled onto these instruments.

- Only qualified individuals should make repairs.

Electromagnetic Radiation Hazards (e.g., UV sources, lasers, microwave sources)

- Overexposure to UV light, direct or reflected, should be minimized. Lamp sources should be sealed or enclosed whenever possible, and appropriate eye protection and/or face shields should be worn. Long-sleeved clothing and gloves should be worn to protect arms and hands.

- Microwave sources must be operated only with appropriate microwave generator shielding in place. Avoid metal in microwave ovens, since arcing may occur, causing the ignition of any solvents present. Since superheating of liquids can occur, capping of vials and other containers can result in explosion from pressure buildup within the vial. Use only selected plastic containers that will resist melting.

- To ensure proper maintenance, it is recommended that periodic maintenance and inspections be documented along with the identity of personnel performing these tasks. In addition, OSHA's Lockout/Tagout standards must be followed for servicing and maintenance.

XVIII. References

Allocca, J. A. and H. E. Levenson. Electrical and Electronic Safety. Reston, Virginia: Reston Publishing Company, 1982.

Fuscaldo, A. A., A. J. Erlick and B. Hindman. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980.

Muir, G.D. ed. Hazards in the Chemical Laboratory. London: The Chemical Society, 1977.

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

National Research Council, Prudent Practices in the Laboratory: Handling and Disposal of Chemicals. Washington: National Academy Press, 1995.

O'Brien, Paul. Principles of Hazardous Material Management. University of California Extention, Santa Cruz, 1993.