CALVIN

College

LAB SAFETY

&

CHEMICAL HYGIENE PLAN

Updated 3/9/2015

EMERGENCY CONTACT INFORMATION

Contact	Name	Cell	Office	Home
To get POWER shut down	Jack Phillips	292-4153	526-7074	
	Luke DeVries	262-6748	526-6859	949-7872
	Don Winkle	437-2643	526-6270	532-1663
To get RETURN AIR or HVAC shut down	Jack Phillips	292-4153	526-7074	784-0057
	Dan Slager	262-5838	526-6267	896-9716
To get GAS shut off	Jack Phillips	292-4153	526-7074	795-2182
	Joel Bosma	318-0241	526-6851	
	Bob VandenBerg			
Campus Safety	Emergency (Dispatch)		526-3333	
	Office		526-6452	
	Supervisor	862-0601	526-6711	
	Bill Corner	446-3927	526-6751	669-3544
	Jim Potter	292-3748	526-6710	897-4205
Environmental Health & Safety	Heather Chapman	299-2246	526-8591	
	Jennifer Ambrose	262-6254	526-6342	669-3141
Chemical Hygiene Officer	Mike Barbachyn	(269) 760-8423		
Young's Environmental Cleanup, Inc.	Primary 24-hour Emergency Response Contractor	800-496-8647		
C. Stoddard & Sons, Inc	Back-up Emergency Response Contractor	Office: 8:00a – 4:00p (269)-792-6591 After hours: 616-889-9944; secondary: 269-792-9556		
24-hour HAZMAT communications center for emergency responders	CHEMTREK	1-800-262-8200		
Expert treatment advice and assistance in case of exposure to poisonous, hazardous or toxic substances	Poison Control Center	1-800-222-1222		

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APPENDICES

1.0 POLICY

The *Lab Safety and Chemical Hygiene Plan* has been prepared in compliance with the Michigan Occupational Safety and Health Administration (MIOSHA) Hazardous Work in Laboratories regulation (the Laboratory Standard – Part 431).

2.0 PURPOSE & SCOPE

Calvin College is committed to providing a safe and healthy work environment for the entire campus community. The principle purpose of this Chemical Hygiene Plan (CHP) is to define work policies and procedures to help ensure that laboratory employees at Calvin College will work safely with hazardous chemicals.

For the purposes of this plan, “laboratory employees” are those who ordinarily work full-time in a laboratory space. The CHP is also intended to ensure that a safe laboratory environment is in place for temporary or visiting personnel such as students, visiting scholars, and office, custodial, maintenance, and repair workers who, as part of their duties, regularly spend a significant amount of time within a laboratory environment.

The CHP does not apply to all places where hazardous chemicals are used. Only laboratories meeting the following four criteria are subject to the plan:

- Chemical manipulations are carried out on a laboratory scale. That is, the work with chemicals is in containers of a size that could be easily and safely manipulated by one person, rather than a manufacturing plant scale.
- Multiple chemical procedures or chemicals are used.
- The procedures involved are not part of a production process whose function is to produce commercial quantities of materials, nor do the procedures in any way simulate a production process.
- Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

The wording of these criteria are specifically intended to differentiate between laboratories like the research labs at Calvin College and laboratories that are devoted to a manufacturing process, which are covered under other regulations.

3.0 DEFINITIONS

See Appendix I

4.0 RESPONSIBILITIES

Laboratory employees and all other personnel who work in laboratories have the right to be informed about the potential health hazards of substances in their work areas and to be properly trained to work safely with or in the presence of these chemicals. They also have the right to file a complaint with EHS and/or OSHA if they feel they are being exposed to an unsafe or unhealthy work environment.

<u>Environmental Health & Safety (EHS)</u>

- Responsible for the development and implementation of institutional procedures for the establishment and maintenance of an environmentally healthy and safe workplace. EHS and the Chemical Hygiene Officer serve as resources for compliance with the CHP.
- Review the plan annually in conjunction with the Chemical Hygiene Officer.

- Ensure that the CHP is available for review on the EHS website or by contacting the CHO.
- Keeps records of employee exposures to hazardous chemicals including, but not limited to, measurements made to monitor exposures and medical consultations/examinations.
- Provide respirators when necessary for working safely with a chemical or, in the case of the spill team, for being prepared to respond to a chemical spill.
- If there is reason to believe that the action level, or permissible exposure limit (PEL), has been exceeded for any chemical for which a substance-specific standard has been established, Calvin must determine the concentration of that chemical in the air.
- If the level measured is greater than the PEL or action level, then:
    - Notify all affected laboratory employees of the results of the measurement, and
    - Comply with the OSHA exposure-monitoring provisions for that chemical, as stated in 29 CFR 1910.1000 through 1910.1199.

<u>Chemical Hygiene Officer (CHO)</u>

- Work closely with EHS, and academic units for overall compliance with the CHP.
- May delegate responsibility to others, as necessary, to implement and carry out the provisions of the CHP.
- Shall have sufficient training and experience to provide technical guidance in the development and implementation of the CHP.
- The College President has the ultimate responsibility for chemical safety. The CHO acts as the representative of the College President in this capacity.
- Duties include the preparation, implementation, and maintenance of the CHP, setting forth the work practices, procedures, personal protective equipment, and other equipment that will protect employees from harm arising from the use of hazardous chemicals in the laboratories.
- Help faculty researchers develop precautions and work in adequate facilities.
- Ensure that workers know the chemical hygiene rules and document that appropriate training has been provided.
- Assist in determining the required levels of protective apparel and equipment and insure that this equipment is available and in working order.
- Monitor procurement, use, and disposal of chemicals in the lab.
- With the help of the Biology and Chemistry Lab Managers, ensure that copies of all SDSs received are properly stored and maintained (See College Hazard Communications – Global Harmonization System Program).
- Insure that a Departmental Chemical Inventory List is maintained.
- Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment. See Appendix J.
- Know the current legal requirements concerning regulated substances.
- Seek ways to improve the chemical hygiene program.

<u>The Radiation Safety Officer (RSO)</u>

- Comply with state and federal requirements for using ionizing and non ionizing radiation including personnel monitoring. In each laboratory where ionizing and/or non-ionizing radiation is used, there will be a Calvin employee who is responsible for certain essential functions to assure regulatory compliance and the safety of those using radiation.

<u>Campus Safety</u>

- Will coordinate response activities in the event of an emergency with EHS and the CHO.

<u>Lab Workers</u>

- All individuals performing work with hazardous substances must accept a shared responsibility for working in a safe manner once they have been informed about the extent of risk and safe procedures for their activities. They also have the responsibility to inform their supervisors of accidents and work practices or working conditions that they believe to be hazardous to their health or to the health of others. Standard reporting procedures and forms are available from the lab supervisor or EHS.
- Be familiar with the CHP and following the policies and safety rules described in it.

- Plan and conduct each laboratory operation in accordance with safe procedures.
- Develop and maintain good personal chemical hygiene habits.

Academic Deans

- Responsible for the overall safety and well-being of faculty, staff, and students in that they can make available the resources necessary to carry out the provisions of the CHP.

Faculty

- Faculty generally serve as laboratory supervisors, either in the teaching or research laboratory settings, and, as such, have a special responsibility to ensure a safe laboratory environment for all occupants (*vide infra*). Faculty members need to provide students and visiting scholars or staff with training at the beginning of each course or research project in which hazardous materials are used. Specific safety training instructions will be provided at the beginning of each class period on an as needed basis.

Lab Managers

- Document incoming hazardous chemicals by:
  - Requiring that incoming hazardous chemicals have adequate labels that are not easily removed or defaced.
  - Requiring that Safety Data Sheets (SDSs) for incoming hazardous chemicals be on hand prior to, or soon thereafter, of the receipt of hazardous chemicals.
  - Filing all SDSs.
  - Making SDSs easily accessible to employees.
  - Maintaining an inventory of all chemicals in Calvin laboratories.
- If select carcinogens, reproductive toxins, or acute toxins are present in concentrations of 0.01% or greater in the laboratory, identify and post one or more areas as "designated area(s)."
- Ensure that the Environmental Health and Occupational Safety (EHOS) office receive SDS that are outdated or obsolete for the purposes of archiving.
- Maintain the Vertere software and keep the chemical inventory up to date in the system.
- Ensure that student employees or visiting scholars know and follow the chemical hygiene rules.
- Ensure that protective equipment is available and in working order.
- Ensure that all containers in the work area are properly labeled.
- Ensure that SDS's are maintained for each hazardous substance in the laboratory and ensuring that they are readily accessible to laboratory employees.
- Determine, with help of the CHO, the required levels of protective apparel and equipment.
- Ensure that facilities for use of any material being ordered are adequate.
- Responsible for the safety and well-being of all persons in contact with any college-related activity utilizing radiation, chemical, or biological hazards.
- Coordinate and work closely with lab supervisors. Lab supervisors include any faculty or staff member running a research project that involves hazardous materials as well as departmental teaching lab supervisors. Specifically, the lab supervisor is responsible for;

  1. Ensuring that all employees under his/her supervision have received the appropriate safety training,
  2. Providing all employees under his/her supervision with site-specific training and documenting such training,
  3. Following appropriate guidelines prescribed in this document, and in department or site-specific procedures.

5.0 TRAINING

- For new faculty and staff, the immediate supervisor or department chair is responsible for the new employee safety orientation (NESO) including review of the CHP. The NESO should normally occur on the first day of employment to emphasize the importance of laboratory safety at Calvin College.

- For research students participating in a summer research program, the CHO and EHS officer will arrange for one or more NESO sessions. This will normally occur on the first day of summer research prior to the beginning of laboratory activities, however more than one session may be required since the start of summer research is not the same for every student. Research mentors are required to supplement the general NESO with lab specific safety information. All summer research students are required to participate in the NESO even if they have previously participated in summer research, and they will complete the NESO form each time they participate in the safety orientation.

- For research students participating in research during the academic year, the research mentor is responsible for an adequate safety orientation.

6.0 EXPOSURE ASSESSMENTS, MEDICAL CONSULTATIONS, AND EXAMINATIONS

Suspected Exposures to Toxic Substances

- There may be times when employees or supervisors suspect that an employee has been exposed to a hazardous chemical to a degree and in a manner that might have caused harm to the employee. If circumstances suggest that such an exposure occurred, the victim is entitled to medical consultation and, if so determined in the consultation, also to a medical examination. All medical examinations and consultations shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

Criteria for Reasonable Suspicion of Exposure

- It is the policy of Calvin College to promptly investigate all employee-reported incidents in which there is a claim that an employee was overexposed to a hazardous substance. Events or circumstances that might reasonably constitute overexposure include:
    - A hazardous chemical leak, spill, or rapid release in an uncontrolled manner.
    - A laboratory employee had direct skin or eye contact with a hazardous chemical.
    - A laboratory employee manifests symptoms, such as headache, rash, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgment, etc., and some or all of the symptoms disappear when the person is taken away from the exposure area and breathes fresh air, and the symptoms reappear soon after the employee returns to work with the same hazardous chemicals.
    - Two or more persons in the same laboratory work area have similar complaints.

Exposures

- All exposure complaints are to be documented by the CHO using the Report of Exposure to Hazardous Chemicals Form. See Appendix L. Copies of these forms shall be sent to EHS. If no further assessment of the event is deemed necessary, the reason for that decision shall be included on the Report of Exposure to Hazardous Chemical Form. If the decision is to investigate, a formal exposure assessment will be initiated by the CHO or EHS.

Exposure Assessment

- In cases of emergency, exposure assessments are conducted after the victim has been treated. Otherwise, exposure assessments should be completed BEFORE medical consultations are undertaken. NOTE: It is not the purpose of an exposure assessment to determine that a failure on the part of the victim, or others, to follow proper procedures was the cause of an exposure. The purpose of an exposure assessment is to determine whether or not there was an exposure that might have caused harm to one or more employees and, if so, to identify the hazardous chemical or chemicals involved.

- Unless circumstances suggest additional steps, these actions constitute an exposure assessment:
    - Interview the complainant and also the victim, if not the same person.
    - Have the exposed individual complete a Report of Exposure to Hazardous Chemical Form. See Appendix L.
    - List the essential information about the circumstances of the complaint, including:
    - The chemical under suspicion.
    - Other chemicals used by the victim.
    - All chemicals being used by others in the immediate area.

    - Other chemicals stored in that area.
    - Symptoms exhibited or claimed by the victim.
    - Were control measures, such as personal protective equipment and hoods, used properly?
    - Were any air sampling or monitoring devices in place? If so, are the measurements obtained from these devices consistent with other information?
- If appropriate, monitor or sample the air in the area for suspect chemicals.
- Determine whether the victim's symptoms compare to the symptoms described in the SDS or other pertinent scientific literature.

Notification of Results of Monitoring

- The employee will be notified of the monitoring results within 15 days after receipt of results.

Medical Consultation and Examination

- If employees believe that they have been over-exposed to hazardous chemicals, employees are required to contact the CHO who will assist them in arranging for an Exposure Assessment if necessary. The Exposure Assessment will be utilized by the consulting physician to determine if further medical consultations and examinations are warranted.
- The medical professional should also be knowledgeable about which tests or procedures are appropriate to determine if there has been an overexposure.
- All employees who work with hazardous chemicals must be provided an opportunity to receive medical consultation and examination when:
    - The employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
    - Monitoring, routine or otherwise, suggests that there could have been an exposure above the action level, or OSHA PEL if there is no action level, for a chemical for which an OSHA substance-specific standard has been established.
    - There is a spill, leak, or other uncontrolled release of a hazardous chemical.
- Employer must provide the physician with:
    - The identity of the hazardous chemical or chemicals to which the employee may have been exposed (Formal Exposure Assessment if available).
    - The exposure conditions.
    - The exposure symptoms the victim is experiencing.
- Ordinarily, physicians will provide EHS with the following written information:
    - Recommendations for follow-up, if necessary.
    - A record of the results of the consultation and, if applicable, of the examination and any tests that were conducted.
    - Conclusions concerning any other medical condition noted that could put the employee at increased risk.
    - A statement that the employee has been informed both of the results of the consultation or examination and of any medical condition that may require further examination or treatment.

These written statements and records should not reveal specific findings that are not related to an occupational exposure.

Documentation: All memos, notes, e-mail messages, and reports related to a complaint of actual or possible exposure to hazardous chemicals are to be maintained as part of the record.

7.0 RECORDKEEPING

OSHA regulation 29 CFR 1910.1020, Access to Employee Exposure and Medical Records, addresses the storage and access to employee exposure and medical records pertaining to toxic substances or harmful physical agents. The following is a summary of this regulation:

- The medical record for each employee is to be preserved and maintained for at least the duration of employment plus thirty years.

Some record of the identity (chemical name if known) of the substance or agent, where it was used, and when it was used is retained for 30 years. SDSs are to be archived through the EHS department.

If an employee or their designated representative, requests a copy of the employee's health record, the College is to provide a copy within 15 days of the request, or provide facilities to make copies at no cost, or loan the records to the employee or designated representative so that copies can be made.

8.0 STANDARD OPERATING PROCEDURES

This CHP provides certain procedures for health and safety standard operating procedures (SOPs) that apply to laboratory work involving the use of chemicals, biological materials, and/or operations with a high degree of risk. SOPs have been prepared to standardize the normal operating conditions. Additional procedures may be necessary for labs with health and safety hazards greater than those presented in the CHP.

General Safety Procedures

The following guidelines have been established to assist lab faculty and staff to manage potential hazards and to maintain a basic level of safety. Shown below are guidelines that establish minimum requirements for those who may use and/or work in labs.

1. Understand the known hazards associated with the materials being used. Never assume all hazards have been identified. Carefully read labels before using an unfamiliar chemical. When appropriate, review the Safety Data Sheet (SDS) for special handling information. Determine the potential hazards and use appropriate safety precautions before beginning any new operation.
2. When moving chemicals in glass containers between labs or storerooms, they must be transported in break-resistant secondary containers. See p. 17 for more details.
3. Label all containers with chemical contents. See p.23 for more details.
4. Be familiar with the location of emergency equipment such as fire alarms, fire extinguishers, emergency eyewash, and shower stations and know the appropriate emergency response procedures.
5. Avoid distracting or startling other workers when they are handling hazardous materials.
6. Use equipment and hazardous materials only for their intended purposes.
7. Always be alert to unsafe conditions and actions and call attention to them so that corrective action can be taken as quickly as possible.
8. Wear appropriate skin, eye and face protection.
9. Always inspect equipment for leaks, tears or other damage before handling a hazardous material. This includes fume hoods, gloves, goggles, etc.
10. Avoid tasting or smelling chemicals.
11. All building electrical repairs, splices, and wiring shall be coordinated through Physical Plant.
12. Extension cords are not to be used as a substitute for permanent wiring.

Health & Hygiene

The following practices have been established to protect laboratory employees from health risks associated with the use of hazardous chemicals:

1. Avoid direct contact with any hazardous material. Know the types of protective equipment required while using any chemical. If in doubt, review the appropriate section of the SDS.
2. Confine long hair and loose clothing and always wear footwear that fully covers the feet.
3. Do not mouth-pipette.
4. Use appropriate safety equipment whenever there is a potential for exposure to hazardous gases, vapors, or aerosols. Check to ensure that local exhaust ventilation equipment is working properly before use. In the event that general or local exhaust ventilation is not functioning properly, immediately stop work, notify Physical Plant, and place a sign to notify others that work with hazardous materials is suspended until the equipment is working properly.
5. Wash thoroughly with soap and water after handling chemicals or biological materials, before leaving the laboratory and before eating or drinking.
6. If there is a hazardous splash potential, splash goggles shall be worn as eye protection.
7. Clean and store personal protective equipment as appropriate.
8. Laboratory employees shall be familiar with the signs and symptoms of exposure for the materials with which they work and the precautions necessary to prevent exposure.

Food and Drink in the Laboratory

1. Prohibit eating, drinking, smoking, or applying of commercial products in any laboratory area where hazardous chemicals or biological hazards are in use.
2. Glassware or utensils that have been used for laboratory operations should never be used to prepare or consume food or beverages.
3. Refrigerators and microwave ovens used for chemical or biological storage or other laboratory use shall not be used for food storage or preparation.
4. Refrigerators used for chemical storage must be labeled as such and indicate that no food or beverages shall be stored in it.

Housekeeping

Safety follows good housekeeping practices. The following guidelines can be used to maintain an orderly laboratory: Custodians are not to clean up chemicals or biohazards.

1. Keep work areas (including floors) clean and uncluttered. Clean up work areas after the work is finished or at the end of each lab or workday.
2. Dispose of waste following disposal policies described in Section 12 (p.23). A separate receptacle must be designated for non-contaminated glass. Contaminated glass is considered hazardous waste and should be disposed of accordingly.
3. Clean spills immediately and thoroughly (if trained), as per the guidelines in this document and the product SDS. Ensure a chemical spill kit is available. Faculty, staff, and students should receive training on the proper procedures of cleaning a spill and a designated employee shall assure that the spill kits are properly stocked.
4. Do not block exits, emergency equipment or controls. Do not use hallways and stairwells for storage.
5. Assure hazardous chemicals are properly segregated into compatible categories (Appendix A).
6. Custodial responsibilities are limited to emptying the trash and sweeping the floors.
7. Stairways and hallways must not be used as storage areas.
8. Reagents and equipment items should be returned to their proper place after use.
9. Contaminated or dirty glassware should be placed in specific cleaning areas and not allowed to accumulate.
10. Chemicals, especially liquids, should never be stored on the floor, except in closed-door cabinets suitable for the material.
11. Large bottles (2.5L or larger) should not be stored above the bench top.
12. Reagents, solutions, glassware, or other apparatus shall not be stored in hoods.

Vacuum Operations
A moderate vacuum (i.e., down to 10 mm Hg), which can be achieved using a water aspirator, may seem safe compared with a high vacuum (i.e., less that 10 mm Hg). However, even moderate vacuum can have a large pressure difference between the outside and inside. Therefore, any evacuated container must be regarded as an implosion hazard.

Apply vacuum only to glassware specifically designed for this purpose, i.e., heavy wall filter flasks, desiccators, etc. Never evacuate scratched, cracked, or etched glassware.

Vacuum glassware that has been cooled to liquid nitrogen temperature or below should be annealed prior to reuse under vacuum. Rotary evaporator condensers, receiving flasks, and traps should be taped or kept behind safety shields when used under vacuum. All condensers connected to rotary evaporators should at least be cooled with circulating ice water.

The use of a vacuum for the distillation of the more volatile solvents, e.g. ether, low boiling petroleum ether and components, methylene chloride, etc., should be avoided whenever possible. In situations requiring reduced pressure, two alternatives should be considered;

I. Utilization of a rotary evaporator system, or
II. Solvent recovery via atmospheric pressure distillation (preferred method).

- Water, solvents, or corrosive gases should not be drawn into a building vacuum system. When a vacuum pump is used to distill volatile solvents, a cold trap should be used to contain solvent vapors. Cold traps should be of sufficient size and low enough in temperature to collect all condensable vapors present in a vacuum system.
    - After completion of an operation in which a cold trap has been used, the system should be vented. This venting is important because volatile substances that have been collected in the trap will vaporize when the coolant has evaporated and cause a pressure buildup that could blow the apparatus apart.
- If such a trap is not used, the pump or compression exhaust must be vented to the outside using explosion proof methods.
- After vacuum distillations, the pot residue must be cooled to room temperature before air is admitted to the apparatus.
- All desiccators under vacuum should be completely enclosed in a shield or wrapped with friction tape in a grid pattern that leaves the contents visible and, at the same time, guards against flying glass should the vessel collapse.

<u>Unattended Operations</u>

At times, it may be necessary to leave a laboratory operation unattended. Follow these basic guidelines in the design of an experiment or project to be left unattended:

1. Always check with your laboratory supervisor to determine if a laboratory operation can be left safely unattended.
2. If the operation is to be left unattended for extended periods and involves hazardous materials or potentially hazardous conditions, develop a protocol. It should be reviewed by the laboratory supervisor and CHO. The protocol should include responses to potential interruptions in electric, water, inert gas and other services and provide containment for hazardous materials.
3. A warning notice must be posted near the experiment if hazardous conditions are present. This notice must contain information concerning the hazard such as indicators of problems and who to contact if such evidence is present.

<u>Working Alone</u>

Avoid working alone whenever possible. Do not work alone in a laboratory if the procedures being conducted are hazardous or involve the use of hazardous materials. If one must work alone, let another Calvin employee or Campus Safety know the expected times you will be in the lab.

9.0 VENTILATION

Ventilation controls are those controls intended to minimize employee exposure to hazardous chemicals by removing air contaminants from the work site. There are two main types of ventilation controls:

1. General (Dilution) Exhaust: a room or building-wide system that brings in air from outside and ventilates within. Laboratory air must be continually replaced, preventing the increase of air concentration of toxic substances during the workday. General exhaust systems are not recommended for the use of most hazardous chemicals.

2. Local Exhaust: a ventilated, enclosed workspace intended to capture, contain, and exhaust harmful or dangerous fumes, vapors, and particulate matter generated by procedures conducted with hazardous chemicals. These may include fume hoods and biological safety cabinets.

To determine ventilation requirements, review the SDS. Once a local ventilation system is installed in a work area, it must be used properly to be effective. For use of hazardous chemicals warranting local ventilation controls, the following guidelines should be observed:

<u>Fume Hood Safe Work Practices</u>

- Conduct all operations that may generate air contaminants at or above the appropriate PEL or TLV inside a fume hood.
- Do not put your head or upper body into the hood, except during initial setup and before hazardous materials are present.
- Hoods should not be used for permanent storage of hazardous materials or equipment. With the exception of certain hazardous waste containers, all chemicals should be stored in an appropriate location outside of the hood.
- Hazardous materials and equipment should be placed > 6" inside the hood for proper containment of chemical vapors. Place heat-generating equipment to the rear of the hood.
- Hood ventilation systems are best designed to have an airflow of not less than 60 ft/min (linear) and not more than 120 ft/min (linear) across the face of the hood. Flow rates of higher than 125 ft/min can cause turbulence problems and are not recommended.
- Equipment inside the hood should be placed so as to not block airflow through slots in the baffle. Blocks may be necessary under large equipment to allow air to flow to the rear baffle.
- The fume hood safety-glass sash should be kept below the "stopper" at approximately 18". The hood sash should be set at this point for procedures which could generate toxic aerosols, gases, or vapors. In general, the sash height should be set at a level where the operator is shielded to some degree from any explosions or violent reactions which could occur and where optimum airflow dynamics are achieved. If a fume hood has no markings regarding sash height or inspection dates, please contact the CHO to arrange for an inspection.
- Alarms: Most hoods are equipped with flow sensors. They will generally alarm if flow is too low or too high. Typically the problem corrects itself, possibly after adjusting sash height. If an alarm continues, stop using the hood and contact a lab supervisor or Physical Plant. The alarm can be "muted", however the hood should not be used until the proper flow rate is shown on the monitor.
- Emergency Purge: In the event or a spill, smoke, or other unintended vapors, press the emergency button on the sensor to increase to maximum fan speed.
- When not in use, the hood should be completely closed in order to reduce energy consumption.
- Minimize foot traffic and other forms of potential air disturbances past the face of the hood.
- Do not have sources of ignition inside the hood when flammable liquids or gases are present.
- Never work with hazardous chemicals if the required ventilation system is not working.
- Do not block air supply vents or exhausts in the room.
- Always use proper personal protective equipment when working with chemicals in a hood. Hoods are used when a chemical or a procedure as a greater than usual potential is especially dangerous, so eye protection, gloves, and lab coats should be worn.
- DO NOT ADJUST BAFFLES unless you have been instructed to do so by the CHO. Do not remove baffles.
- ONLY ITEMS NECESSARY TO PERFORM THE PRESENT EXPERIMENT SHOULD BE IN THE HOOD. The more equipment in the hood, the greater the air turbulence and the chance for gaseous escape into the lab.

- When instrumentation is utilized for a process inside a hood, all instruments should be elevated a minimum of two inches from the hood base to facilitate proper air movement. Elevation platforms should not be solid but have legs.
- Use of perchloric acid requires specialized hoods. Never use perchloric acid in a hood not designed for that use. Perchloric acid hoods have a wash-down feature which should be used after each use of the hood and at least every two weeks when the hood is not in use.
- Always make sure that the fan motor power switch is in the "on" position before initiating experiment. Note: Some hoods do not have individual "on/off" switches and remain "on" continuously.
- Radioactive materials *may not* be used in the hoods without prior approval of the Radiation Safety Officer.
- An emergency plan should be prepared in the event of ventilation failure or other unexpected occurrence such as fire or explosion in the hood.
- Hoods shall not be used as a means of disposing of toxic or irritating chemicals, but only as a means of removing small quantities of vapor which might escape during laboratory operations. If vaporization of large quantities of such materials is a necessary part of the operation, a means of collecting the vapor by distillation or scrubbing should be considered, rather than allowing it to escape through the hood vent. The collected liquid can then be disposed of as a liquid waste.

Biological Safety Cabinet Safe Work Practices

The Biological Safety Cabinets are used to provide containment of infectious splashes or aerosols generated by many microbiological procedures. BSC's use High Efficiency Particulate Air (HEPA) filters to protect personnel and products inside the BSC from contamination from aerosols and particulates. They also protect the laboratory by isolating and containing the work in progress within the BSC. Properly maintained Biological Safety Cabinets are used whenever:

- Procedures with a potential for creating infectious aerosols or splashes are conducted. These may include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of infectious materials whose internal pressures may be different from ambient pressures, inoculating animals intranasally, and harvesting infected tissues from animals or eggs.
- High concentrations or large volumes of infectious agents

Guidance for safe use of biological safety cabinet (BSC)s:

- Never use chemicals with the potential to generate hazardous vapors. The HEPA filters are intended only to remove particulates and biological agents.
- Never work in or near the hood with the ultraviolet light turned on. UV light can damage eyes and exposed skin very quickly. Only use the light for the minimum period of time necessary for disinfection, never more than 15 minutes. Note: NIH, CDC, and ABSA all discourage the use of UV as the primary means for disinfection.
- Work surfaces should be decontaminated with an appropriate disinfectant on a routine basis, after work with infectious materials is finished, and especially after spills, splashes, or other contamination by infectious materials.
- If the unit is not left running continuously, turn the blower on and air purge for at least five minutes to remove airborne contamination before the next use.
- Each laboratory should develop procedures which identify the hazards that will or may be encountered, and which specifies practices and procedures designed to minimize or eliminate risks.
- Laboratory personnel must receive appropriate training on the potential hazards associated with the work involved, including the necessary precautions to prevent exposures, and the exposure evaluation procedures.

Standards for Inspection: Each user is responsible for ensuring that fume hoods and biological safety cabinets are operating properly prior to use. Calvin arranges for annual inspections of fume hoods and BSCs to evaluate the airflow, sash, and overall condition of each hood. Hoods and BSC's will be posted with date of certification. Notify the Physical Plant if there are operation or maintenance concerns.

Standard repair or decommissioning procedures
When a request for equipment repair or transfer to another location is initiated, the following steps must be undertaken to ensure the safety of the employees responsible for repair or transfer if the equipment has been contaminated by hazardous chemicals:

1. Inform EHS and Physical Plant of the repairs and/or decommissioning of a hood or cabinet.

2. Remove chemical contaminants with an appropriate solvent or cleaning solution if it's safe to do so. If not, then tag the unit with caution and post a sign indicating that it is contaminated and not available for use.
3. Once contaminants have been eliminated, place sign indicating decontamination status in a prominent position on the equipment to be repaired or transferred.

10.0 HAZARDOUS MATERIAL HANDLING & STORAGE

The decision to use a hazardous material should be a commitment to handle and use the material properly from initial receipt to disposal.

Information on proper handling, storage, and disposal of hazardous materials are available to all employees at http://www.calvin.edu/admin/physicalplant/departments/ehs/ or by contacting EHS or the CHO. Always purchase the minimum amount necessary to maintain operations.

1. Chemical containers with missing or defaced labels should not be accepted.
2. Chemicals utilized in the laboratory or hood must be appropriate for the type and capacity of the ventilation system.
3. Hazardous biological materials should be manipulated using safety equipment and techniques appropriate to the risk group and the evaluated biosafety level of the specific experimental conditions. Biosafety cabinets used to protect researchers from biological hazards must be functioning properly, certified annually and appropriate to the biological and chemical hazards in use.
4. Hazardous materials should be stored in appropriate safety cabinets, closed cabinets or not more than five feet above the floor.
5. Chemicals shall be segregated by compatibility.
6. Hazardous material storage areas must be labeled as to their contents
7. Storage of hazardous materials at the lab bench or work area shall be kept to a minimum.
8. A hazardous material mixture shall be assumed to be as toxic as its most toxic component.
9. Substances of unknown toxicity shall be assumed to be toxic.

Transferring hazardous materials

When transporting hazardous materials outside the laboratory or research storeroom, precautions should be taken to avoid dropping or spilling them.

1. Carry glass containers in commercially available bottle carriers or other leak resistant, unbreakable secondary containers made of rubber or plastic, with a carrying handle.
2. When moving hazardous materials on a cart, use a cart suitable for the load and with raised edges to contain leaks/spills.
3. Use the one-glove method when in public spaces: the gloved hand will hold the chemical/material that you are transporting and the un-gloved hand will be used to touch common public touch points (door handles, elevator buttons, etc)

Biological Safety Cabinets

Biological Safety cabinets are among the most effective, as well as the most commonly used, primary containment devices in laboratories working with infectious agents. Class I and II biological safety cabinets, when used in conjunction with good microbiological techniques, provide an effective partial containment system for safe manipulation of moderate and some high-risk microorganisms.

It is imperative that Class I and II biological safety cabinets are tested and certified after installation, any time the cabinet is moved, and at least annually thereafter. Certification at locations other than the final site may attest to the performance capability of the individual cabinet or model but does not supersede the critical certification prior to use in the laboratory. Biological fume hoods are certified annually by Quality Air Services.

As with any other piece of laboratory equipment, personnel must be trained in the proper use of the biological safety cabinets. Of particular note are those activities which may disrupt the inward directional airflow through the opening of Class I and II cabinets. Aerosol particles can escape the cabinet in various ways. Among these are repeated insertion and withdrawal of workers' arms in and from the work chamber, opening and closing doors to the laboratory or isolation cubicle, improper placement or operation of materials or equipment within the work chamber, or brisk walking past the cabinet while it is in use.

Strict adherence to recommended practices for the use of biological safety cabinets is as important in attaining the maximum containment capability of the equipment as is the mechanical performance of the equipment itself. Always decontaminate the hood using procedures adopted by the laboratory after each use or at the end of the work day.

Hazards Subject to Prior Approval

It is the responsibility of the faculty/staff to evaluate hazards and identify lab activities that are sufficiently hazardous as to cause or have a significant potential to cause injury to employees and/or students. As a guide (and as a minimum), the activities discussed in the MIOSHA lab standard shall be reviewed and assessed for personnel exposure.

Be sure to check Calvin's policies and regulatory guidance on the use of animals and biological materials in teaching or research. These activities require Committee review prior to beginning any work.

Provisions for Particularly Hazardous Substances

Permissible Exposure Limits. The Laboratory Standard requires that employers, for laboratory uses of substances regulated by OSHA/MIOSHA, assure that employees' exposures do not exceed the Permissible exposure Limits (PELs). The PELs represent Time Weighted Averages (TWAs) in parts per million (ppm) or milligrams of substance per cubic meter of air (mg/m3). The TWA represents the ratio between exposure and work shift. PELs can be found in the Occupational Health Standard Part 301 of Michigan's Department of Labor and Economic Growth. An additional reference is the American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLVs), which are TWA values similar to the PELs. Refer to the SDS or MIOSHA's web site for exposure limits and related information.

Employee Exposure Determination. Employees must contact the EHS to perform exposure monitoring under the following circumstances:

1. Initial monitoring must be performed if there is reason to believe employee exposure levels routinely exceed the action level, or PEL.

2. Periodic monitoring must be performed when initial monitoring reveals an exposure. The employer must comply with exposure monitoring provisions of the relevant standard.

3. Employers must notify the employee of the monitoring results within 15 working days after receipt of monitoring results. Records of exposure monitoring data should be retained with the EHS department indefinitely.

Special Considerations. The MIOSHA Laboratory Standard requires that special precautions for additional employee protection be followed for the laboratory use of select carcinogens, reproductive toxins, and chemicals with a high degree of acute and chronic toxicity. Protection from these hazards is provided by assuring exposure to such hazards is minimized or eliminated. To minimize exposure, it is necessary to determine the route by which exposure may occur, whether by inhalation, absorption, injection, ingestion or a combination of exposure routes. To ensure employees do not receive exposures in excess of the PEL, hygienic standards have been established for many toxic materials. The following general hygiene standards should be observed when using select carcinogens, reproductive toxins, and chemicals with a high degree of acute and chronic toxicity.

1. Establish a designated area.
   a. Use and store materials only in designated areas such as a restricted access hood, glove box, or portion of a lab designated for use of highly toxic substances. Assure that all personnel with access are aware of necessary safety precautions and engineering controls are adequate.

b. Label all containers, storage and use areas appropriately. See section 12 for more detail.

2. Use proper containment devices for the protocol and chemical(s) being used.
   a. Use a hood or other containment device for procedures which may result in the generation of aerosols or vapors.
   b. It is recommended that breakable containers be stored in chemical-resistant trays. Work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.

3. Remove contaminated waste in accordance with Calvin waste disposal guidelines (see p. 22 for details)

4. Follow decontamination procedures prior to leaving the designated area.
   a. Before leaving the designated area, remove protective apparel. Place it in an appropriate, labeled container. Thoroughly wash hands, forearms, face, and neck.
   b. Thoroughly decontaminate or dispose of contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion to a less toxic product.
   c. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed.
   d. Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces contaminated with particulates. DO NOT DRY SWEEP.
   e. Protect vacuum pumps against contamination with scrubbers or HEPA filters and vent effluent into the hood.

5. Always take extra precautions when working with particularly hazardous substances.
   a. Consult the SDS for toxic properties and follow the specific precautions and procedures.
   b. Guard against spills and splashes. Appropriate safety apparel, especially gloves, should be worn. All hoods, glove boxes, or other essential engineering controls should be operating properly before work is started.
   c. Notify the lab manager immediately of all incidents of exposure or spills.

<u>Physical Hazard Provisions</u>
Physical hazards of chemicals are provided below. User must take certain precautions to avoid personal injury or property damage. Additionally, users should understand chemical incompatibilities and avoid storage or mixing practices that may cause a violent reaction or a toxic gas.

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

	Flash Point*	**Boiling Point**
Flammable		
Class IA	< 73°F (22.8°C)	< 100°F (37.8°C)
Class IB	< 73°F (22.8°C)	≥100°F (37.8°C)
Class IC	≥73°F (22.8°C) <100°F (37.8°C)	
Combustible		
Class II	≥100°F (37.8°C)&< 140°F (60°C)	
Class IIA	≥140°F (60°C)&< 200°F (93°C)	
Class IIIB	≥200°F (93°C)	

*Flash Point is defined as the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

For handling flammable/combustible materials, observe the following guidelines:

1. Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity.
2. Store in NFPA approved flammable liquid containers or storage cabinets, in an area isolated from ignition sources or in a special storage room designed for flammable materials.
3. Ensure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Assure bonding and grounding is checked periodically.
4. Assure appropriate fire extinguishers and/or sprinkler systems are in the area.

- Corrosives are materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface.

1. Containers and equipment used for storage and processing of corrosive materials should be corrosion resistant.
2. Eye protection and rubber gloves should always be used when handling corrosive materials. A face shield, rubber apron, and rubber boots may also be appropriate, depending on the work being performed.
3. Never add water to acid. When mixing concentrated acids with water, add the acid slowly to water.
4. An eyewash and safety shower must be readily accessible to areas where corrosives are used and stored. In the event of skin or eye contact with corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Obtain medical help.

- Oxidizers are materials that react with other substances by giving off electrons and undergoing reduction. This reaction may result in fire or explosion. The intensity of the reaction depends on the oxidizing-reducing potential of the materials involved. Know the reactivity of the materials involved in the experiment or process. Ensure there are no extraneous materials in the area that could become involved in a reaction. If the reaction is anticipated to be violent or explosive, use shields or other methods for isolating the materials or the process.

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

- Pyrophoric Materials are materials that ignite spontaneously upon contact with air. Often the flame is invisible. Examples of pyrophoric materials are silane, silicon tetrachloride, and white or yellow phosphorous. Pyrophoric chemicals should be used and stored in inert environments, and dated when received and opened.

- Peroxidizable Chemicals (Organic Peroxides) are materials which undergo auto-oxidation (a reaction with oxygen in the air) to form peroxides which can explode with impact, heat, or friction. Since these chemicals may be packaged in an air atmosphere, peroxides can form even though the container has not been opened, necessitating careful handling. Date all peroxidizables upon receipt and upon opening. Dispose of or check for peroxide formation after the recommended time depending on the chemical. See Appendix – Common Peroxide Forming Chemicals and Protocol for Detection and Inhibition of Peroxides. Do not open any container that is deformed or has obvious solid formation around the lid.

- Light-Sensitive Materials are materials that degrade in the presence of light, forming new compounds that can be hazardous, or resulting in conditions such as pressure build-up inside a container that may be hazardous. Examples of light sensitive materials include chloroform, tetrahydrofuran, ketones, and anhydrides. Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers that reduce or eliminate penetration of light.

- Unstable Materials are compounds that can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as peroxides, perchlorates (from perchloric acid), picric acid, and azides.

1. Contact the CHO when it is suspected that the inadvertent formation of shock-sensitive materials in ductwork, piping, or chemicals being stored has occurred.
2. Date all containers of explosive or shock-sensitive materials upon receipt and when opened.
3. Store containers of shock sensitive or explosive materials in unbreakable secondary containers, away from heat and direct sunlight.
4. If there is a chance of explosion, use barriers or other isolation methods.

- Cryogens are liquefied gases that can condense oxygen from the air to create an oxygen rich atmosphere in the nitrogen solution; increasing the potential for fire if flammable or combustible materials are present. Asphyxiation and container over-pressurization are significant hazards due to the large expansion ratio from liquid to gas (700 to 1). Many materials become brittle at extremely low temperatures. Brief contact with materials at extremely low temperatures can cause burns similar to thermal burns. Some of the hazards associated with cryogens are fire, pressure, weakening of materials, and skin or eye burns upon contact with the liquid.
  - Equipment should be kept clean, especially when working with liquid or gaseous oxygen.
  - Gases or fluids should be controlled to prevent formation of flammable or explosive mixtures.
  - Always wear safety glasses with side shields or goggles when handling. If there is a chance of a splash or spray, a full-face protection shield, an impervious apron or coat, cuffless trousers, and high-topped shoes should be worn. Watches, rings, and other jewelry should not be worn. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen spill. Potholders could also be used.
  - Containers and systems containing cryogens should have pressure relief mechanisms.
  - Containers and systems should be capable of withstanding extreme cold without becoming brittle.
  - Since glass ampoules can explode when removed from cryogenic storage if not sealed properly, storage of radioactive, toxic, or infectious agents should be placed in plastic cryogenic storage ampoules. Reheat cold sample containers slowly.

Radioactive Material

The use of radioactive materials and equipment that produces ionizing and non ionizing radiation is strictly controlled. Faculty and staff working with radioactive materials are required to follow the safety practices documented in the respective Plans and Calvin's Radiation Safety Plan. In order to work in the area, personnel monitoring devices may be required to monitor for exposure. If there are any questions regarding the information or requirements of working in the area, review the Radiation Safety Program or contact the Radiation Safety Officer (RSO).

Biological Material Hazards

Use of biological materials requires a review by the BSO, Lori Keen. In some cases, your work may need to be reviewed by the Institutional Biosafety Committee. Refer to Calvin's Biosafety Manual.

NIH Guidelines for Research involving Recombinant DNA Molecules

The 2013 NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules defines levels of review necessary for this type of research, responsibilities of institutions, and investigators, physical and biological containment for research. These guidelines apply to all institutions receiving NIH funding for any research.

11.0 COMPRESSED GASES

Special systems are needed for handling materials under pressure. Cylinders pose mechanical, physical and/or health hazards, depending on the compressed gas in the cylinder.

1. Cylinders with regulators must be individually secured. Only cylinders with valve protection caps securely in place may be safely gang-chained (chained in groups).
2. When storing or moving a cylinder, have the valve protection cap securely in place to protect the stem.
3. Cylinders must be secured in an upright position at all times. Use suitable racks, straps, chains, or stands to support cylinders against an immovable object, such as a bench or a wall, during use and storage. Do not allow cylinders to fall or lean against one another.

4. Use an appropriate cart to move cylinders.
5. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
6. Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Use an oxygen approved regulator.
7. Always wear goggles or safety glasses with side shields when handling compressed gases.
8. Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled.
9. When work with a toxic, corrosive, or reactive gas is planned, the CHO should be contacted for information concerning specific handling requirements. Generally, these gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.
10. Outside contractors/suppliers have been hired to exchange empty cylinders with full ones. Faculty and staff should limit moving cylinders, but when necessary, use the cylinder restraint cart.

12.0 STANDARD LABORATORY SAFE HANDLING / STORAGE REQUIREMENTS

<u>Hazard Identification</u>

At a minimum, hazardous material containers must have the chemical name(s) and hazard identification(s). With respect to identifying containers, storage areas and laboratory entranceways, the following guidelines should be followed. These responsibilities can be delegated to someone who has received adequate training but the ultimate responsibility lies with the lab supervisor and faculty/staff who are using or directing the use of the material.

1. Labels on incoming containers of hazardous materials for laboratory use may not be removed or defaced. Labels contain information on the identity and the hazards associated with the material. It is recommended that incoming containers be labeled with the department or user name and date received.
2. Laboratory containers must be labeled (i.e.: bottles filled from the original container).
3. Hazardous material storage areas must be labeled per the guidelines established in section.

<u>Labeling</u>

As a rule, all containers must be labeled with the name of the contents and the hazard(s), if not provided by the manufacturer. If a material has more than one hazard, it must be labeled with both hazards. Additionally, the subsequent guidelines shall be followed:

No hazardous chemicals and/or substances will be accepted for use at Calvin College, or shipped to any other location unless they are clearly labeled with the following information:

1. The identity of the hazardous material and proper safety precautions
    - a. For containers labeled by the manufacturer:
        - i. Inspect the labeling on incoming containers.
        - ii. Replace damaged or semi-attached labels.
    - b. For transferred products or prepared solutions labeled by the user:
        - i. Label each chemical container with the chemical name and hazard warning
        - ii. Refer to the SDS for hazard warning
    - c. For labeling multiple small containers using the box or tray method:
        - i. Put containers in box or tray.
        - ii. Label tray with chemical name and hazard warning
        - iii. If containers are removed from the box/tray, they must be properly labeled or returned to the box or tray within the work-shift.
    - d. Peroxide Forming Chemicals must be labeled with: Date received, opened, tested, and results.

2. The appropriate hazard warnings as outlined in the Federal Right to Know Standard.
    - a. All hazardous chemical labels must be clearly legible and prominently displayed on the container
    - b. If the chemical in question is subject to any special regulatory provisions - such as Michigan class "A" carcinogen, then said chemical must be labeled in accordance with the provision.
    - c. In work situations involving stationary process containers or any process that might create a health hazard during the normal completion of a given task (welding, for instance) the label can be replaced

by a sign, placard or batch ticket indicating the identity and nature of the hazard. These warnings must be readily visible to employees.

d. Any portable vessel containing hazardous chemicals that will not be used on the work shift during which the container was filled, must be labeled with the appropriate hazard information.
e. No label may be removed or defaced unless a substitute is immediately provided. Employees must not remove or deface any label without express consent from a supervisor or appointed Chemical Hygiene Officer. The OSHA Compliance Directive states that, before any product can be used, the proper label must be present. Any container without a label should be reported by the employee to his/her supervisor.
f. The identity on the container label must read exactly as it does on the Safety Data Sheet. If a trade name is used on the SDS, then a trade name should be on the label. If the chemical name is used on the SDS, then the container should be labeled accordingly.
g. Anything available over the counter as a "consumer product" to the public is exempt from labeling requirements if it has already been labeled by the manufacturer and the label is intact.

A summary of the new Hazard Communication GHS pictogram and hazard warnings are below:

Waste Containers. All hazardous chemical waste should be segregated and labeled according to Calvin waste disposal guidelines. Special attention should be given to the following areas:

1. Glass containing no hazardous material must be kept in receptacles labeled "Broken Glass".

2. Chemical waste is to be collected in containers labeled "Hazardous Waste", the category of hazard, the specific chemical or reagent if known and the date.

13.0 HAZARDOUS WASTE DISPOSAL

Each laboratory has a designated space where hazardous waste is accumulated. All such waste must be collected in the lab in clearly labeled bottles that are tightly capped. It is recommended that waste be reagent/chemical specific, but waste reagents may be mixed if they are of the same category of waste and not capable of reacting with other wastes stored in the same container. When waste is ready for storage, it may be moved to SB055 by a lab manager or EHS.

Procedures for waste disposal are as follows:

1. Hazardous waste is accumulated in the Hazardous Waste Storage room, SB055. Instructions are provided on the door of the storage room for inventorying and labeling of waste containers.
2. A licensed waste hauler is contracted to make hazardous waste pickups every 180 days.
3. Manifest tracking
   a) Designated person from Calvin signs off on pick-up,
   b) Calvin retains the Initial Generator Copy and records the manifest number in the tracking log.
   c) Transporter keeps remaining copies to be signed by the transporter and the treatment, storage, and disposal facility (TSDF) after completion of the delivery.
   d) The signed Designated Facility To Generator (DFTG) copy is mailed back to Calvin after delivery is complete.
   e) Calvin keeps the DFTG copy.

14.0 EMERGENCY PROCEDURES

The following situations identify emergencies that may be expected due to hazards found in laboratory areas:

1. There is a spill of an unknown chemical.
2. The release requires evacuation.
3. The release involves or poses a threat of:
   .. fire, suspected fire, explosion or other imminent danger,
   .. conditions that are Immediately Dangerous to Life and Health (IDLH),
   .. high levels of exposure to toxic substances.
4. The person(s) in the work area is uncertain they can handle the severity of the hazard with the personal protective equipment (PPE) and response equipment that has been provided and/or the exposure limit could easily be exceeded.

Only trained employees may respond to an emergency. If you have not received training, specific for the emergency and subsequent response, call the emergency contact number(s) on Page 2 of this Plan. After the situation has been made safe, an incident report should be completed describing the cause, response actions, current condition, and identifying any persons who may have been exposed.

<u>In case of chemical spill:</u>
If the chemical spill is considered a low-hazard spill (as defined below), and you are properly trained and aware of the hazards presented by the spill, then follow the procedures outlined in Appendix A of the Spill Plan or in the SDS. If you are uncomfortable with the situation or need assistance, contact Campus Safety promptly.

If the chemical spill is considered a high-hazard or emergency spill (as defined below), do NOT attempt to clean up the spill. Evacuate the area and report the incident immediately to Campus Safety at x3-3333. Campus Safety & a member of the Spill Advisory Team will determine the need for outside assistance.

Emergency Spill: A hazardous material spill where any of the following are true:

- People have symptoms of exposure (dizziness, headaches, eyes are burning, breathing difficulties, skin is affected)
- Chemicals are mixing and heat or vapors are being released

- Spilled material can't be identified
- People involved are unsure of the spill type or how to respond
- Building has been evacuated
- The hazardous material is flammable, explosive, under pressure, radioactive, infectious or highly toxic

High Hazard Spill: A spill/release that is immediately dangerous to life or health, involves a large area (i.e., an entire lab), there are injured personnel, involves material that is radioactive, infectious, toxic, corrosive or reactive. If you do not know the nature of the emergency or are in any way uncertain as to how to identify or classify the spill, use the Emergency Spill procedures and contact EHS immediately.

***High-Risk Areas*:** Areas deemed to have a higher risk of a chemical spill. These areas include: Grounds, Paint, Transportation, Chemistry, Biology and Engineering

***Low Hazard Spill*:** A small (i.e., localized within a few square feet) spill that does not present a fire hazard or involves low to moderately toxic material. In this situation, employees who have received training may follow the precautions and procedures outlined in the chemical's SDS to clean-up the spill after consulting with EHS.

Spill Advisory Team: Faculty and staff that have received training in emergency response and chemical hazards and have special knowledge and/or experience in chemical spill response. The team consists of Jennifer Ambrose, Heather Chapman, Jim Potter, and Mike Barbachyn. These team members can serve as advisors in the event of a spill when determining if outside expertise is required.

<u>In case of fire</u>:
The following describes the expected response for faculty and staff when responding to a fire or fire-related emergency in a laboratory. There are two; minor or incipient fires and those that are larger and may involve the structure of the facility, room, or building. Calvin faculty and staff, who have received proper training, may (voluntarily) respond to incipient fires by using the nearest fire extinguisher. For larger fires, the proper response is;

1. Pull the fire alarm, if available
2. Evacuate to a safe location.
3. Notify Campus Safety by calling 526-3333 or 3-3333 using a campus phone.

<u>In case of power outages</u>:
Emergency lighting is provided for emergency egress. If emergency lighting and fire alarms ARE NOT operable, evacuate the building. If adequate lighting is provided, leave the area after the following steps have been taken.

1. Place lids on all open containers of volatile chemicals
2. Lower the sash on chemical fume hoods
3. Shut down all equipment (leave cooling water and purge gases on as necessary)
4. Turn off ignition sources
5. Secure or isolate reactions that are underway (boiling liquid on a hot plate, distillations)
6. Close fire doors
7. Take your books, coats, purse/wallet, keys, etc.
8. Lock outside door to lab

In anticipation of possible power outages, emergency preparedness should include:
1. a flashlight or other emergency lighting,
2. communication of emergency contact numbers (it's a good idea to program emergency numbers into your cell phone)

<u>In case of injury:</u>
For medical emergencies dial 3-3333 from a campus phone. For employees seeking non-emergency medical treatment, you may use a nearby first aid cabinet and/or contact Campus Safety for first response (x66452). Injured students seeking non-emergency medical attention are to make their own decisions regarding their medical care. The supervisor or instructor must ensure the appropriate injury report forms are completed. If you have any questions regarding injury and illness procedures, contact your supervisor or EHS.

Eye Splash:

1. Remove victim from spill area only if an attempt to rescue does not present a danger to the rescuers.
2. Lead the victim(s) immediately to an emergency eyewash facility.
3. Assist the victim as needed. The goal is to flush the eyes and upper portion of the face.
4. Flush for at least 15 minutes or longer if pain persists.
5. Contact the CHO and/or EHS and inform them of the incident and possible chemical(s) involved.

Chemical Body Splash:

1. Remove victim(s) from the spill area to fresh air only if an attempt to rescue victim(s) does not present a danger to the rescuers.
2. Don appropriate personal protective equipment (gloves, eye protection, etc.)
3. Remove contaminated clothing while under an emergency shower.
4. Flood affected area of the body with cold water for at least 15 minutes or longer if pain persists.
5. Wash skin with mild soap and water – do not use neutralizing chemicals, creams, lotions or salves.
6. Contact the CHO and/or EHS and inform them of the incident and possible chemical(s) involved.

Whenever emergency shower or eye wash stations are used, inform EHS.

15.0 STANDARD LABORATORY REQUIREMENTS

Signs and information

Labels and warning signs should alert employees to potentially hazardous materials and allow those unfamiliar with the laboratory surroundings to identify hazardous chemical use and storage areas, safety facilities, emergency equipment, exits, and aid emergency response personnel. (Signs and labels are generally available from the Lab Manager or EHS.) The following signs have been posted in areas readily accessible. They include:

1. The Michigan Right-to-Know law poster, listing the location of SDSs for all hazardous chemicals used in the laboratory
2. Emergency contact numbers are posted on the doorway leading out into a corridor.

Safety Data Sheets (SDSs)

A Safety Data Sheet (SDS) is a document containing chemical hazard identification and safe handling information and is prepared in accordance with the OSHA Global Harmonization System (Hazard Communication) and the Michigan Right-to-Know law. Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals an appropriate SDS for each hazardous chemical/product purchased. Contact your lab manager if you would like to review a SDS.

Restricted Access and Designated Areas

Facilities containing certain hazards must have warning signs posted at the designated area of the laboratory where the hazard exists, and at the entranceway to the laboratory. Any areas placarded as such are restricted access, designated areas, and have certain standards regarding training and use by employees. Such hazards include:

1. MIOSHA carcinogens
2. HIV and HBV research laboratories and production facilities
3. Biological agents that require Biosafety Level 2 or BSL2+ controls
4. Sources of ionizing radiation
5. Radioisotopes and radiolabeled materials
6. Areas with high magnetic fields, UV light, laser usage, or radio frequency generators

Other hazards will be addressed on a case-by-case basis with consultation from the CHO and/or EHS.

Storage Areas

Chemicals should be stored according to compatibility as designated by hazard classes. Particularly hazardous chemicals should be stored and handled with extreme care. When ordering chemicals that are unfamiliar, request and review the SDS before purchase. To make sure that proper use and storage guidelines are understood. Assure that the following areas are labeled and chemicals are stored appropriately:

1. Carcinogens
2. Corrosives
3. Flammable Liquids
4. Flammable Solids
5. Oxidizers
6. Perchloric Acid
7. Biosafety Level 2 or higher

Additionally, storage areas for biohazardous agents and radioisotopes should be appropriately labeled. Please contact the CHO or the RSO for information.

Control measures

Calvin has identified control measures to reduce employee exposure to hazardous materials. The three primary types of control measures are:

1. Administrative Controls: methods of controlling employee exposures to contaminants by job rotation, work assignment or time periods away from contaminant. Examples include Standard Operating Procedures, Chemical Hygiene Plan, and Safety Manuals.
    - Use training and education as primary administrative controls for reducing exposures.
    - Substitute less harmful chemicals whenever possible.
    - Change or alter processes to minimize exposure.

2. Engineering Controls: methods of controlling employee exposures by modifying the source or reducing the quantity of contaminants released into the work environment. Examples include fume hoods and biosafety cabinets.
    - Isolate or enclose a process or work operation to reduce the number of employees potentially exposed (i.e. fume hood, glove box, etc.).
    - Use local exhaust ventilation (hoods) at the point of generation or dispersion of contaminants and use dilution (general) ventilation to reduce air contaminant concentrations.
    - Use wet methods to reduce the generation of dust.
    - Use special control methods such as shielding and continuous monitoring devices to control exposures in special situations.
    - Practice good housekeeping procedures to reduce unnecessary exposures.

3. Personal Protective Equipment (PPE): personal safety equipment designed for secondary employee protection from hazardous chemicals. Examples include gloves and lab coats.

Control measures are required when the following circumstances are met:
1. Whenever employees use hazardous materials.
2. Whenever employee exposures exceed the action level (or, in the absence of an action level, the Permissible Exposure Limit, the published exposure limit or the Threshold Limit Value).
3. Upon addition of new chemicals or changes in procedures.
4. Other situations will be addressed on a case-by-case basis. Please consult the CHO for assistance in establishing the appropriate control measure.

Use the following primary methods for detecting exposures:
1. Determine the source of exposure.
2. Determine the path the contaminant follows to reach the employee
3. Determine the employee's work pattern and use of personal protective equipment.
4. Change one or more of the above pathways to reduce or eliminate exposure.

PPE and safety equipment
1. Calvin will provide necessary engineering controls and safety equipment to all employees to maintain a safe working environment. It is the employee’s responsibility to ensure proper use and care of such equipment.

2. Each lab will assess its operations and hazards, to determine the necessary personal protective equipment (PPE) necessary to adequately protect employees. The lab manager or faculty member is responsible for hazard evaluation, PPE determination, and enforcement of required PPE rules in their lab. In common or prep areas, departmental leaders and faculty are ultimately responsible for ensuring that they follow and enforce PPE requirements.
3. Each laboratory must evaluate lab specific tasks to determine what PPE is recommended or required. A hazard assessment must be done in order to evaluate PPE choices and document for all laboratory tasks.
4. The SDS will provide some information on the PPE and safety procedures recommended for a given chemical, though the SDS may not provide sufficient information concerning the specific type of safety equipment required (for example, it may say "use gloves" but not list the best type of glove to use).

Eye and Face Protection

Eye protection is available to all employees or visitors to laboratories where chemicals are used and stored. Protective eye and face equipment must be used where there is a reasonable probability of injury from hazardous materials that can be prevented from such equipment.

The laboratory manager establishes the minimum level of eye protection needed for the laboratory activity. Specialized types of eye protection, such as ultraviolet light restricting safety glasses, are available on an as needed basis. All eye protective devices for laboratory use must meet ANSI standards and be stamped with "Z87" by the manufacturer. If the eye protection is not so marked, it may not meet minimum eye safety protection standards.

Note that the wearing of safety glasses does not excuse employees from the requirement of wearing safety goggles.

1. Safety glasses with side shields offer minimal protection against flying fragments, chips, particles, sand, and dirt. Safety Glasses are the minimum level of eye protection required when an impact hazard exists or when working with hazardous materials. Safety glasses are acceptable when:

    a. Pipeting or using syringes to transfer hazardous materials
    b. Handling closed bottle of hazardous materials
    c. Mixing solutions of hazardous materials
    d. Opening centrifuge tubes

2. Safety goggles (impact goggles) offer adequate protection against flying particles. These should be worn when working with glassware under reduced or elevated pressure or with drill presses, grinders or other similar conditions.

3. Chemical splash goggles have indirect venting for splash proof sides, which provide adequate protection against splashes. Chemical splash goggles offer the best eye protection from chemical splashes. Impact goggles should not be worn when danger of a splash exists. Chemical Splash Goggles are required when working with corrosive or injurious chemicals and a reasonable probability of splash exists, for example:

    a. Pouring acid out of a 1 pint bottle
    b. Pouring methylene chloride from a 1 liter bottle
    c. Working with liquids under pressure

4. Face shields protect the face and neck from flying particles and splashes. Always wear additional eye protection under face shields. Ultra-violet lightface shields should be worn when working over UV light sources. Face Shield and Chemical Splash Goggles are required when working with larger quantities of corrosive chemicals or a high probability of eye and face injury exists such as:

    a. Working with an acid bath
    b. Pouring 4 liters of acid into a container
    c. Handling highly reactive chemicals that may spatter

Note: Ordinary prescription glasses do not provide adequate protection against eye injury. Eye protection equipment must be ANSI Z87 approved.

Protection of Skin and Body

Skin and body protection involves the use of protective clothing to protect individuals from chemical exposure. Determine clothing needed for the chemical being used, as protective garments are not equally effective for every hazardous chemical. Some chemicals will permeate a garment in a very short time, whereas others will not.

1. The basic and most effective forms of protection are gloves and lab coats.
2. Protect exposed skin surfaces when there is a reasonable anticipation of a splash.
3. Open toed shoes and sandals are not permitted in labs.
4. Even when there is minimal danger of skin contact with an extremely hazardous substance, lab coats, coveralls, aprons, or protective suits should be utilized. These garments should not leave the lab.
5. Exposures to strong acids and acid gases, organic chemicals and strong oxidizing agents, carcinogens, and mutagens require the use of specialized protective equipment that prevents skin contamination. Impervious protective equipment must be utilized. Examples include rubber gloves, aprons, boots, and protective suits.

Safety Equipment

Safety Showers are required to provide an immediate water drench of an affected person. MIOSHA has adopted the following ANSI standards for location, design, and maintenance of safety showers:

1. Showers are located within 25 feet of areas where chemicals with a pH of < 2.0 or > 12.5 are used.
2. Showers are located within 100 feet of areas where chemicals with a pH between 2 and 4 or 9 and 12.5 are used.
3. Shower location is to be clearly marked, well lighted, and free of obstacles, closed doors, or turns.
4. Safety showers are checked and flushed periodically.

Eyewash Facilities are required in all laboratories where injurious or corrosive chemicals are used or stored and are subject to the same proximity requirements as safety showers. MIOSHA has adopted the following ANSI standards for location, design, and maintenance of emergency eyewash facilities:

1. Optimally, those affected must have both hands free to hold open the eye to ensure an effective wash behind the eyelids. This means providing eyewash facilities that are operated by a quick release system and simultaneously drench both eyes.
2. Eyewash facilities will provide the minimum of a 15-minute water supply at no less than 0.4 gallons per minute.
3. Eyewash facilities should be checked and flushed at a minimum between semesters (3 times per year). A log documenting flushes is recommended.

16.0 REVISIONS

Revision	Date	Description
1	8/2/2010	Changed formatting;
2	1/29/15	CHO edited sections 2.0, 4.0 (general responsibilities/EHS/Faculty/Lab Mgrs), 5.0 (exposure assessment), 8.0 (SOPs), 9.0 (vacuum operations), 10.0 (transferring haz mat), EHS Officer updated to reflect current NIH Guidelines, 12.0 (labeling and included pictogram), 14.0 (updated spill advisory team), 15.0 (PPE ANSI standard reference); EHS Officer included links for GHS and NIH Guidelines

APPENDICES

APPENDIX A

INCOMPATIBILITY OF COMMON LABORATORY CHEMICALS

When certain hazardous chemicals are stored or mixed together, violent reactions may occur because the chemicals are unsuitable for mixing, or are *incompatible*. Classes of incompatible chemicals should be segregated from each other during storage, according to hazard class. Use the following general guidelines for hazard class storage:

1. Flammable/Combustible Liquids and Organic Acids
2. Flammable Solids
3. Mineral Acids
4. Caustics
5. Oxidizers
6. Perchloric Acid
7. Compressed Gases

Before mixing any chemicals, refer to this partial list, the chemicals' SDS's, or contact the Chemical Hygiene Officer to verify compatibility:

CHEMICAL	INCOMPATIBLE CHEMICAL(S)
Acetic acid	aldehyde, bases, carbonates, hydroxides, metals, oxidizers, peroxides, phosphates, xylene
Acetylene	halogens (chlorine, fluorine, etc.), mercury, potassium, oxidizers, silver
Acetone	acids, amines, oxidizers, plastics
Alkali and alkaline earth metals	acids, chromium, ethylene, halogens, hydrogen, mercury, nitrogen, oxidizers, plastics, sodium chloride, sulfur
Ammonia	acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, sulfur
Ammonium nitrate	acids, alkalis, chloride salts, combustible materials, metals, organic materials, phosphorous, reducing agents, urea
Aniline	acids, aluminum, dibenzoyl peroxide, oxidizers, plastics
Azides	acids, heavy metals, oxidizers
Bromine	acetaldehyde, alcohols, alkalis, amines, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.), metals, sulfur
Calcium oxide	acids, ethanol, fluorine, organic materials
Carbon (activated)	alkali metals, calcium hypochlorite, halogens, oxidizers
Carbon tetrachloride	benzoyl peroxide, ethylene, fluorine, metals, oxygen, plastics, silanes
Chlorates	powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid	acetone, alcohols, alkalis, ammonia, bases
Chromium trioxide	benzene, combustible materials, hydrocarbons, metals, organic materials, phosphorous, plastics
Chlorine	alcohol's, ammonia, benzene, combustible materials, flammable compounds (hydrazine), hydrocarbons (acetylene, ethylene, etc.), hydrogen peroxide, iodine, metals, nitrogen, oxygen, sodium hydroxide
Chlorine dioxide	hydrogen, mercury, organic materials, phosphorous, potassium hydroxide, sulfur
Copper	calcium, hydrocarbons, oxidizers
Hydroperoxide	reducing agents
Cyanides	acids, alkaloids, aluminum, iodine, oxidizers, strong bases
Flammable liquids	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	alcohol's, aldehydes, ammonia, combustible materials, halocarbons, halogens, hydrocarbons, ketones, metals, organic acids
Hydrocarbons (Such as butane, propane benzene, turpentine,	acids, bases, oxidizers, plastics

etc.)	
Hydrofluoric acid	metals, organic materials, plastics, silica (glass), (anhydrous) sodium
Hydrogen peroxide	acetylaldehyde, acetic acid, acetone, alcohol's carboxylic acid, combustible materials, metals, nitric acid, organic compounds, phosphorous, sulfuric acid, sodium, aniline
Hydrogen sulfide	acetylaldehyde, metals, oxidizers, sodium
Hypochlorites	acids, activated carbon
Iodine	acetylaldehyde, acetylene, ammonia, metals, sodium
Mercury	acetylene, aluminum, amines, ammonia, calcium, fulminic acid, lithium, oxidizers, sodium
Nitrates	acids, nitrites, metals, sulfur, sulfuric acid
Nitric acid	acetic acid, acetonitrile, alcohol's, amines, (concentrated) ammonia, aniline, bases, benzene, cumene, formic acid, ketones, metals, organic materials, plastics, sodium, toluene
Oxalic acid	oxidizers, silver, sodium chlorite
Oxygen	acetaldehyde, secondary alcohol's, alkalis and alkalines, ammonia, carbon monoxide, combustible materials, ethers, flammable materials, hydrocarbons, metals, phosphorous, polymers
Perchloric acid	acetic acid, alcohols, aniline, combustible materials, dehydrating agents, ethyl benzene, hydriotic acid, hydrochloric acid, iodides, ketones, organic material, oxidizers, pyridine
Peroxides, organic	acids (organic or mineral)
Phosphorus (white)	oxygen (pure and in air), alkalis
Potassium	acetylene, acids, alcohols, halogens, hydrazine, mercury, oxidizers, selenium, sulfur
Potassium chlorate	acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic materials, sugars
Potassium perchlorate (also see chlorates)	alcohols, combustible materials, fluorine, hydrazine, metals, organic matter, reducing agents, sulfuric acid
Potassium permanganate	benzaldehyde, ethylene glycol, glycerol, sulfuric acid
Silver	acetylene, ammonia, oxidizers, ozonides, peroxyformic acid
Sodium	acids, hydrazine, metals, oxidizers, water
Sodium nitrate	acetic anhydride, acids, metals, organic matter, peroxyformic acid, reducing agents
Sodium peroxide	acetic acid, benzene, hydrogen sulfide metals, oxidizers, peroxyformic acid, phosphorous, reducers, sugars, water
Sulfides	Acids
Sulfuric acid	potassium chlorates, potassium perchlorate, potassium permanganate

References:

Safety Data Sheets, various chemical companies.

APPENDIX B

COMMON LABORATORY FLAMMABLE AND COMBUSTIBLE CHEMICALS

Flammable and combustible chemicals are the most commonly used hazardous chemicals. The hazard of a flammable or combustible chemical is based on its flash point, and, in the case of a flammable chemical, its boiling point as well. The National Fire Protection Association (NFPA) has identified flammability classes from the flash point and boiling point data of chemicals. The following table lists some common flammable and combustible chemicals, their flash points and boiling points, and associated NFPA flammability classes:

Chemical	Flash Point		Boiling Point		NFPA Class
	° F	° C	° F	° C	
Acetaldehyde	-38	-39	69	21	IA
Dimethyl sulfide	-36	-38	99	37	IA
Ethyl ether	-49	-45	95	35	IA
Ethylene oxide	-20	-29	55	13	IA
Pentane	-57	-49	97	36	IA
Propane	-157	-105	-44	-42	IA
Benzene	12	-11	176	80	IB
Carbon disulfide	-22	-30	115	46	IB
Cyclohexane	-4	-20	179	81	IB
Ethyl alcohol	55	13	173	78	IB
n-Hexane	-7	-22	156	69	IB
Isopropyl alcohol	53	12	180	82	IB
Methyl alcohol	52	11	149	65	IB
Methyl ethyl ketone	16	-9	176	80	IB
Pyridine	68	20	239-241	116	IB
Tetrahydrofuran	6	-14	153	67	IB
Toluene	40	4	231	111	IB
Triethylamine	20	-7	193	89	IB
tert Butyl isocyanate	80	27	185-187	85-86	IC
Chlorobenzene	82	28	270	132	IC
Epichlorohydrin	88	31	239-243	115-117	IC
2-Nitropropane	75	24	248	120	IC
Xylene	81-90	27-32	280-291	138-144	IC
Acetic Acid, glacial	103	39	244	48	II
Bromobenzene	118	48	307-316	153-158	II
Formic Acid	156	69	213	101	II
Morpholine	100	38	263	128	II
Stoddard Solvent	100-140	38-60	300-400	150-200	II
Benzaldehyde	145	63	352	178	IIIA
Cyclohexanol	154	68	322	161	IIIA
Methacrylic Acid	170	77	316	158	IIIA
Nitrobenzene	190	88	412	211	IIIA
Tetrahydronaphthalene	160	71	406	208	IIIA
Benzyl Alcohol	213	101	401	205	IIIB
Caproic Acid	215	102	400	204	IIIB
Ethylene Glycol	232	111	388	198	IIIB
Phenyl Ether	239	115	498	258	IIIB
Stearic Acid	385	196	726	386	IIIB

References: Safety Data Sheets and the National Fire Protection Agency document "NFPA 321: Classification of Flammable and Combustible Liquids, 1991 Edition."

APPENDIX C

FLAMMABLE AND COMBUSTIBLE LIQUID CONTAINMENT AND STORAGE REQUIREMENTS

Containment:

Only approved containers and metal portable tanks authorized by NFPA (National Fire Protection Association) 30 shall be used to store flammable liquids.

	Flammable Class			Combustible Class	
Container	**IA**	**IB**	**IC**	**II**	**III**
Glass	1 pt*	1 qt*	1 gal	1 gal	5 gal
Metal or Approved Plastic	1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	2 gal	5 gal	5 gal	5 gal	5 gal
Metal Drums	60 gal	60 gal	60 gal	60 gal	60 gal
Approved Metal Portable Tanks	660 gal	660 gal	660 gal	660 gal	660 gal
Polyethylene	1 gal	5 gal	5 gal	60 gal	60 gal

*Class IA and IB liquids may be stored up to one gallon in glass containers if liquid purity would be affected by storage in metal containers or if metal containers could undergo excessive corrosion by the contained liquid.

Storage

Only NFPA 45 approved amounts of flammable liquids shall be stored in laboratory units outside of flammable liquid storage rooms.

Flammable / Combustible Class	Maximum Quantity per 100ft^2 of Laboratory Unit	Maximum Quantity per Laboratory Unit	
List as Class A Lab		Unsprinklered	Sprinklered
I	20 gallons	600 gallons	1200 gallons
I, II and IIIA	40 gallons	800 gallons	1600 gallons
List as Class B Lab			
I	10 gallons	300 gallons	600 gallons
I, II and IIIA	20 gallons	400 gallons	800 gallons
List as Class C Lab			
I	4 gallons	150 gallons	300 gallons
I, II and IIIA	8 gallons	200 gallons	400 gallons

- The amounts above include quantities stored in approved storage cabinets and safety cans. Allowable quantities stored outside of approved storage cabinets and safety cans are 50% of the quantities listed above.
- Laboratories listed as Class A shall be considered high hazard laboratories and **shall not be used as instructional laboratories.**
- Laboratories listed as Class B shall be considered intermediate hazard laboratories.
- Laboratories listed as Class C shall be considered low hazard laboratories.
- **Should Class B or C laboratories be used for instructional purposes, quantities of flammable and combustible liquids shall be 50% of those listed in the above table.**

APPENDIX D

COMMON LABORATORY CORROSIVES

ORGANIC ACIDS	ORGANIC BASES	INORGANIC ACIDS
Formic Acid	Ethylenediamine	Hydrofluoric Acid
Acetic Acid (Glacial)	Ethylimine	Hydrochloric Acid
Propionic Acid	Tetramethylethylenediamine	Hydrobromic Acid
Butyric Acid	Hexamethylenediamine	Hydriotic Acid
Chloroacetic Acid	Trimethylamine aq. soln.	Sulfuric Acid
Trichloroacetic Acid	Triethylamine	Chromerge™
Acetyl Chloride	Phenylhydrazine	No-Chromix™
Acetyl Bromide	Piperazine	Chlorosulfonic Acid
Chloroacetyl Chloride	Hydroxylamine	Sulfuryl Chloride
Oxalic Acid	Tetramethylammonium	Bromine Pentafluoride
Propionyl Chloride		Thionyl Chloride
Propionyl Bromide	**ELEMENTS**	Tin Chloride
Acetic Anhydride	Fluorine (gas)	Tin Bromide
Methyl Chloroformate	Chlorine (gas)	Titanium Tetrachloride
Dimethyl Sulfate	Bromine (liquid)	Perchloric Acid
Chlorotrimethylsilane	Iodine (crystal)	Nitric Acid
Dichlorodimethylsilane	Phosphorus	Phosphoric Acid
Phenol		Phosphorus Trichloride
Benzoyl Chloride		Phosphorus Tribromide
Benzoyl Bromide	**INORGANIC BASES**	Phosphorus Pentachloride
Benzyl Chloride	Ammonium Hydroxide	Phosphorus Pentoxide
Benzyl Bromide	Calcium Hydroxide	
Salicylic Acid	Sodium Hydroxide	
	Potassium Hydroxide	**ACID SALTS**
	Calcium Hydride	Aluminum Trichloride
	Sodium Hydride	Antimony Trichloride
	Hydrazine	Ammonium Bifluoride
	Ammonium Sulfide	Calcium Fluoride
	Calcium Oxide	Ferric Chloride
		Sodium Bisulfate
		Sodium Fluoride

References:

The Foundations of Laboratory Safety, S. R. Rayburn, 1990.
Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, 1981.
Improving Safety in the Chemical Laboratory, 2nd Ed., J. A. Young, 1991. Safety Data Sheets, various chemical companies.

APPENDIX E

COMMON LABORATORY OXIDIZERS

Oxidizers react with other chemicals by giving off electrons and undergoing reduction. Uncontrolled reactions of oxidizers may result in a fire or an explosion, causing severe property damage or personal injury. Use oxidizers with extreme care and caution and follow all safe handling guidelines specified in the SDS.

Bleach
Bromates
Bromine
Butadiene
Chlorates
Chloric Acid
Chlorine
Chlorite
Chromates
Chromic Acid
Dichromates
Fluorine
Haloate
Halogens
Hydrogen Peroxide
Hypochlorites
Iodates
Mineral Acid
Nitrates
Nitric Acid

Nitrites
Nitrous oxide
Ozanates
Oxides
Oxygen
Oxygen difluoride
Ozone
Peracetic Acid
Perhaloate
Perborates
Percarbonates
Perchlorates
Perchloric Acid
Permanganates
Peroxides
Persulfate
Sodium Borate Perhydrate
Sulfuric Acid

APPENDIX F

Classes of Peroxidizable Chemicals

A. Chemicals that form explosive levels of peroxides without concentration

Butadiene[a]	Divinylacetylene	Tetrafluoroethylene[a]	Vinylidene chloride
Chloroprene[a]	Isopropyl ether		

B. Chemicals that form explosive levels of peroxides on concentration

Acetal	Diacetylene	2-Hexanol	2-Phenylethanol
Acetaldehyde	Dicyclopentadiene	Methylacetylene	2-Propanol
Benzyl alcohol	Diethyl ether	3-Methyl-1-butanol	Tetrahydroforan
2-Butanol	Diethylene glycol dimethyl ether	Methylcyclopentane	Tetrahydronaphthalene
Cumene	(diglyme)	Methyl isobutyl ketone	Vinyl ethers
Cyclohexanol	Dioxanes	4-Methyl-2-pentanol	Other secondary alcohols
2-Cyclohexen-1-ol	Ethylene glycol dimethyl ether	2-Penten-1-ol	
Cyclohexene	(glyme)	4-Penten-1-ol	
Decahydronaphthalene	4-Heptanol	1-Phenylethanol	

C. Chemicals that may autopolymerize because of peroxide accumulation

Acrylic acid[b]	Chlorotrifluoroethylene	Vinyl acetate	Vinyladiene chloride
Acrylonitrile[b]	Methyl methacrylate[b]	Vinylacetylene	
Butadiene[c]	Styrene	Vinyl chloride	
Chloroprene[c]	Tetrafluoroethylene[c]	Vinylpyridine	

D. Chemicals that may form peroxides but cannot clearly be placed in sections A-C

Acrolein	tert-Butyl methyl ether	Di(1-propynyl) ether[f]	4-Methyl-2-pentanone
Allyl ether[d]	n-Butyl phenyl ether	Di(2-propynyl) ether	n-Methylphenetole
Allyl ethyl ether	n-Butyl vinyl ether	Di-n-propoxymethane[d]	2-Methyltetrahydrofuran
Allyl phenyl ether	Chloroacetaldehyde diethylacetal[d]	1,2-Epoxy-3-isopropoxypropane[d]	3-Methoxy-1-butyl acetate
p-(n-Amyloxy)benzoyl chloride	2-Chlorobutadiene	1,2-Epoxy-3-phenoxypropane	2-Methoxyethanol
n-Amyl ether	1-(2-Chloroethoxy)-2-phen-	Ethoxyacetophenone	3-Methoxyethyl acetate
Benzyl n-butyl ether[d]	oxyethane	1-(2-Ethoxyethoxy)ethyl acetate	2-Methoxyethyl vinyl ether
Benzyl ether[d]	Chloroethylene	2-Ethoxyethyl acetate	Methoxy-1,3,5,7-cycloocta
Benzyl ethyl ether[d]	Chloromethyl methyl ether[e]	(2-Ethoxyethyl)-o-benzoyl	Tetraene
Benzyl methyl ether	§-Chlorophenetole	Benzoate	§-Methoxypropionitrile
Benzyl 1-naphthyl ether[d]	o-Chlorophenetole	1-Ethoxynaphthalene	m-Nitrophenetole
1,2-Bis(2-chloroethoxy)ethane	p-Chlorophenetole	o,p-Ethoxyphenyl isocyanate	1-Octene
Bis(2-ethoxyethyl) ether	Cyclooctene[d]	1-Ethoxy-2-propyne	Oxybis(2-ethyl acetate)
Bis(2-(methoxyethoxy)ethyl)	Cyclopropyl methyl ether	3-Ethoxyopropionitrile	Oxybis(2-ethyl benzoate)
ether	Diallyl ether[d]	2-Ethylacrylaldehyde oxime	§,§-Oxydipropionitrile

Bis(2-chloroethyl) ether	p-Di-n-butoxybenzene	2-Ethylbutanol	1-Pentene
Bis(2-ethoxyethyl) adipate	1,2-Dibenzyloxyethane[d]	Ethyl §-ethoxypropionate	Phenoxyacetyl chloride
Bis(2-ethoxyethyl) phthalate	p-Dibenzyloxybenzene[d]	2-Ethylhexanal	Œ-Phenoxypropionyl
Bis(2-methoxyethyl)	1,2-Dichloroethyl ethyl ether	Ethyl vinyl ether	Phenyl o-propyl ether
Bis(2-methoxyethyl) ether	2,4-Dichlorophenetole	Furan p-Phenylphenetone	
Bis(2-	Diethoxymethane[d]	2,5-Hexadiyn-1-ol	n-Propylether
Bis(2-methoxymethyl)	2,2-Diethoxypropane	4,5-Hexadien-2-yn-1-ol	n-Propyl isopropyl ether
Bis(2-n-butoxyethyl)	Diethyl ethoxymethylenemalonate	n-Hexyl ether	Sodium 8,11,14-eicosa
Bis(2-phenoxyethyl) ether	Diethyl fumarated	o,p-Iodophenetole	Tetraenoate
Bis(4-chlorobutyl) ether	Diethyl acetal[d]Isoamyl benzyl	Sodium ethoxyacetylide[f]	
Bis(chloromethyl) ether[e]	Diethylketene[f]	Isoamyl ether[d]	Tetrahydropyran
2-Bromomethyl ethyl ether	m,o,p-Diethoxybenzene	Isobutyl vinyl ether	Triethylene glycol diacetate
§-Bromophenetole	1,2-Diethoxyethane	Isophorone[d]	Triethylene glycol
o-Bromophenetole	Dimethoxymethane[d]	p-Isopropoxypropionitrile[d]	1,3,3-Trimethoxypropene[d]
p-Bromophenetole	1,1-Dimethoxyethane[d]	Isopropyl 2,4,5-	1,1,2,3-Tetrachloro-1,3-
3-Bromopropyl phenyl ether	Dimethylketene[f]	Acetate	Butadiene
1,3-Butadiyne	3,3-Dimethoxypropene	Limonene	4-Vinyl cyclohexene
Buten-3-yne	2,4-Dinitrophenetole	1,5-p-Methadiene	Vinylenecarbonate
tert-Butyl ethyl ether	1,3-Dioxepane[d]	Methyl p-(n-amyloxy)benzoate	Vinylidene chioride[d]

a. When stored as a liquid monomer
b. Although these chemicals form peroxides, no explosions involving these monomers
c. When stored in liquid form, these chemicals form explosive levels of peroxides without concentration. They may also be stored as a gas in gas cylinders. When stored as a gas, these chemicals may autopolymerize because of peroxide accumulation.
d. These chemicals easily form peroxides and should probably be considered under part B.
e. OSHA-regulated carcinogen
f. Extremely reactive and unstable compound.

Safe Storage Period for Peroxide Forming Chemicals

Description	**Period**
Unopened chemicals from manufacturer	18 months
Opened containers	
Chemicals in Part A	3 months
Chemicals in Parts B and D	12 months
Uninhibited chemicals in Part C	24 hours
Inhibited chemicals in Part C	12 months[a]

Do not store under inert atmosphere, oxygen required for inhibitor to function.

Sources: Kelly, Richard J., Chemical Health & Safety, American Chemical Society, **1996**, Sept, 28-36Revised 12/97

APPENDIX G

SHOCK SENSITIVE AND EXPLOSIVE CHEMICALS

Shock sensitive refers to the susceptibility of a chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated. Explosive chemicals are those chemicals that have a higher propensity to explode under a given set of circumstances than other chemicals (extreme heat, pressure, mixture with an incompatible chemical, etc.). The label and SDS will indicate if a chemical is shock sensitive or explosive. The chemicals listed below may be shock sensitive or explode under a given number of circumstances and are listed only as a guide to **some** shock sensitive or explosive chemicals. Follow these guidelines:

1. Write the date received and date opened on all containers of shock sensitive chemicals. Some chemicals become increasingly shock sensitive with age.
2. Unless an inhibitor was added by the manufacturer, closed containers of shock sensitive materials should be discarded after 1 year.
3. Wear appropriate personal protective equipment when handling shock sensitive chemicals.

acetylene	fulminate of mercury	nitroguanidine
acetylides of heavy metal	fulminate of silver	nitroparaffins
amatex	ethylene oxide	nitrourea
amatol	ethyl-tetryl	organic nitramines
ammonal	fulminating gold	ozonides
ammonium nitrate	fulminating mercury	pentolite
ammonium perchlorate	fulminating platinum	perchlorates of heavy
ammonium picrate	fulminating silver	peroxides
azides of heavy metals	gelatinized nitrocellulose	picramic acid
baratol	Guanyl	picramide
calcium nitrate	guanyl nitrsamino	picratol
chlorate	Guanyltetrazene	picric acid
copper acetylide	Hydrazine	picryl sulphonic acid
cyanuric triazide	nitrated carbohydrate	silver acetylide
cyclotrimethylenetrinitramine	nitrated glucoside	silver azide
dinitrophenol	nitrogen triiodide	tetranitromethane
dinitrophenyl hydrazine	nitrogen trichloride	
dinitrotoluene	Nitroglycerin	
ednatol	Nitroglycide	
erythritol tetranitrate	Nitroglycol	
Mixtures:		
germanium	Tetracene	
hexanitrodiphenyamine	Tetrytol	
hexanitrostilbene	Trimethylolethane	
hexogen	Trimonite	
hydrazoic acid	Trinitroanisole	
lead azide	Trinitrobenzene	
lead mononitroresorcinate	trinitrobenzoic acid	
lead styphnate	Trinitrocresol	
mannitol hexanitrate	Trinitroresorcinol	
sodium picramate	Tritonal	
tetranitrocarbazole	urea nitrate	

References: Safety Data Sheets, various chemical companies

APPENDIX H

Guidelines for the disposal of unused chemical upon PI departure

Whenever a Principal Investigator or faculty member (or a person under their charge performing work with hazardous materials in their laboratory) leaves the college or is transferred to a different location, proper disposition of hazardous materials is required. This includes faculty, staff, post-doctoral and graduate students.

If improper management of hazardous materials at closeout requires removal services from an outside contractor, the responsible department will be charged for this service.

Hazardous Chemical Disposal in Laboratories and Containment Areas

The following procedures should be completed before the responsible individual leaves the university or transfers to a different location on campus.

- Assure that all containers of chemicals are labeled with the name of the chemical. All containers must be securely closed. Beakers, flasks, evaporating dishes, etc., should be emptied. Hazardous chemical wastes must not be sewered or trashed; they must be collected for disposal.
- Clean chemicals from glassware and assure proper waste disposal guidelines are followed. Never pour chemical residues down the sink unless it is specified by the EHS Department that this is the safe and preferred method of disposal.
- Check refrigerators, freezers, fume hoods, storage cabinets, and bench tops for chemical containers and thoroughly clean these locations.
- If another room or facility (such as a freezer or refrigerator, stock rooms, etc.) is shared with other researchers, remove, transfer, or dispose of items used by the departing researcher.
- Contact the appropriate Lab Manager for pick-up of hazardous waste at least one week prior to vacating the lab.
- For gas cylinders, remove regulators, replace cap and return to supplier. Gas cylinders used in the containment area must be decontaminated prior to return.

As an alternative to disposal, if the chemical is still usable, transfer the responsibility of the chemical to a supervisor who is willing to take charge of the chemical.

Follow all guidelines for disposal of unwanted chemicals. Hazardous waste chemicals should be placed in the Hazardous waste disposal room (SB055) provided:

- All chemical containers are properly labeled as "hazardous waste" and are accompanied with a completely filled out hazardous waste tag.
- All containers are securely closed.

Notify EHS when laboratories or containment area/rooms have been cleared.

Disposal of Controlled Substances

The United States Drug Enforcement Agency (DEA) issues permits for controlled substances. There are several considerations when disposing of controlled substances.

- Abandonment of a controlled substance is a violation of the DEA permit under which it is held.
- Permission to transfer ownership of a controlled substance must be received from the DEA.
- If controlled substances for which the licensee is unknown are found, contact the CHO & EHS.
- Controlled substances being held by a licensed individual and to be surrendered for destruction must be inventoried on DEA Form 41. Contact Drug & Lab for proper disposal:

Drug and Laboratory Disposal Inc.
331 Broad St.
Plainwell, MI 49081-1439
tel: 800-685-9824
fax: 616-685-1130

Disposal of Biological Materials

Microorganisms and Cultures

- Use an autoclave to decontaminate all culture waste, and dispose of it as the policy states.
- If the material cannot be decontaminated, place it in a biohazard bag for incineration.
- Clean and disinfect incubators, drying or curing ovens, refrigerators and freezers.
- If samples need to be saved, locate the supervisor to take responsibility for them.

Transportation of Biological Materials on Campus

All biological materials* that are of potential risk to humans and/or animals must be stored and transported in a primary and secondary container. Primary containers can be culture tubes, flasks, vials etc. All containers must meet the following requirements:

- Rigid
- Puncture resistant
- Leak proof
- Impervious to moisture
- Of sufficient strength to prevent tearing or bursting under normal conditions of use and handling
- Sealed to prevent leakage during transport
- Labeled with a biohazard or infectious substance label

All containers should be accompanied by a list of content, the person responsible for this material, a contact person and phone number.

If materials are to be transported in liquid nitrogen or with other protection from ambient or higher temperatures, all containers and packaging should be capable withstanding very low temperatures, and both primary and secondary packaging must be able to withstand a pressure differential of at least 95 kPa and temperatures in the range of -40 ° C to +50 ° C. If the material is perishable, warnings should appear on accompanying documents, e.g., "Keep cool, between +2 ° C and +4 ° C."

*** Infectious substances:** viable microorganisms, including a bacterium, virus, rickettsia, fungus, or a recombinant, hybrid or mutant, that are known or reasonably believed to cause disease in animals or humans.

*** Diagnostic specimens:** any human or animal material including but not limited to, excreta, secreta, blood and its components, tissue and tissue fluids.

Close Out Procedures for Radioactive Materials Use Areas

For appropriate close out procedures for Radioactive Materials, please contact:
Paul Harper, Associate Professor of Physics & Astronomy (SB 161), at 616.526.6408 or at pharper@calvin.edu

Equipment

If laboratory equipment is to be left for the next occupant, clean or decontaminate it before departing the laboratory. If exhaust or filtration equipment has been used with extremely hazardous substances or organisms, alert the CHO and EHS.

If laboratory equipment is to be discarded, be aware that capacitors, transformers, mercury switches, mercury thermometers, radioactive sources, and chemicals must be removed before disposal. Contact EHS for assistance.

Shared Storage Areas

One of the most problematic situations is the sharing of storage units such as refrigerators, freezers, cold rooms, stock rooms, waste collection areas, etc., particularly if no one has been assigned to manage the unit. Departing researchers must carefully survey any shared facility in order to locate and appropriately dispose of their hazardous materials.

Regulatory Impact

Mishandling of hazardous materials can result in citations, fines, and/or loss of right to use hazardous materials. Adverse publicity is also a frequent result.

APPENDIX I

List of Definitions

ACGIH -- The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLV's) for hundreds of chemicals, physical agents, and includes Biological Exposure Indices (BEI).

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

Acute -- Severe, often dangerous exposure conditions in which relatively rapid changes occur.

Acute Exposure -- An intense exposure over a relatively short period.

ANSI -- The American National Standards Institute is a voluntary membership organization (run with private funding) that develops national consensus standards for a wide variety of devices and procedures.

Asphyxiant -- A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants such as nitrogen either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

Autoclave -- A device to expose items to steam at a high pressure in order to decontaminate the materials or render them sterile.

Biohazard -- Infectious agents that present a risk or potential risk to the health of humans or other animals, either directly through infection or indirectly through damage to the environment.

Boiling Point -- The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. The boiling point is usually expressed in degrees Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.

"**C**" or **Ceiling --** A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value--Ceiling (See also THRESHOLD LIMIT VALUE).

Carcinogen -- A substance that may cause cancer in animals or humans.

C.A.S. Number -- Identifies a particular chemical by the Chemical Abstracts Service, a service of the American Chemical Society that indexes and compiles abstracts of worldwide chemical literature called "Chemical Abstracts."

Chemical Hygiene Officer -- An employee who is designated by the employee and who is qualified by training and experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan -- A written program developed and implemented by the department which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting students, instructors and other personnel from the health hazards presented by the hazardous chemicals used in that particular workplace.

Chronic exposure -- A prolonged exposure occurring over a period of days, weeks, or years.

Combustible -- According to the DOT and NFPA, COMBUSTIBLE liquids are those having a flash point at or above 100deg.F (37.8deg.C), or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances, and must be handled with caution. Substances such as wood, paper, etc., are termed "Ordinary Combustibles."

Compressed Gas -- A gas or mixture of gases that, in a container, will have an absolute pressure exceeding 40 psi at 70°F or 21.1°C. A gas or mixture of gases having, in a container, an absolute pressure exceeding104 psi at 130°F or 54.4°C, regardless of the pressure at70°F. A liquid having a vapor pressure exceeding 40 psi at 100°For 37.8°C.

Concentration -- The relative amount of a material in combination with another material. For example, 5 parts (of acetone) per million (parts of air).

Corrosive -- A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

Cutaneous/Dermal -- Pertaining to or affecting the skin.

Cytotoxin -- A substance toxic to cells in culture, or to cells in an organism.

Decomposition -- The breakdown of a chemical or substance into different parts or simpler compounds. Decomposition can occur due to heat, chemical reaction, decay, etc.

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

Dermatitis -- An inflammation of the skin.

Dilution Ventilation -- See GENERAL VENTILATION.

DOT -- The United States Department of Transportation is the Federal agency that regulates the labeling and transportation of hazardous materials.

Dyspnea -- Shortness of breath, difficult or labored breathing.

EPA -- The Environmental Protection Agency is the governmental agency responsible for administration of laws to control and/or reduce pollution of air, water, and land systems.

EPA Number -- The number assigned to chemicals regulated by the Environmental Protection Agency (EPA).

Epidemiology -- The study of disease in human populations.

Erythema -- A reddening of the skin.

Evaporation Rate -- The rate at which a material is converted to vapor (evaporates) at a given temperature and pressure when compared to the evaporation rate of a given substance. Health and fire hazard evaluations of materials involve consideration of evaporation rates as one aspect of the evaluation.

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

Flammable Gas -- A gas that, at an ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or, a gas that, at an ambient temperature and pressure forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

Flammable Liquid -- According to the DOT and NFPA, a flammable liquid is one that has a flash point below 100deg.F. (See FLASH POINT).

Flammable Solid -- A solid, other than a blasting agent or explosive, 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 it creates a serious hazard.

Flash Point -- The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture and burn when a source of ignition (sparks, open flames, etc.) is present. Two tests are used to determine the flashpoint: open cup and closed cup. The test method is indicated on the SDS after the flash point.

Fume -- A solid particle that has condensed from the vapor state.

Gas -- Chemical substances that exist in the gaseous state at room temperature.

General Ventilation -- Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition (See LOCALEXHAUST VENTILATION).

Grams per Kilogram (g/Kg) -- This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 grams (of substance) per kilogram of body weight (of the experimental animal).

Hazardous Chemicals -- Any chemical for which there is significant evidence that acute or chronic health effects may occur in exposed personnel. The term "health hazard" includes chemicals that are carcinogens, toxins, irritants, corrosives, sensitizers or other agents that can damage the lungs, skin, eyes, or mucous membranes.

Ignitable -- A solid, liquid, or compressed gas waste that has a flashpoint of less than 140deg.F. Ignitable material may be regulated by the EPA as a hazardous waste, as well.

Incompatible -- The term applied to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

Ingestion -- Taking a substance into the body through the mouth as food, drink, medicine, or unknowingly as on contaminated hands or cigarettes, etc.

Inhalation -- The breathing in of an airborne substance that may be in the form of gas, fumes mists, vapors, dusts, or aerosols.

Inhibitor -- A substance that is added to another to prevent or slowdown an unwanted reaction or change.

Irritant -- A substance that produces an irritation effect when it contacts skin, eyes, nose, or respiratory system.

Laboratory -- A facility where relatively small quantities of hazardous materials are used on a non-production basis.

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

Laboratory-type Hood -- A device constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory.

Laboratory Use of Hazardous Materials -- The handling or use of chemicals in which the following conditions are met: (1) Chemical manipulations are carried out on a laboratory scale. (2) Multiple chemical procedures or chemicals are used. (3) The procedures involved are not part of a production process. (4) Protective laboratory practices and equipment are available and in common use to minimize the potential for personnel exposure to hazardous chemicals.

Laminar Air Flow -- Air flow in which the entire mass of air within a designated space move with uniform velocity in a single direction along parallel flow lines with a minimum of mixing.

Lethal Concentration$_{50}$ -- The concentration of an air contaminant **(LC_{50})** that will kill 50 percent of the test animals in a group during a single exposure.

Lethal Dose$_{50}$ -- The dose of a substance or chemical that will **(LD_{50})** kill 50 percent of the test animals in a group within the first30 days following exposure.

Local Exhaust Ventilation (Also known as exhaust ventilation.) **--**A ventilation system that captures and removes air contaminants at the point they are being produced before they escape into the workroom air. The system consists of hoods, ductwork, a fan, and possibly an air-cleaning device. Advantages of local exhaust ventilation over general ventilation include: removing the contaminant rather than diluting it; less airflow making it a more economical system over the long run; and conservation or reclamation of valuable materials. However, the system must be properly designed with the correctly shaped and placed hoods, correctly sized fans and correctly connected ductwork.

Lower Explosive Limit (LEL) (Also known as Lower Flammable Limit-LFL) **--** The lowest concentration of a substance that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn (See also UEL).

Melting Point -- The temperature at which a solid changes to a liquid. A melting range any be given for mixtures.

Mutagen -- Anything that can cause a change (or mutation) in the genetic material of a living cell.

Narcosis -- Stupor or unconsciousness caused by exposure to a chemical.

NFPA -- The National Fire Protection Association is a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 704, "Identification of the Fire Hazards of Materials." This system rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

NIOSH -- The National Institute for Occupational Safety and Health is a Federal agency that among its various responsibilities trains occupational health and safety professionals conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

Occupational Safety and Health Administration (OSHA) -- A Federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.

Odor Threshold -- The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

Oxidation -- The process of combining oxygen with some other substance or a chemical change in which and atom loses electrons.

Oxidizer -- Is a substance that gives up oxygen easily to stimulate combustion of organic material.

Oxygen Deficiency -- An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% oxygen at sea level.

Permissible Exposure Limit (PEL) -- An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short-term exposure limit (STEL), or a ceiling (C). The PELs are found in Tables Z-1, Z-2, or Z-3 of OSHA regulations 1910.1000. (See also TLV).

Personal Protective Equipment -- Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are respirators, gloves, and chemical splash goggles.

Physical Hazard -- A chemical that has scientifically valid evidence proving it to be a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

Polymerization -- A chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction with an uncontrolled release of energy.

RAD -- The unit of absorbed dose equal to 100 ergs per gram or 0.01joules per kilogram of absorbing material.

Reactivity -- A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosion, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on a SDS.

Reproductive Toxins -- Chemicals that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses.

Respirator -- A device that is designed to protect the wearer from inhaling harmful contaminants.

Respiratory Hazard -- A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some bodily function impairment.

Select carcinogens are chemicals listed by MIOSHA as carcinogens, by the National Toxicology Program (NTP) as "known to be carcinogens" and by the International Agency for Research on Cancer (IARC) as Group 1 carcinogens. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP *and* that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
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 $10 mg/ml^3$
After repeated skin application of less than 300 mg/kg of body weight per week
After oral dosages of less than 50 mg/kg of body weight per day

Sensitizer -- A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

Short Term Exposure Limit -- Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. In addition, the daily TLV-TWA must not be exceeded.

"Skin" -- This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes. Thus, protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.

Systemic -- Spread throughout the body; affecting many or all body systems or organs; not localized in one spot or area.

Teratogen -- An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.

Threshold Limit Value -- Airborne concentrations of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLV's are advisory exposure guidelines, not legal standards that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLV's: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL), and Ceiling (TLV-C). (See also PEL).

Time Weighted Average -- The average time, over a given work period (e.g. 8-hour workday) of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the time period. Represented as TLV-TWA.

Toxicity -- The potential of a substance to exert a harmful effect on humans or animals and a description of the effect and the conditions or concentration under which the effect takes place.

Trade Name -- The commercial name or trademark by which a chemical is known. One chemical may have a variety of trade names depending on the manufacturers or distributors involved.

Unstable (Reactive) -- A chemical that, in its pure state or as commercially produced, will react vigorously in some hazardous way under shock conditions (i.e., dropping), certain temperatures, or pressures.

Upper Explosive Limit -- Also known as Upper Flammable Limit is the highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically, above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is1ppm and the UEL is 5ppm, then the explosive range of the chemical is 1-ppm to5ppm. (See also LEL).

Vapor -- The gaseous state of substances, which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with low boiling points will evaporate.

Vapor Pressure -- The pressure that a solid or liquid exerts when it is in equilibrium with its vapor at a given temperature.

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

Appendix J Lab Safety Inspection At Calvin College

Department: ______________________________

Instructor: ______________________________ Date: ___________

Course: ______________________________

Time: ___________

Person doing inspection: ____

____

√ = compliance X= non-compliance NA= not applicable

General Laboratory Status:

_____Door signs posted with contact personnel
_____Emergency numbers posted by telephone
_____Chemical hygiene plan present
_____Personnel (faculty and student assistants) aware of CHP
_____Chemical inventory for all chemicals maintained by the Department
_____Personal protective equipment present and used
_____All accidents reported to instructor
_____Coats and backpacks stored on coat rack or under a table

Safety Equipment Present and in Working Condition:

_____Emergency shower
_____Emergency eye-wash
_____Fire Extinguisher & Inspection Date
_____Fume hoods and Inspection Date
_____Spill kits readily available
_____Biological safety cabinet

General Practice:

_____Awareness of potential hazards (physical, chemical and biological)
_____Containers properly labeled
_____Eating/drinking/gum or tobacco chewing/smoking prohibited
_____Work areas clean and neat/equipment returned to the proper location
_____Aisles kept clear
_____Hands washed prior to leaving laboratory

Equipment Use:

_____Mechanical pipeting device used
_____Work performed in fume hood (when appropriate)
_____Placement of equipment does not interfere with safety equipment
_____Proper vacuum operation
_____Proper ultraviolet and laser light operation

Laboratory Apparel:

_____Closed-toe shoes required
_____Clothing must cover from the top of the shoulders to well below the knees.
_____Ties, scarves, long hair, jewelry, etc. secured
_____Safety glasses, goggles, or prescription glasses (with side shields) worn whenever chemicals, glassware, or heat are being used in the room.

_____Face shield, gloves and other protective equipment worn if needed
_____Lab coat required for selected biology courses

Management of Laboratory Waste:
_____Glassware/plastics/sharps managed properly
_____Items contaminated with blood managed properly
_____Biological waste managed properly
_____Non-volatile aqueous solutions managed properly
_____Other wastes managed properly
_____Radiological waste managed properly

Chemical Storage:
_____All containers labeled properly
_____Gas cylinders secure, capped, and labeled (contents, and whether full, empty, or in use)
_____Chemicals stored on shelves/in cabinets
_____Chemicals (in storeroom) stored by class
_____Large containers on low shelves

Other:
_____ (Specify) ____
_____ (Specify) ____

Comments: [Area(s) of non-compliance and suggested corrective action]

____
____
____

Appendix K: Safety Data Sheet Request Form

Name: ______________________________ Date: ________________________

Dept.: _______________________________ Phone: ______________________

Date needed: ________________________

Chemical Name (s)	Manufacturer (if known)
___________________________________	_____________________________
___________________________________	_____________________________
___________________________________	_____________________________
___________________________________	_____________________________
___________________________________	_____________________________

Return this form to Environmental Health and Occupational Safety via mail or fax (526-8563).
If you have any questions call EHOS at 526-8591.

Appendix L: Calvin College Report of Exposure to Hazardous Chemicals Form

COMPLETED BY EXPOSED INDIVIDUAL

Name ______________________________ SS# ____________ Position ________________
Department ___________________ Date of incident _________ Time of incident ___________

Location of incident (building, room, etc)____

What chemical were you exposed to? ____

Explain what parts of your body became exposed and how long were you exposed.
____

List any symptoms you are experiencing. ______________________________________

What other chemicals were you using?____
____

List all chemicals being used by others in the immediate area. _________________________
____

List other chemicals being stored in the area. __________________________________
____

Describe what task(s) you were performing and what specific equipment you were using when the exposure occurred.____
____

Explain what caused the exposure (accident, equipment malfunction, etc.) ________________
____
____

List any Personal Protective Equipment that you were wearing.________________________
____

Were you working under a hood? ____

What actions were taken after your exposure (decontamination, first aid received, reporting, etc.)?____
____

Signature: ____ Date: ______________________