# Chemical Hygiene Plan

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# Section One

## Introduction

### 1.1 Purpose

The objective of this Chemical Hygiene Plan (CHP) is to provide specific guidance to individuals who work at or attend Sonoma State University (SSU) for the control of potentially hazardous occupational exposures to chemical and physical agents in the laboratory environment. This CHP is a "living" document which will need to be updated from time to time to best reflect specific, current conditions and practices. Environmental Health and Safety (EH&S) will work with the SSU Chemical Hygiene Officer to keep this document current so that the specific guidance provided herein is operationally accurate and useful.

### 1.2 Policy

It is SSU's policy to provide its employees with a safe and healthful work environment and to comply with all pertinent SSU, federal, state, and local regulatory requirements. Further, SSU is committed to the protection of school property from damage or loss caused by accidents/emergencies, and to the prevention of harm to the general public or the environment resulting from SSU activities.

SSU's administration recognizes that unique chemical and physical hazards may be found in laboratories. This CHP is designed to address those hazards by stating laboratory-specific EH&S requirements and guidelines. It is a requirement that all instructors, students, laboratory workers, contractors, and visitors who work in SSU laboratories be familiar with and follow the requirements of this document.

### 1.3 Background

The Federal Occupational Safety and Health Administration (OSHA) promulgated an important standard in January 1990 entitled, "Occupational exposure to hazardous chemicals in laboratories" (29CFR 1910.1450). This Standard addresses the inherent differences between typical industrial work environments and laboratories, with respect to the use and handling of hazardous materials. Cal-OSHA subsequently adopted a parallel standard in the California Code of Regulations (CCR) Title 8, Section 5191 with the same title, effective April 24, 1991, and with a start-up date of October 31, 1991 (See Appendix One). The standard requires that SSU determine the applicability of the standard to its laboratories and, where applicable, develop and implement a written Chemical Hygiene Plan (CHP) document.

## 1.4 Scope & Application

The scope of this CHP applies to all SSU laboratory operations. While the focus of this CHP is on "Laboratory Scale"[1] operations, many of the control recommendations, administrative procedures, and required uses of personal protective equipment (PPE) apply to other SSU operations, e.g. facilities maintenance activities. Therefore, all SSU operations that find this document (or portions thereof) pertinent shall use it for reference and guidance.

[1] "Laboratory scale" is defined as; "work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person." "Laboratory scale" excludes those work places whose function is to produce commercial quantities of materials.

# Section Two

## Responsibilities

Consistent with SSU policy, responsibility for chemical hygiene and safety in the laboratory is shared by administrators, faculty, laboratory workers, and any other persons directly or indirectly involved with laboratory operations. Specific responsibilities are described below.

### 2.1 Program Administrator

The program administrator, The Dean of The school of Science and Technology, is responsible for the overall management and administration of the CHP. This is consistent with the responsibility section in the SSU Injury and Illness Prevention Program. The Program Administrator is also responsible for:

1. Ensuring that appropriate technical and administrative human resources, budget, and equipment are provided to achieve the objectives of this document.
2. Providing leadership and direction to the School of Science and Technology regarding chemical hygiene and safety within the laboratory.

### 2.2 Faculty & Staff

Faculty & Staff are responsible for:

1. Implementing the pertinent requirements of this document in their respective areas.
2. Providing specialized training, or ensuring that students working under their direction in their laboratory area or with their laboratory equipment are trained specifically on the chemical and physical hazards associated with that work. This training must take place at the on-set of use of new equipment, new lab assignment, or changed lab assignment.
3. Ensuring that Safe Work Practices are developed for all "high hazard" operations. The guidelines for the development of Safe Work Practices are provided in Section 5.2 of this document. A current listing and copies of all Safe Work Practices are maintained by the Chemical Hygiene Officer (CHO).
4. Suggesting solutions to improve the safety of the process, equipment, production materials, and training.
5. Knowing safety and emergency equipment locations and operating procedures.
6. Regularly communicating safety information to students as necessary.
7. Ensuring that students are aware of, and familiar with, emergency procedures and the proper use of emergency equipment.

8. Ensuring that all safety training of students is documented and maintained in Department files.
9. Reinforcing training by monitoring the activities of students for unsafe acts and implementing corrective action as necessary.
10. Issuing Facility work orders to the Department Technician to initiate safety corrective actions.
11. Placing defective or unsafe equipment out of service and contacting the Department Technician to arrange for servicing of equipment that is in need for maintenance and/or repair.
12. Managing hazardous materials operations within their areas by making Safety Data Sheets (SDS) available to workers and ensuring that hazardous materials are handled, stored, transported, and disposed of in the correct manner. SDS information for all chemicals can be found at http://www.sonoma.edu/ehs/hazmat/msds.html. It is recommended that labs post this information in a conspicuous location.
13. Ensure a formal safety inspection is completed twice per year and all documentation, including follow up corrective actions, are maintained for a minimum of three years.
14. Maintaining personal work areas in accordance with housekeeping guidelines.

## 2.3 Chemical Hygiene Officer

The Cal-OSHA standard requires the appointment of a Chemical Hygiene Officer for each laboratory facility. This officer is qualified either through training or experience to oversee the development and implementation of the CHP. This designated officer may hold another job title provided he or she is technically competent to fulfill the responsibilities of both job titles. The Chemical Hygiene Officer (CHO), is responsible for:

1. Providing technical guidance and assisting the Program Administrator in the development and implementation of the Chemical Hygiene Plan.
2. Assisting in the development and documentation of Safe Work Practices for their laboratory. This program does not include radioactive materials. The University's radiologic license governs the use of radioactive materials and is available through EH&S or the Radiation Safety Officer within the School of Science and Technology.
3. Overseeing and arranging for the monitoring of worker exposures to hazardous materials as defined by the Laboratory Standard.
4. Organizing the inspection of the laboratories for the purposes of identifying and facilitating necessary modifications/changes for continual compliance on an annual basis.
5. Reviewing, the CHP annually (with the Chemical Hygiene team – CHO, Assoc. CHO, Chemical Hygiene Committee and EHS Director) and updating it as necessary to remain current.
6. Responsible for resolution of appropriate chemical hygiene management issues through SSU's EH&S.
7. Making certain that Safety Data Sheets and other related information are available to all employees anytime the lab is accessible.

## 2.4 Associate Chemical Hygiene Officer

The Associate Chemical Hygiene Officer will work closely with the CHO to ensure continuity and implementation of the program. The primary role of the Associate CHO is to serve as another source of reference for elements of the CHP and assist in facilitating programs, and structural modifications or other changes to ensure chemical safety. The authority to enforce the policies of the CHP rests with the CHO, EHS Director and Dean, not the Associate CHO. The Associate CHO will complete Chemical Hygiene assignments as directed by CHO. The Associate CHO shall also adhere to the following responsibilities:

1. Investigating all accidents within their area of supervision and submitting a completed Incident Investigation Report to the EH&S Director within 24 hours.
2. Ensuring that area-specific safety self-inspection programs occur in Chemistry, Biology, Physics and Geology semiannually. If audit demonstrates lack of compliance notify Chemical Hygiene Officer, Department Program Administrator and EH&S Director.
3. Follow required chemical purchasing process for new materials not previously on inventory.

## 2.5 Environmental Health and Safety

Environmental Health and Safety is responsible for certain elements of the CHP. These elements include:

1. Overseeing the education and training of faculty and staff before using hazardous materials.
2. Coordinating the required training classes as requested by the CHO.
3. Reviewing and monitoring the safe disposal of hazardous materials according to the appropriate federal and state regulations.
4. Auditing inspections records to ensure local inspections and facilities preventative maintenance are occurring on the require intervals.
5. Ensuring that medical consultative services are available to those employees requesting or needing such services.
6. Maintaining knowledge of the current legal requirements concerning regulated substances.
7. Responsible for resolution of appropriate chemical hygiene management issues.

## 2.6 Facilities Management

The Facilities Department is responsible for:

1. Reviewing and approving laboratory equipment installations for compliance with pertinent building codes and regulations.

2. Maintaining and servicing facilities-related equipment which services laboratories including local exhaust ventilation systems, eye wash/drench showers, and emergency/life safety equipment (e.g. building fire alarms and fire extinguishers).
3. Providing guidance to Laboratory management, researchers, and the CHO regarding appropriate engineering control installations for chemical and physical hazards.
4. Testing the performance of equipment identified in item 2 above on the prescribed intervals.

# Section Three

## Preplanning and Approval of Proposed Laboratory Operations

### 3.1 Approval Process

Generally speaking, it is the responsibility of the faculty to identify new or modified procedures that utilize instrumentation, chemicals and/or equipment that pose special hazards (e.g. ionizing radiation, high voltage). In these instances, the faculty shall inform the Program Administrator, EH&S, and CHO prior to use and/or installation as a means of acquiring the necessary facilities and EH&S/guidance to assure project viability, cost and maintain a safe working environment. New equipment that poses such hazards shall be discussed with EHS prior to purchase to ensure that a safe working environment can be established and facility can be modified to safely meet need. New laboratory equipment must be approved through new equipment process. This requirement does not include newer replacement equipment or equipment with Underwriters Laboratory (UL) or other safety inspected and certified equipment.

### 3.2 Laboratory Safety Support Equipment

Laboratory areas shall be equipped with the following as determined necessary by Facilities Management, EH&S, CHO, and faculty or PI:

1. Fire sprinkler system
2. Fire extinguisher(s)
3. Eyewash and Safety shower (where corrosive chemicals are used)
4. Eye wash (where hazardous materials are used)
5. Respirators (if required by EH&S)
6. Safety glasses/goggles
7. Face shields
8. Lab protective clothing (lab coat at a minimum)
9. Lab entry postings/signage
10. Fume hood(s)
11. Safety signage
12. Other equipment as may be deemed necessary

# Section Four

## Chemical Procurement

### 4.1Specific Requirements

It is the responsibility of the Faculty to follow reasonable guidelines when ordering/procuring chemicals for use in teaching and/or research. It is prudent to consider the following:

1. Chemical purchases should consider high waste disposal costs at a later date.
2. Containers shall not be accepted without an adequate identifying label (e.g., chemical identity, hazard warnings, manufacturers name and address). Unsolicited samples of hazardous materials must not be accepted by SSU personnel.
3. Procedures for chemical ordering and SDS Procurement:
    A. Person wishing to order any chemical will fill out Purchase Requisition (PR)
    B. Technician receives PR from requester (can be in the form of an email), evaluates against allowed storage amounts for the use area, ensure is not a significant hazard, and with above restrictions met order is made.
    C. In cases of chemicals of significant hazard, the faculty requesting the material shall consult the CHO and EHS Director for help in assuring proper storage, handling, and to allow for the future disposal of waste products. This is the responsibility of the faculty and shall be done prior to ordering and must include written documentation.
    D. For chemicals deemed particularly hazardous by regulatory citation (e.g., CCR, Title 8, fire code or other) or the requesting faculty, the person ordering should provide an SDS sheet, or equivalent information (if possible) . The requesting faculty shall demonstrate compliance with all pertinent regulations, including baseline medical monitoring if required prior to ordering.
    E. Chemical sent to requester directly from vendor.
    F. Technician places SDS at appropriate location. SDS may also be obtained from a campus computer at **http://www.sonoma.edu/ehs/hazmat/msds.html.** Faculty and Staff must review SDS prior to working with a material and it is recommended to create an electronic SDS binder for your specific area.

See SDS information in Appendix Five.

# Section Five

## Safe Laboratory Work Practices and Procedures

### 5.1 General Principles

The number of hazardous chemicals and the number of reactions among them is so large that previous knowledge of all potential hazards cannot be assumed. Therefore, when the chemical properties of a material are not fully known, it should be assumed hazardous and used in the smallest quantity possible. This will minimize exposure potential, and thus, reduce the probable magnitude of unexpected chemical events.

The following general safety principles should be observed by all personnel when working with chemicals:

1. Substitute less toxic materials whenever possible (e.g., toluene may be substituted for benzene).
2. Minimize all chemical exposures through the use of engineering (e.g., lab-hoods), administrative (e.g. Safe Work Practices), and personal protective (e.g. gloves) controls.
3. Obtain and read the SDS and other hazard information on solids, liquids, and gases used to support laboratory operations.
4. Confine long hair and loose clothing in the laboratory.
5. Be knowledgeable in the use of laboratory emergency equipment such as eyewashes, showers, and fire extinguishers, and receive information about how to obtain additional help in an emergency.
6. Carefully label or cross-reference every secondary container with the identity of its contents. Appropriate hazard warnings will be required if more than one person will be using the secondary container or if the container is to be left unattended for more than half an hour.
7. Utilize equipment only for its designed purpose.
8. Keep the work area clean and orderly.
9. Determine compatibility of chemicals and store incompatibles separately (refer to Appendix Two).
10. Provide a means of containing the materials if equipment or containers should break or spill their contents (secondary containment). A pre-determined spill abatement procedure should be part of the Safe Operating Procedure which covers the use of the chemical.
11. Limit the volume of volatile or flammable materials to the minimum needed for short operation periods. Refer to Section 11.4 for a specific discussion on flammable and combustible liquids.

12. Position and clamp reaction apparatus thoughtfully in order to permit manipulation without the need to move the apparatus until the entire reaction is complete. Combine reagents in appropriate order.
13. All chemical storage cabinets and racks, and all laboratory equipment using hazardous materials shall be seismically braced in accordance with best structural engineering practices.
14. **A**lways **A**dd **A**cids to water to avoid reactions and splattering.
15. Consider the appropriateness of engineering design controls for systems that can generate or operate at high or low pressure.

## 5.2 Safe Work Practices

The most important administrative controls for hazardous operations are the safe work practices that are developed and used in the Laboratory. **Safe work practices** are those practices used in a laboratory operation, which have been communicated via on-the-job training, through reading of equipment and process specifications, and through reading of general safety information.

Written safe work practices are required for "high hazard" operations and recommended for other potentially hazardous operations. Safe work practices should be developed by the faculty and maintained in Appendix Three of this document. A list of possible "high hazard" operations requiring Safe Work Practices by classification is provided below.

**Example High Hazard Operations Requiring Written Safe Work Practices**

1. Equipment and processes which use carcinogenic, mutagenic, or teratogenic substances.
2. Equipment or processes which use more than 2 pint/ 2 pound of organic solvents, acids, bases, oxidizers, heavy metals, toxic materials.
3. Equipment or processes which involve accessible hazardous electricity or ionizing and non-ionizing radiation, including laser light.
4. Powered machining areas and equipment.
5. Any other area/operation as deemed appropriate by the Program Administrator, CHO, EH&S, or faculty.

## 5.3 Health and Hygiene

1. NEVER use mouth suction to pipette chemicals or to start a siphon; a pipette bulb or an aspirator should be used to provide vacuum.
2. Contamination of food, drink, and smoking materials is a potential route for exposure to toxic substances. Food shall be stored, handled, and consumed in areas free of hazardous substances.
3. Food and drink shall not be permitted in areas where chemicals or chemical equipment are being used.
4. Glassware or utensils that have been used for laboratory operations should never be used to prepare or consume food or beverages. Laboratory refrigerators and ice chests shall not be used for food storage.

5. Thoroughly wash hands and remove contaminated lab coats etc. prior to leaving laboratory.

## 5.4 Personal Protective Equipment (PPE)

The use of personal protective equipment (PPE) is needed to compliment the variety of engineering and administrative controls present in the laboratory environment. Operation-specific PPE requirements are provided in Safe Work Practices. The following is a listing of minimum PPE use guidelines for laboratory personnel:

### 5.4.1 Apparel

The following practices concerning apparel should be observed at all times:

1. Appropriate clothing must be worn, including a protective apron or laboratory coat to protect against chemical splashes or spills, cold, and heat. Use protective apparel, including face shields, gloves, and other special clothing or footwear, as needed.
2. Skin and eyes should always be protected from possible exposure by use of appropriate laboratory clothing, gloves, safety glasses, or goggles.
3. Remove jewelry from wrists and hands to prevent chemicals from collecting underneath, contacting electrical sources, catching on laboratory equipment, and/or damaging the jewelry itself.
4. To prevent spreading contamination to areas outside of a laboratory, laboratory coats should not be removed from the laboratory area.
5. Loose apparel should be confined.
6. Open-toed shoes or sandals should not be worn in any laboratory area.
7. If laboratory coats are contaminated with hazardous materials, they should be removed immediately and placed in a hazardous waste bag for decontamination.

### 5.4.2 Gloves

Gloves should be worn whenever working with hazardous chemicals, rough or sharp-edged objects, or very hot or very cold materials. Select gloves based on the material being handled, the particular hazard involved, and their suitability for the procedures being conducted. Gloves should be checked visually for discoloration, punctures, and tears or by other means prior to each use and should be changed often, based on their frequency of use and permeability to the chemical(s) handled. Even appropriate, high quality gloves will eventually be permeated by chemicals. For general information refer to Appendix Four or see CHO or Associate CHO for glove compatibility. EH&S will supply and update compatibility charts as needed.

### 5.4.3 Eye Protection

Safety glasses are required in all laboratory areas where hazardous materials are stored and used. The safety glasses should be impact resistant eyeglasses with side shields. Goggles and/or Face Shields should be worn in addition to safety glasses when pouring or mixing bulk chemicals. **Contact lenses are prohibited** where handling of corrosive chemicals and/or particulate emissions could result in exposure to the eye.

### 5.4.4 Respirators

The use of respirators at SSU is governed by the requirements set forth in the SSU Respiratory Protection Plan. Respirators should not be needed in a normal laboratory setting. However, if engineering and administrative controls cannot assure that concentrations of airborne hazardous materials are maintained below OSHA Permissible Exposure Limits (PELs), or when atmospheric conditions are unknown, respiratory protection is required.

## 5.5 Unattended Operations & Working Alone

### 5.5.1 General

Precautions should be taken for unattended laboratory operations that are carried out continuously or overnight. Unattended operations should be designed to be safe, and plans should be made to avoid hazards in case of failure. If possible, make arrangements for routine surveillance (e.g., each hour) of the operation, leave the lights on, and leave an appropriate sign on the door to indicate that the operation is going but has been left unattended.

1. Names and telephone numbers of lab operator(s) are to be posted on the entrance door for unattended operations.
2. Operations requiring cooling water shall employ monitoring devices that will shut the operation down in the event of water supply failure.
3. In general, it is imprudent to work in laboratories alone. Arrangements should be made between individuals working in separate laboratories to crosscheck with one another periodically.
4. **Laboratory work known to be hazardous must not be undertaken by faculty/staff alone in a laboratory. At least two persons must be present. Safe Work Practices shall specify this requirement.**
5. For hazardous operations (as determined by the faculty supervisor or regulation), students shall not be left unsupervised while working in the laboratory.

### 5.5.2 Working Alone

SSU employees should not work alone in laboratories when involved in highly hazardous operations. Examples of highly hazardous operations follow:

1. Confined space entry.
2. Conditions requiring the use of Self-Contained Breathing Apparatus (SCBA), air line respirators, or Supplied Air Breathing Apparatus (SABA).
3. Work on energized high voltage (600 volts or more) electrical equipment.
4. Work involving the potential for atmospheres Immediately Dangerous to Life or Health (IDLH). (e.g., those operations where engineering controls are not in place to preclude IDLH atmospheres from occurring).
5. Work on unguarded moving equipment or machinery.
6. Work on energized high-pressure systems or vessels.
7. Work with high-energy materials (i.e., oxidation, polymerization, radioactive, etc.).

8. Work in laboratories involving the handling and processing of bulk chemicals (e.g., greater than 1 gallon containers).
9. Any other work activity identified by faculty, the Program Administrator or EH&S as being too hazardous to be performed alone.

## 5.6 Housekeeping

The following housekeeping practices should be observed at all times in the laboratory:

1. There is a definite relationship between safety performance and orderliness in the laboratory. Work areas should be kept as clean as possible and free from obstructions. Cleanup should be completed following any operation.
2. Stairways and hallways should not be used as storage areas.
3. Spilled chemicals shall be identified, isolated, safely as soon as feasible, cleaned up and disposed of properly. Only trained personnel shall perform spill clean-ups. Spills of large quantities of chemicals where there is the potential for personal injury, for environmental impact, and for property damage shall be reported to EH&S for response.
4. Old containers and chemical wastes should be disposed of promptly and not be allowed to accumulate in the laboratory. Wastes shall not be accumulated for more than 90 days except in designated satellite accumulation areas. Waste containers shall be labeled for contents and dated.
5. Non-hazardous materials spills (e.g. water) are to be cleaned up immediately.
6. Access to exits, emergency equipment, and essential equipment shut downs and controls shall never be blocked.
7. Equipment and chemicals all should be stored properly; clutter should be minimized.
8. Incompatible chemicals and operations need to be segregated during use.
9. Chemical storage containers should be closed and stored appropriately at all times except during use.

## 5.7 Glassware

The following safe work practices should be observed at all times in the laboratory:

1. Careful handling and storage procedures should be used to avoid damaging glassware.
2. Adequate hand protection should be used when inserting glass tubing into rubber stoppers or corks or when placing rubber tubing on glass hose connections. Glass tubing should be fire polished or rounded and lubricated, and hands should be held close together to limit movement of glass, should fracture occur. The use of plastic or metal connectors should be considered.
3. Glass-blowing operations should not be attempted unless proper annealing facilities are available.
4. Vacuum-jacketed glass apparatus should be handled with extreme care to prevent implosions. Equipment such as Dewar flasks should be taped or shielded. Only glassware designed for vacuum work should be used for that purpose.

5. Mechanical means (dust pan and broom) or Hand protection should be used when picking up broken glass.
6. Glass disposal boxes should be made available where broken glass may be generated. When glass boxes are full, the Recycling Department should be contacted for pick-up and disposal.
7. Proper instruction should be provided in the use of glass equipment designed for specialized tasks, which can represent unusual risks for the first-time user. (For example, separatory funnels containing volatile solvents can develop considerable pressure during use.)

## 5.8 Access to SSU Laboratories

Access to SSU Laboratories is controlled by Faculty and Technicians. SSU requires that every employee, visitor, contractor, or other person performing work at the site be familiar with, and observe the applicable SSU EH&S requirements. New employees and, where appropriate, contractors, students and visitors are required to receive chemical safety and hazard training matched to their responsibilities and duties. The responsible Faculty ensures that this requirement is met in their areas.

## 5.9 Transport of Hazardous Materials On-Site or From SSU Site

Transport of hazardous materials containers on-site, within a building or back and forth to the hazardous materials storage facility must have secondary containment. The secondary containment shall involve the use of transport carts capable of containing all contents of the containers on the cart, or One-bottle secondary containment totes designed specifically for transport of hazardous materials. Except for transport to the outside hazardous materials storage facility, transportation of hazardous materials by SSU employees outside of the building is prohibited. Transportation of hazardous materials by private vehicle, or non-designated SSU vehicle is not permitted because of the possibility of spillage or breakage of the container and resulting risk of injury to personnel and damage to property. Note: For the purpose of hazardous materials transport there are no exempt quantities that don't require secondary containment.

## 5.10 Signage/Labeling

### 5.10.1 Labeling of Hazardous Materials Containers

All containers (including lab glassware, safety cans, plastic squeeze bottles) must have labels that identify their chemical contents. Primary responsibility is held by the department using/generating such containers. Experiments that carry over or must otherwise be stored must be properly labeled and contained. Exceptions to this requirement are secondary containers (such as beakers, graduated cylinders or containers) used solely by one person within their workstation for a portion of a day. The container labels may contain an abbreviated or common chemical name, such as HCl or Urea. The complete chemical name associated with each abbreviated or common name will be posted in an accessible place in the laboratory. Safety Data Sheets for each chemical will be stored in a central location readily accessible to faculty and staff (normally through MSDS Online system). The Technician and Associate CHO will regularly inspect labs and other pertinent areas to ensure that proper labeling occurs. EH&S will also conduct routine inspections as well.

## 5.11 Chemical Storage

The separation of chemicals (solids or liquids) during storage is necessary to reduce the possibility of unwanted chemical reactions which may result from accidental mixing. Use either distance or barriers (e.g., trays) to isolate chemicals into the following minimum classifications. Note: Additional information on chemical storage is provided in Appendix Four.

1. Flammable or combustible liquids (e.g., acetone, benzene, ether, alcohol).
2. Other liquids (e.g., chloroform, trichloroethane).
3. Inorganic Acids (e.g., nitric, sulfuric, hydrochchloric, perchchloric)- treat acetic acid as a flammable liquid.
4. Bases (e.g., sodium hydroxide, ammonium hydroxide) and oxidizers and poisons.
5. Explosives or unstable reactives, such as picric acid, should be stored separately, outdoors in flammable storage facility.

In addition to the above classifications:

1. Carcinogens should be stored in secondary containers that are chemically resistant and unbreakable.
2. Stored chemicals (such as Peroxide Formers) should be examined semiannually for deterioration, integrity and expiration dates.
3. The amount of chemicals permitted for storage should be kept as small as practical.
4. Exposure of chemicals to heat or direct sunlight shall be avoided.
5. Fume hoods are not intended as a primary storage area of chemicals. Chemicals stored in fume hoods should be kept to a minimum and should not block vents or alter airflow.
6. Lips, strips, or bars should be installed across the width of reagent shelves to restrain the chemicals in case of earthquake.
7. Chemicals must not be stored in the same refrigerator used for food storage. Refrigerators used for storing chemicals must be appropriately identified by placing the following label on the door (labels may be obtained from EH&S).

***CAUTION***

**REFRIGERATOR FOR CHEMICAL STORAGE ONLY. NO FOOD OR DRINK.**

Chemical Storage areas will be labeled with a National Fire Protection Association (NFPA) diamond reflecting the hazards in the area. Reference the Hazard Communication Program for a discussion of the NFPA labeling system.

## 5.12 Spills of Hazardous Materials

The following actions should be taken when responding to chemical spills of less than one pint or one pound:

1. Wear appropriate personal protective equipment during clean up.
2. Pour appropriate sorbent and/or neutralizing agent on spill.
3. Clean up; place waste in labeled plastic bag for disposal.
4. Decontaminate spilled area if required.
5. Complete a label/tag and attach it to spill clean-up containers for identification of contents.
6. Contact EH&S to pick up hazardous waste.

If the spill is greater than one pint or one pound and has the potential to cause personal injury, environmental impact, or property damage, the following actions should be taken:

- If in laboratory hood close sash.
- Evacuate people from the area.
- Isolate the spilled material, if possible to do so safely.
- Identify the spilled material.
- **If the material is flammable, turn off ignition and heat sources.**
- **Call 911 to reach Police and summon Environmental Health and Safety and stay on the line to answer questions.**

# Section Six

## Laboratory Hazard Control Measures & Equipment

### 6.1 General

1. EH&S will measure an employee's anticipated worse-case exposure to any regulated hazardous chemical if there is reason to believe that exposure levels for that chemical routinely exceed the action level [one-half of the Cal-OSHA Permissible Exposure Level (PEL)], or in the absence of an action level, the (PEL) or Threshold Limit Value (TLV).
2. Routine monitoring of airborne concentrations is not usually justified nor practical in laboratories, but may be appropriate when testing, redesigning or introducing new fume hoods or other exhaust ventilation devices, or when a highly hazardous chemical or process is used in a manner which is likely to cause exposure.
3. The CHO and EH&S will promptly investigate all employee-reported incidents in which there is a possibility of employee overexposure to a hazardous chemical. If you suspect that chemical exposures may exceed the PEL, contact the CHO. If symptoms are present, arrange for a visit to SSU's authorized medical facility.
4. Events or circumstances that might reasonably constitute overexposure include:
    A. A hazardous chemical leaked, spilled, or otherwise was released in an uncontrolled manner.
    B. Direct skin or eye contact with a hazardous chemical.
    C. Faculty or staff manifests symptoms, such as a headache, rash, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgment, and
    D. 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.
    E. Two or more persons in the same laboratory work area have similar complaints.

### 6.2 Chemical Control Criteria Guidelines

Exposures by inhalation of airborne contaminants (gases, vapors, fumes, dusts, and mists) must not exceed levels listed as permissible exposure limit (PEL) by Cal-OSHA. These PEL levels refer to airborne concentrations of substances and represent conditions under which it is believed that workers may be repeatedly exposed without adverse effect. PELs are normally published on manufacturer's Safety Data Sheets (SDS), which are available in the laboratory area or through EH&S.

In all cases of potentially harmful exposure, feasible engineering or administrative controls must first be established. In cases where respiratory protective equipment alone or with other control measures is required to protect the employee, the protective equipment must be approved by the CHO for each specific use.

## 6.3 Hazard Control Prioritization

No laboratory can rely on one particular type of control technology to ensure that exposures to hazardous chemical agents are kept as low as reasonably achievable. The primary and most effective approach is through the use of engineering controls. Complementing the engineering controls should be the correct combination of administrative procedures and the use of personal protective equipment.

## 6.4 Recirculation of Air

Recirculation of contaminated exhaust air in laboratories using toxic, corrosive, flammable or other hazardous agents is prohibited.

Laboratory facilities using carcinogens and acute toxins that if released, could pose a personal injury or environmental impact risk, shall be designed so that a negative pressure differential exists between the laboratory and the exit corridor(s) servicing the laboratory. The only exception to this is where clean room requirements mandate that the room be under positive pressure with respect to the surrounding facilities.

## 6.5 Laboratory Hoods

### 6.5.1 General Principles

1. Laboratory exhaust hoods should be considered as backup devices that can contain and exhaust toxic, offensive, or flammable materials when the material being used on the design of an experiment causes vapors, gas, or dust to escape from the apparatus being used.
2. Hoods are <u>not</u> regarded as a means for disposing of chemicals.
3. Hoods should be evaluated by operators prior to and during each use by means of simple visual indicators (such as flow meters, pressure meters, or mylar strips) for adequate airflow.
4. Except when adjustments of apparatus within the hood are being made, the hood sash should be kept closed. If the hood does not have a bypass grill, then the sash should be left open at least six inches to avoid the flow from being choked off. Vertical sashes should be left down and horizontal sashes closed. Sliding sashes should not be removed from horizontal sliding-sash hoods.
5. During operations, keep the face opening of a hood as small as possible to improve the performance of the hood. Reducing the opening in the laboratory hood may also provide protection from explosions due to chemical reactions, over pressurization, etc.
6. Performance of a hood depends upon such factors as the placement of materials and equipment in the hood, room drafts from open doors or windows, turbulence caused by persons walking by, and the presence of the user in front of the hood. Keep apparatus back from the front edge of the hood to reduce the potential for contaminant release.

7. Hoods are not intended for storage of chemicals. Materials stored in hoods should be kept to a minimum. Stored chemicals should not block vents or alter airflow patterns. Chemicals not in use should be covered or capped.
8. Laboratory workers should be prepared for the event of ventilation failure or other unexpected occurrences such as fire or explosion in the hood.
9. Mechanical ventilation must remain in operation at all times when hoods are in use and for a sufficient time thereafter to clear hoods of airborne hazardous substances. When mechanical ventilation is not in operation, hazardous substances in the hood must be covered or capped off.
10. Hoods must be inspected frequently and cleaned as necessary to ensure adequate airflow and the prevention of residue buildup. The Facilities Department shall conduct an annual ventilation survey and post flow rate and date of test on each hood.

### 6.5.2 Hood Construction

1. Newly purchased laboratory hoods and installed exhaust ducting for solvent operations shall be constructed of non-combustible materials to reduce the potential of damage should a fire occur within the workstation.
2. Newly purchased laboratory hoods and exhaust ducting for corrosive applications shall be constructed from or coated with, materials that are resistant to corrosive compounds.
3. Provisions must be made for adequate make up air for all hoods that are used in a laboratory.
4. General airflow should not be turbulent and should be relatively uniform throughout the laboratory.
5. Laboratory-type hood face velocities (including wet bench enclosures) must be sufficient to maintain an inward flow of air at all openings into the hood under normal operating conditions. Air flow into hoods depends upon configuration but must be at a minimum average face velocity of at least 100 linear feet per minute (lfpm) with a minimum of no less than 70 lfpm at any point, except where more stringent special requirements are identified. Hoods used for carcinogen control must have minimum face velocity of 150 lfpm with a minimum of 125 lfpm at any point.
6. The face velocity must be obtainable with the movable sashes opened at least 18". Where the required velocity can be obtained by partly closing the sash, the sash and/or jamb must be marked to show the maximum opening at which the hood face velocity meets the requirements. Any hood failing to meet the requirements must be considered deficient in airflow and must be posted with placards, plainly visible, which prohibit use of hazardous substances within the hood.
7. When sufficient quantities of flammable gases or liquids are used, or when combustible liquids are heated above their flash points, hoods that are not bypassed must have permanent stops installed which restrict closure of the sash so that sufficient airflow is maintained to prevent explosions. Concentrations in the duct must not exceed 10% of the lower explosive/flammable limit.
8. Exhaust fan systems must be non sparking where ignition sources are isolated if exhausting sufficient quantities of flammable vapors and corrosion resistant if handling corrosive fumes.

9. Exhaust stacks must be located in such a manner with respect to air intakes as to preclude the recirculation of laboratory hood emissions within a building.
10. Laboratory hoods must be seismically braced to prevent toppling or sliding during an earthquake.
11. Perchloric acid must be used in a closed system or within a specially designated acid fume hood with wash down systems to prevent the accumulation of explosive perchlorates in the fume hood.

## 6.6 Other Ventilation Systems

Other local exhaust systems used in the laboratory, should be coordinated by Facilities Department in accordance with ACGIH, American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), National Fire Protection Association (NFPA) requirements and other nationally recognized standards.

Do not attach canopy hoods or snorkel systems to existing fume hood exhaust ducts without consulting Facilities.

Glove boxes generally operate under negative pressure, though some operate under positive pressure, in which case, leaks could cause problems. Positive pressure glove boxes should be thoroughly tested before each use and there should be a method of monitoring the integrity of the system (such as a shutoff valve or a pressure gauge designed into the system).

Laboratory apparatus that may discharge hazardous vapors (vacuum pumps and distillation columns) should be vented to an auxiliary local exhaust system such as direct ducting, canopy, or snorkel hoods.

## 6.7 Safety & Emergency Equipment

### 6.7.1 Equipment Guarding

1. All machining, test and mechanical equipment shall be adequately furnished with guards that prevent access to hazardous electrical connections, pinch points or moving parts.
2. All guards should be inspected before using equipment.
3. Faculty/Staff shall not turn on, use, repair, or operate any hazardous laboratory equipment unless trained and authorized by the responsible lab technician or faculty member.

### 6.7.2 Shields

Safety shields must be used for protection against possible explosions or uncontrolled reactions. Laboratory equipment must be shielded on all sides so that there is no line-of sight exposure to personnel. The sash on a chemical fume hood is a readily available partial shield. However, a portable shield must also be used, particularly with hoods that have vertical-rising sashes rather than horizontal-sliding sashes for operations having the potential for explosion such as:

1. Whenever a reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards); and
2. Whenever a familiar test or reaction is carried out on a larger than usual scale.

### 6.7.3 Pressure

Standards for the use of pneumatic and high-pressure hydraulic equipment are available in American Society of Mechanical Engineering (ASME) documents however; the following are additional requirements for laboratory operations:

1. Reactions should never be carried out in, nor heat applied to, an apparatus that is a closed system unless it is designed and tested to withstand pressure.
2. Pressurized apparatus shall have an appropriate relief device.
3. If the reaction cannot be opened directly to the air, an inert gas purge and bubbler system should be used to avoid pressure buildup.
4. All pressurized gas cylinders and systems shall be installed and used in accordance with Safe Operating Procedures developed by faculty or lab technicians and approved by EH&S for safe equipment usage, handling, and storage.

### 6.7.4 Eyewash & Showers

1. Eyewash fountains are required if the substance in use presents an eye hazard (e.g., any corrosive). The eyewash fountain must provide a soft stream or spray of aerated water.
2. Safety showers must be provided in areas where a corrosive chemical or rapid fire hazard exists, for immediate first aid treatment of chemical splashes and for extinguishing clothing fires. The shower must be capable of drenching the victim immediately in the event of an emergency.
3. Eyewash fountains and safety showers should be located close to each other so that, if necessary, the eyes can be washed while the body is showered. Access to these facilities must remain open at all times and within ten seconds of travel distance. In case of accident, flush the affected body part for at least 15 minutes. Report the accident to 911 for assistance.
4. Eyewash and showers shall be tested and flushed by Facilities personnel at least monthly to ensure that they are operating properly. Inspection tags must be filled out to document testing. Faulty equipment shall be repaired by Facilities, when problem is identified or upon request.

### 6.7.5 Fire Extinguishers

Laboratories using hazardous chemicals should have a BC or ABC rated, dry chemical fire extinguisher in close proximity of any exit for use on ordinary combustibles, flammable liquids, and electrical fires. If additional extinguishers are needed for an area, contact EH&S for information concerning recommendations and requirements.

### 6.7.6 Flammable Liquid Storage Cabinets

1. Generally, a minimum amount of flammable liquids necessary for normal lab operations should be kept on hand and stored in a cabinet.
2. Capacity should not exceed the volume capacity rating of each chemical storage cabinet.
3. Cabinets must be labeled "Flammable - Keep Fire Away."
4. Storage of flammable liquids in excess of ten gallons must be in an UL listed, Factory Mutual (FM) approved, flammable liquids storage cabinet.
5. Flammable liquids storage cabinets should be used for the storage of flammable and combustible liquids only. Do not store corrosives, oxidizers, or reactive chemicals with flammable or combustible liquids.

(Note: A storage cabinet for flammable liquids is not fireproof, but only protects the contents from extreme temperatures for a limited time to allow evacuation of personnel and prompt entry of fire fighters.)

## 6.8 Preventative Maintenance

### 6.8.1 Equipment Maintenance

Proper equipment maintenance is important for safe and efficient operation. Equipment should be inspected and maintained on a regular basis. Preventative equipment maintenance, (e.g., vacuum pump oil change outs) and facilities- related equipment (e.g., HVAC, ventilation hoods) is maintained by Facilities.

### 6.8.2 Exhaust Ventilated Hood Performance Evaluations

1. All hoods are checked by the Facilities Department when they are first installed and annually thereafter, for adequate ventilation performance. Performance measurements and the initials of the individual performing the test are left on the hood as record to verify performance.
2. Performance of a ventilation system must be checked whenever there has been a change in a system or location.
3. Laboratory ventilation equipment scheduled for maintenance or repair work must be cleaned and/or decontaminated. Facilities Department workers have the right to refuse to do work if the area or equipment is not clear of hazards.
4. All ventilation systems need routine maintenance to prevent blocked or plugged air intakes and exhaust, loose belts, bearings in need of lubrication, motors in need of attention, corroded duct work, and component failure.
5. Filters should be replaced periodically in certain types of ventilation systems, such as electrostatic precipitators and cyclones for dust collection.
6. Ventilation system monitoring devices such as a magnehelic gauge or digital flow meter should be installed in ventilation systems that control certain highly toxic operations, such as those involving carcinogens, to notify the user of malfunctions.

## 6.9 Laboratory & Equipment Decommissioning

The Dean of The School of Science and Technology is ultimately responsible for assuring that all laboratory space occupied by their programs and/or activities is maintained free from undue hazards. In particular, when vacating laboratory space, the Dean must ensure that all chemicals, radioactive materials, and/or hazardous wastes are removed and properly disposed. The Chemistry Technician and CHO can provide assistance in labeling, packaging and removing chemicals and waste. If laboratory premises are left in an environmentally unacceptable state, it may be necessary to obtain the services of outside contractors to identify and dispose of unidentified chemicals and waste. Should this be necessary, the costs of these services will be borne by the vacating organization.

When occupying new space, Laboratory supervision is advised to assure that said space is free from hazards. Please call the CHO and/or EH&S.

Equipment which is being surplused, readied for transport to another facility, or disposed of must be checked for hazardous material contamination as part of the decommissioning process. Equipment decommissioning and decontamination may require support from EH&S, Facilities Department and/or outside contractor services. The Dean of The School of Science and Technology is responsible to ensure that the decommissioning process leaves the equipment free of hazardous contamination prior to off-site transport or shutdown in place.

# Section Seven

## Hazardous Materials Disposal and Spill Response

### 7.1 Introduction

The information provided in this section is a practical overview of the guide to Hazardous Waste Management. The purpose is to ensure that waste is handled in a safe, legal, and cost effective manner. More detailed information can be found in SSU's Hazardous Waste Management Policy or in the SSU Spill Response Plan on file with EH&S.

### 7.2 Identification of a Hazardous Waste

The general definition of hazardous waste is any substance which exhibits characteristic(s) of flammability, reactivity, corrosivity, or acute or chronic toxicity. Substances which may lack these characteristics may also be considered hazardous due to their concentration or quantity. A substance is only considered a waste after it is determined unusable.

### 7.3 Containers

Only those containers which are provided and approved by EH&S will be used for the containment of hazardous materials and their waste(s). Check with EH&S for the locations of empty hazardous waste containers. It is critical that each container be labeled properly. Labels shall include, though not limited to, name of waste and date of generation. It is important that hazardous waste is collected in Department of Transportation approved containers and drums to prevent unnecessary re-containerization of hazardous waste. Examples of properly labeled containers can be found in the Hazardous Waste Container Labeling Guide, located online at http://www.sonoma.edu/ehs/hazmat/waste_management.html

### 7.4 Notification

EH&S shall be notified prior to the commencing of activities that may generate hazardous wastes. In the event of a spill or contamination by hazardous materials, EH&S shall be notified immediately.

## 7.5 Hazard Communication

Information on hazardous properties of chemical substances is generally accessed through the Safety Data Sheet:

### 7.5.1 Safety Data Sheets

Manufacturers and distributors are required to develop a safety data sheet (SDS) for each hazardous material they produce or import. All SDSs provide information regarding; the specific chemical identity of the material(s) involved and their common names, information on physical and chemical characteristics, known acute and chronic health effects and related health information, exposure limits, precautionary measures, emergency and first aid procedures, and the identification of the organization responsible for preparing the sheet. Reference Appendix Five for details on "using The Safety Data Sheet". Safety Data sheets are discussed in detail in the SSU Hazard Communication Program.

Every work area that uses hazardous materials must have, readily accessible to the employees, an SDS for every hazardous material used in the area. If an SDS is inadvertently not received at the time of the first shipment, a copy may be obtained from any campus computer with internet access at **http://www.sonoma.edu/ehs/hazmat/msds.html** or through the manufacturer.

Laboratory supervision must maintain an accurate and up to date inventory of SDSs for their area. The inventory made be maintained online through the MSDS Online system.

# Section Eight

## Training and Employee Information

### 8.1 Introduction

Faculty and Staff must be provided area-specific training on the hazards to which they may be exposed and the means to avoid these hazards. Training must be updated when a new hazard is introduced into the workplace. Training is provided and documented as follows:

1. Students – Instructor is responsible for student safety, ensuring proper training, and personal protective equipment in labs. Every student training must be documented by the current School of Science and Technology form and/or method and retained for three years.
2. New Faculty and/or Staff must receive in person, online through campus system, and/or "On the Job Training" OJT. Within the first 90 days of work. The training will be facilitated by the CHO and EH&S, but it is faculty and staff responsibility to ensure access is available to the necessary training and it is completed. All training must be documented and retained as required.

For additional information on Hazard Communication, refer to the SSU Hazard Communication Program. For additional information on Training Requirements, see the SSU "Injury and Illness Prevention Program".

As a minimum, area-specific training must include:

1. The use of safe work practices,
2. An indication of which operations involve hazardous materials;
3. Potential chemical, physical, and/or biological hazards;
4. Applicable health and safety standards;
5. Purpose and results of exposure monitoring for chemical and physical hazards;
6. Purpose and use of control measures;
7. Requirements for use of personal protective equipment (See Appendix Four);
8. Detection systems, odor and irritation threshold for chemicals, monitors, alarms, odors, symptoms, etc.;
9. Safety data sheet-location and how to use (See Appendix Five);
10. The requirements of the Hazard Communication & Chemical Hygiene Standards;
11. Non-routine tasks; and
12. Labeling, Postings, and Signage Requirements.

13. When working with Hazardous Materials in the lab, information regarding the material and its possible reproductive effects shall be provided. (See Appendix Seven)
14. While working in the lab, all should be cognizant of the existence of special hazards concerning pregnant women, women of childbearing age, and for those planning to have children. (See Appendix Seven)

## 8.2 Responsibilities

It is the faculty or staff member's responsibility to work safely and ensure that the students work safely to prevent harm to themselves, the general public and environment. SSU safety standards must be observed. To assist Faculty and Staff, general health and safety training is coordinated by EH&S upon request. Any condition that may lead to a violation of these standards must be reported immediately to the CHO or EH&S. Faculty and Staff are obligated to stop work under unsafe conditions. Report any injuries received on the job. In addition, Faculty and Staff are obligated to respond to emergencies by following laboratory emergency procedures.

Faculty and Staff must be made aware of the various building/fire codes, EPA/OSHA standards and emergency procedures to use if an accident should occur and other codes/regulations impacting their activities. This is the responsibility of the EH&S and the CHO. Examples of training required for Faculty and Staff includes:

1. Hazard Communication
2. Chemical Hygiene & Safety in the Laboratory
3. Hazardous Waste Generator Training
4. Emergency Procedures

Other training that may be required depending on lab assignments, chemical agents and/or physical hazards includes:

1. Radiation Safety
2. Respirator Use
3. Laser Safety
4. Specialized Chemical Safety Training
5. Hearing Conservation
6. CPR
7. First Aid
8. Fire Extinguisher Use
9. Lockout, Tag-out and Electrical Safety

## 8.3 Resources

Information on hazardous properties of chemical substances can be accessed through Safety Data Sheets and Key Laboratory Safety references discussed in Section Twelve. For a

thorough discussion on how to use and understand Safety Data Sheets reference Appendix Five and/or the Hazard Communication Program. Additional reference material can be found in the chemical stockroom or the EH&S office, including online references training at https://web.sonoma.edu/ehs.

## 8.3 Chemical Hygiene Committee

Sonoma State University has elected to maintain a Chemical Hygiene Committee. The goal of the committee is it communicate information related to maintaining safe and efficient laboratory operations that meet regulatory and campus requirements.

The Committee is made up of a representative from Biology, Chemistry, Geology, Physics, Engineering, Environmental Health & Safety, and the Science and Technology Administrative Office. The committee will meet once per semester and at a minimum will review completion status of laboratory inspections and closure of issues identified during the inspection, review of any incidents, and a general update by each department.

Additional communications will primarily be conducted via email as appropriate and if there is the necessity to meet an additional time anyone can make such a request.

# Section Nine

## Medical Consultations and Monitoring

### 9.1 Criteria for Selection

SSU has established a Medical Surveillance Program to monitor the health status of faculty and staff with respect to the hazards of the materials and process equipment they use. This Section summarizes those requirements.

Medical consultation and examinations are provided under the direction of consulting physician(s) at a contract medical services facility. The primary objectives of the Medical Consultation and Monitoring program are:

- To ensure that staff and faculty are assigned duties they are physically able to perform.
- To provide medical care and rehabilitation of the occupationally ill or injured.
- To provide emergency treatment of serious illnesses or injuries.
- To encourage staff and faculty to maintain their physical and mental health.
- To assist in maintaining a healthful and safe work environment.

Pre-employment and termination examinations are provided as necessary based on the job hazards. The current types of chemicals used and operations performed at SSU limits the necessity to include many employees in the comprehensive medical surveillance program. This policy will be reviewed by the CHO and EH&S annually. Specialized Examinations may be required for the following, as determined by the EH&S or the CHO:

- Individuals returning to work following non-occupational illness or injury;
- Individuals returning to work following occupational illness or injury;
- Individuals with significant potential for internal exposure to radioisotopes;
- Individuals using regulated, known human or highly suspect human carcinogens or reproductive tract toxins; and
- Individuals using an OSHA-regulated compound (e.g., inorganic arsenic) that exceeds the action level as specified by the OSHA standard.

The use of the following California regulated carcinogenic compounds (and similarly toxic chemicals) requires special diligence on the part of the faculty that include demonstrated compliance with pertinent regulations that are approved by CHO and EH&S prior to bringing chemicals to campus:

1. Methylene dianiline

2. Cadmium and cadmium compounds (see EH&S for exceptions)
3. Asbestos (if determined to be present in airborne concentrations of 0.1 fiber per cubic centimeter of air; average for 8 hour exposure)
4. Non-asbestoform Tremolite, Anthophyllite, and Actinolite
5. Vinyl chloride
6. Coke oven emissions
7. 1,2-dibromo-3-chloropropane (DBCP)
8. Acrylonitrile
9. 4,4'-methylenebis (2-chloroaniline)
10. Lead (see EH&S for exceptions)
11. Formaldehyde (see EH&S for exceptions)
12. Benzene (see EH&S for exceptions)
13. Ethylene dibromide
14. Ethylene oxide

Reference Appendix Six for a complete list of Cal-OSHA Select Carcinogens.

Proper storage and use facilities should be in place prior to ordering. Use of these types of compounds shall involve a faculty-initiated warning given to EH&S prior to arrival on campus. This will alert EH&S to advise on requirements for proper containment, OSHA monitoring standards, waste removal and appropriate signage.

## 9.2 Hazardous Materials and Reproductive Effects

Both men and women may be exposed to hazardous agents that pose a reproductive hazard such as infertility, hormonal changes, birth defects and genetic damage. These agents include ionizing radiation, alcohol, cigarette smoke, pharmaceuticals, and some of the thousands of different chemicals that are used in the home or workplace. Although many of these have been tested to determine whether they cause acute (immediate) effects on the body, few have been studied to see if they cause birth defects (teratogens) or genetic defects (mutagens). Even fewer have been studied to see if they can cause infertility, reduced sperm count, menstrual disorders, or other disorders relating to reproduction. Therefore, EH&S and the CHO shall consider the potential reproductive effects of chemicals prior to selecting materials for use, and where feasible, preclude or limit their use. Reference Appendix Seven for more information.

## 9.3 Hazardous Materials and Pregnancy

The primary path for hazardous substances to reach an unborn child is through the placenta. Many chemicals and drugs that enter a pregnant woman's body (through breathing, swallowing, absorption through the skin, etc.) will eventually enter the mother's blood circulation, cross the placenta and thus affect the developing fetus. In general, the important questions of exactly how much of the toxic substance that enters the mother's body will reach the fetus, or what concentration the fetus can tolerate without harmful effects have not yet been answered.

The fetus is usually most vulnerable in the early weeks of pregnancy (first 13 weeks or trimester) but may also be at risk later in pregnancy. In light of the potential harm from workplace exposures to both the pregnant woman and her developing fetus, it is important for the woman to inform her supervisor of her pregnancy as soon as possible, so that necessary steps to avoid exposure to reproductive toxins can be taken. This recommendation is not intended to discriminate against women; rather, it is intended to provide the pregnant woman with information about the possible hazards and her options.

# Section Ten

## Recordkeeping

Accurate documentation and recordkeeping of exposure monitoring, medical surveillance and health and safety training is an important component of this CHP. This section defines the recordkeeping requirements for important aspects of the Plan.

### 10.1 Specific Recordkeeping Responsibilities:

Current chemical inventories and Safety Data Sheets for each laboratory shall be readily available for staff and faculty access and reference in the event of an emergency. *Responsibility: Principal Investigator in Research and Chemical Technician in GE Labs.*

Exposure records for hazardous chemicals and harmful physical agents will be maintained for 30 years from end of employment per 29 CFR 1910.20. *Responsibility: EH&S and CHO.*

Medical records for staff or faculty exposed to hazardous chemicals and harmful physical agents will be maintained for the duration of employment plus 30 years per 20 CFR 1910.20. *Responsibility: EH&S.*

Additionally, the following records must be kept for a minimum of three years:

1. Staff and Faculty Training Records-will be held by EH&S, while Student Records are held by faculty. Student records must be held for three years. *Responsibility. EH&S for staff and faculty and Faculty for students.*
2. Lab Safety inspections records maintained by Faculty for a minimum of three years, including follow up corrective actions. *Responsibility: Faculty.*
3. Ensure semi-annual lab inspections and Facilities preventative maintenance are audited annually to ensure compliance. *Responsibility: EH&S*
4. Area Sponsored or Area Specific Classes including Training on Safe Work Practices presented to students by faculty or staff; *Responsibility: Faculty.*
5. Accident Investigations. *Responsibility: School Dean of Science and Technology, EH&S and CHO.*
6. Lab Safety Committee Meetings; *Responsibility: CHO.*

# Section Eleven

## Requirements for the Use of High Hazard Materials and Equipment

### 11.1 Chemical Carcinogens

#### 11.1.1 Introduction

This section describes the recommendations and requirements established to govern the use of substances that pose a potential carcinogenic risk. All SSU personnel using chemical carcinogens are expected to be familiar with these standards and guidelines and conduct their operations accordingly.

#### 11.1.2 Purpose

The purpose of these guidelines is to assist the faculty and staff in the selection and use of appropriate safeguards. These safeguards consist of good laboratory practices and engineering controls that permit the safe use of high hazard chemicals and maintain exposures to these substances as low as reasonably achievable. In selecting appropriate safeguards, specific attention must be given to:

1. The quantity of the chemical carcinogen used;
2. The physical and chemical properties;
3. The carcinogenic potency;
4. The type of research and experimental procedures involved;
5. The engineering controls available in the laboratory; and
6. The applicable health and safety standards.

#### 11.1.3 Scope

Cal-OSHA has developed a list of "select carcinogens". (This list is included in Appendix Six). These are chemicals that are listed as known or probable human carcinogens by any of the following sources:

1. American Conference of Governmental Industrial Hygienists (ACGIH);
2. International Agency for Research on Cancer (IARC);
3. National Toxicology Program (NTP); and
4. Occupational Safety and Health Administration (OSHA).

### 11.1.4 Responsibilities

The responsibilities of various groups involved with chemical carcinogen safety at SSU are briefly described below. A more detailed review of general EH&S responsibilities is provided in Section Two of this document.

#### *11.1.4.1 SSU EH&S*

1. Recommends and reviews policies and procedures that provide for the safe conduct of work involving high hazard materials such as carcinogens; and
2. Reviews the status of compliance with these established practices.
3. Investigates all reported incidents that result in exposure of personnel or the environment to chemical carcinogens and recommends corrective actions to reduce the potential for recurrence; and
4. Supervises cleanup operations where incidents have resulted in significant contamination of laboratory areas or personnel.
5. Determines if the use of a carcinogen creates a significant potential for occupational exposure;
6. Evaluates operations for compliance with OSHA requirements;
7. Provides technical guidance to personnel and students regarding the selection of appropriate laboratory practices and engineering controls;

#### *11.1.4.2 Faculty and Staff*

1. Prepares safety plans, specific laboratory Safe Work Practices, or experimental and research protocols describing the use of a chemical carcinogen and the procedures used to control exposure before the initiation of an operation or when significant process changes occur;
2. Employs and ensures the use of appropriate laboratory practices, engineering controls, and personal protective equipment that reduce the potential for exposure to that which is as low as reasonably achievable;
3. Informs students under his/her supervision of the potential hazards associated with the use of carcinogens and provides proper training and instruction in the use of laboratory practices, engineering controls, and emergency procedures;
4. Conducts an annual review of specific laboratory Safe Work Practices;
5. Reports to the CHO any incident that results in the exposure of personnel to carcinogens;
6. Reports to EH&S any incident that results in danger of environmental contamination from carcinogens; and
7. Provides any necessary assistance during accident investigations.

#### *11.1.4.3 Faculty will ensure Students*

1. Know and comply with laboratory safety practices required for the assigned task;
2. Wear appropriate protective clothing;
3. Report all unsafe conditions to the supervising faculty or staff member;

4. Attend appropriate training in safety procedures for handling and using carcinogenic materials provided by the faculty member;
5. Report to the supervising faculty or staff member when they first become pregnant to review upcoming lab working conditions; and
6. Report to the CHO all facts pertaining to incidents resulting in exposure to carcinogens or environmental contamination.

### 11.1.5 Laboratory Practices and Engineering Controls

The laboratory practices and engineering controls included in this section provide general safeguards that are recommended for the use of chemical carcinogens. To select the appropriate safeguards, knowledge is required of the physical and chemical properties, the proposed use, the quantity needed, the carcinogenic and other toxic hazards, and the applicable health and safety standards. Careful judgment is therefore essential in planning any activity that involves chemical carcinogens. The CHO is available to assist the faculty and staff in selecting the appropriate safeguards.

#### *11.1.5.1 Personal Practices*

1. Lab coats are required when whenever working in the laboratory environment.
2. Wear gloves appropriate to the task. Discard after each use and immediately after any obvious contact.
3. Wear appropriate eye protection. The type of eyewear used will depend upon the hazard presented by the operation and chemical in use. Contact lenses should be removed.
4. Do not eat, drink, smoke, chew gum or tobacco, apply cosmetics or store utensils, food, or food containers in laboratory areas where chemical carcinogens are used or stored.
5. Do not pipette by mouth--use mechanical aids.
6. Wash hands immediately after the completion of any procedure. Wash immediately after exposure, or if appropriate, shower the affected area.

#### *11.1.5.2 Operational Practices*

1. Label all primary and secondary containers. To determine appropriate labels and signs, contact the CHO and or reference https://web.sonoma.edu/ehs for guidance. (Reference labeling requirements discussed in Section 5.10 of this Plan).
2. Limit entry to personnel authorized by the supervising faculty for entry to work or storage areas. Women who are pregnant should consult with the CHO before the start of any laboratory activity involving chemical carcinogens. Facilities Department and emergency personnel must be advised of potential problems and hazards before entering these work or storage areas.
3. Cover work surfaces with stainless steel or plastic trays, absorbent paper with a moisture-proof lining, or other impervious material. Decontaminate or discard the protective covering materials as a hazardous waste after the procedure has been completed.
4. Conduct aerosol-generating procedures or procedures involving volatile carcinogens in a chemical fume hood, a glove box, or other suitable containment

equipment. Examples of aerosol-producing operations include the opening of closed vessels, transfer operations, preparation of mixtures, blending, sonification, open vessel centrifugation.

5. Capture vapors or aerosols produced by analytical instruments with local exhaust ventilation or ventilation into a chemical fume hood.
6. Decontaminate obviously contaminated equipment.
7. Transfer carcinogens in tightly closed containers placed within a durable outer container.
8. Maintain an inventory of all carcinogens including the quantities acquired, dates of acquisition, and disposition.
9. Keep working quantities to a minimum; do not exceed the amounts required for use in one week. This does not include amounts stored in a designated area or a cabinet that is located within the laboratory.
10. Dissolve finely divided powdered carcinogens, if possible, into a liquid. This reduces the possibility of generating an aerosol.
11. Use mixtures that are as dilute as possible.
12. Place contaminated materials in a closed plastic bag and sealed primary container. Place the primary container in a durable box before transporting.
13. Inactivate carcinogens, if possible, before disposal. Consult with EH&S for additional information on waste disposal.
14. When cleaning, use a wet mop or vacuum cleaner equipped with a high efficiency particulate (HEPA) filter to remove dusts. Do not dry sweep or dry mop.
15. Protect vacuum lines, pumps, and equipment with absorbent liquid trap and a HEPA filter to prevent entry of any chemical carcinogens into the system. When working with volatile carcinogens, use a separate vacuum pump placed within or vented to a chemical fume hood. This pump should be labeled for carcinogen use and the oil discarded as carcinogen waste when it is changed.

#### *11.1.5.3 Facility Requirements*

1. Provide a handwashing facility within the work area. The use of a liquid soap is recommended.
2. Provide an emergency eye wash facility in each laboratory. A safety shower should also be installed in the area if corrosive chemicals are being stored, transported or dispensed. The eyewash and/or shower shall be located in close proximity to the chemical operations area.

## 11.2. Toxic Metals and Metal Containing Compounds and Solutions

Toxic metals and metal-containing compounds and solutions may be used in many forms at SSU. This section is intended to provide some general information on such materials which may be found at SSU operations.

### 11.2.1 Arsenic

Inorganic arsenic is a poison. Common routes of exposure include skin contact and inhalation. Skin contact with inorganic arsenic may cause local skin irritation and dermatitis. Exposure to airborne inorganic arsenic may cause lung cancer. Inorganic arsenic is regulated by Cal/OSHA, Title 8, Section 5214 for the control of employee exposure to inorganic arsenic. Cal-OSHA has established the following Control Limits for inorganic arsenic. Exposure may not exceed **10 ug/m$^3$** as an 8-hour time-weighted average.

Cal-OSHA has also established an Action Level of 5 ug/m$^3$ as an 8-hour time-weighted-average triggering additional medical surveillance and monitoring requirements. The CHO will arrange for (or perform) initial and periodic monitoring to ensure that control measures are maintaining arsenic exposure levels as low as feasible. Wipe sampling of surfaces within the work area may also be performed to assess area and equipment surface contamination levels and to monitor adequacy of housekeeping practices. The following items are required for arsenic use operations:

1. **Engineering Controls** are required for all inorganic arsenic operations. Only carcinogen-approved hoods, ventilated equipment or glove boxes may be used to maintain airborne arsenic concentrations at the lowest feasible level.
2. **Written Work Procedures** Safe Work Practices are required for inorganic arsenic laboratory operations. EH&S and the CHO can assist with procedure development and must provide written approval.
3. **Personal Protective Equipment** such as respirators or chemically resistant gloves may be required to minimize potential contact or exposure.
4. **Arsenic Hazard Training** must be included as part of the Hazard Communication training for laboratory personnel working with arsenic.

### 11.2.2 Lead

Lead is a blue-gray metal which may be used in SSU laboratory operations to demonstrate chemical reactions and properties. The primary routes of exposure to lead are inhalation of airborne lead fume released from hot soldering or lead bath operations, and inhalation and/or ingestion of lead dust released from grinding, sanding, polishing, or otherwise abrading lead-containing materials. Exposure to lead can cause damage to the blood forming, urinary, nervous, and reproductive systems. Inorganic lead is regulated by Cal-OSHA, Title 8, Section 5216 for the control of employee exposure to inorganic lead. The following information is a highlight of applicable regulatory and handling guideline information for laboratory operations using lead.

The Cal-OSHA Permissible Exposure Limit (PEL) for lead is **50 ug/m$^3$**. The PEL is based upon an 8-hour time-weighted average (TWA) concentration. A Cal-OSHA Action Level of **30 ug/m$^3$** has been established to trigger annual air monitoring and medical surveillance requirements.

The CHO will conduct or arrange for initial and periodic monitoring to ensure that control measures are effective in keeping airborne lead concentrations significantly below the Action Level.

Most laboratory operations are of such short duration using very small quantities of lead that airborne lead concentrations are usually maintained very low. Special care must be exercised for larger scale laboratory operations using lead. Lead is a poison and exposure should be minimized as much as possible by following the guidelines below:

1. **Engineering Controls** are required to control lead exposures to at least the PEL or below, but should also be used whenever it is possible to further minimize lead exposure. Ventilation equipment used to control lead exposure must be inspected and tested at least every three (3) months.
2. **Written Safe Work Practices** are required for any laboratory lead handling operations which are capable of generating lead exposures in excess of 25% of the PEL (12.5 micrograms per cubic meter of air). The CHO can assist with the evaluation and any necessary procedure development and must provide written approval.
3. **Personal Protective Equipment** such as respirators or disposable protective clothing may be required as a protective or temporary exposure control measure.
4. Good Housekeeping is essential when working with lead. All surfaces must be maintained as free as possible of lead accumulation. Surface cleaning using compressed air or sweeping is prohibited. Use wet methods (such as wet rags) or special high efficiency vacuums for safe surface cleaning.
5. Medical Surveillance is required for all personnel working with lead where the Action Level may be exceeded more than 30 days/year. Detailed medical surveillance requirements are provided in the Cal-OSHA Standard for lead and will not be detailed here.
6. Lead Handling Training is required for any personnel with potential lead exposure. The CHO should be consulted to determine the level of necessary training and to support training arrangements.
7. Lead and lead-contaminated materials must be properly packaged and labeled. See EH&S for more information on packaging and labeling.

Many of the detailed Cal-OSHA requirements for lead are not normally applicable to laboratory operations due to small quantity use, short operation duration, and the usual low potential for significant lead exposure. The Cal-OSHA Standard is available from The CHO.

## 11.3 Reactive Chemicals

### 11.3.1 Peroxidizable Compounds

Isopropyl ether, ethyl ether, dioxane, tetrahydrofuran, and other alkyl ethers form peroxides on exposure to air and light. Because these chemicals are packaged in an air atmosphere, peroxides can form even though the containers have not been opened. The longer the storage period of these chemicals, the greater the amount of dangerous peroxides that may form. Experience has shown that isopropyl ether is by far the worst offender.

#### *11.3.1.1 Hazards*

When peroxides form, they are highly unstable, explosive chemicals that may detonate if subjected to high temperature, shock, or friction. Concentration by evaporation or distillation of the ether increases the risk of detonation.

#### *11.3.1.2 Precautions*

1. Ethers containing an inhibitor should be purchased when possible.
2. Ethers should be kept in cans rather than glass bottles.
3. Ethers should be stored in as cool a location as feasible (but not stored in refrigerators unless explosion proof).
4. Ethers should always be tested for peroxide content before any distillation procedure and, of course, should not be used if peroxides are found to be present.
5. Safety shields should be placed in front of reaction vessels or distillation apparatus in hoods when they involve ethers.
6. At least 10% bottoms in distillation should be left.
7. Any container of uncertain age or condition must not be opened, particularly when the cap or stopper is tightly stuck.
8. Suspected containers must not be removed or disposed of. Contact EH&S for assistance.
9. Containers of ether must have the red label that indicates the date of purchase, attached to the outside surface. These labels should be applied by the user. The container shall be labeled when received and when it is opened by the user. The CHO will assist with labels, as required.

## 11.4 Solvents

Some of the operations at SSU use organic solvents. These solvents are used in typical laboratory operations. This section provides some general guidelines and background information on these materials. Examples of solvents used at SSU include reagent alcohol, isopropyl alcohol (IPA), methanol, acetone, benzene, toluene, dichloromethane, chloroform, and carbon tetrachloride. Some of these solvents are flammable and most of them cause narcosis upon prolonged inhalation and defatting of the skin upon prolonged or repeated contact.

### 11.4.1 Flammable and Combustible Solvents

#### *11.4.1.1 Classifications*

Flammable and combustible liquids (many are solvents) are defined and divided into classes as shown below.

1. Flammable Liquids (Class I). Liquids having flash points below 100°F (37.8°C) and having vapor pressures not exceeding 40 psi (absolute) at 100°F (37.8°C). Flammable Class I liquids are subdivided as follows:
2. Class IA. Liquids having flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C). Flammable aerosols (spray cans) are included in Class IA.
3. Class IB. Liquids having flash points below 73°F (22.8°C) and having boiling points at or above 100°F (37.8°C).
4. Class IC. Liquids having flash points at or above 73°F (37.8°C) and below 100°F (37.8°C).

### *11.4.1.2 Properties*

Class B combustibles are flammable and combustible liquids (including oils, greases, tars, oil base paints, lacquers) and flammable gases. Flammable aerosols (spray cans) are also included here.

Water should not be applied to fire in a Class B combustible. The use of water may float burning liquids, causing the fire to spread more rapidly. Class B fires usually extinguished by excluding the air around the burning liquid. This is accomplished by one of several approved types of fire extinguishing agents, e.g., carbon dioxide, ABC multipurpose dry chemical, and Halon 1301 (a vaporizing liquid that breaks the flame front).

Technically, flammable and combustible liquids do not burn. However, under appropriate conditions, they generate sufficient quantities of vapors to form ignitable vapor-air mixtures. As a general rule, the lower the flashpoint of a liquid, the greater the fire and explosion hazard. (The flash point of a liquid is the minimum temperature at which it gives off sufficient vapor to form an ignitable mixture with the air near its surface or within its containment vessel). Many flammable and combustible liquids also pose health hazards.

It is the responsibility of the user to ensure that all Class B combustibles are properly identified, labeled, handled, and stored. If assistance is required, contact the CHO.

### *11.4.1.3 Fire Hazards*

Fires involving Class B combustibles are especially dangerous because they release heat quickly, causing the fire to spread rapidly. The handling and use of these combustibles presents a significant source of fire hazard at this Laboratory. Misuse or improper storage threatens not only the researcher and the experiment, but the laboratory unit and the entire building.

Liquids with flash points below room temperature (Class IA and IB liquids) continually emit sufficient quantities of vapors to be ignitable, except when chilled to temperatures below their flash points. Even when chilled, if spilled on a floor or work surface, they will heat rapidly and may pose severe fire and explosion hazards. Liquids with flash points above room temperature (Class IC, II, IIIA, and IIIB liquids) can easily be heated to the point at which they will create flammable vapor-air mixtures.

Flammable liquid vapors are heavier than air. They can travel for appreciable distances and accumulate in low places. Since it is the vapor of a flammable liquid that burns, the fire hazard may not be confined to the immediate vicinity of actual use. Vapors can be ignited several hundred feet from the point of vapor generation. Flammable liquid vapors generally have low ignition-energy requirements and can often be ignited by small sparks from electrical motors, switches, relay contacts, etc.

### *11.4.1.4 Precautions*

Recommended precautions are based on the properties of the liquid to be used and the intended application. The user cannot make a correct decision on necessary precautions unless the properties of the liquid are known and the intended use is reviewed form a safety standpoint.

There must be sufficient ventilation to preclude the accumulation of flammable vapors. Flammable liquids should be used in a fume hood or with local exhaust ventilation. Normal room ventilation may be sufficient to permit small-scale use of flammable liquids (milliliter quantities). However, if larger quantities of liquid must be used in such facilities, it will be necessary to provide additional ventilation by opening doors and windows or providing some form of temporary exhaust ventilation. Extreme care must be exercised when using flammable liquids in closed spaces with minimal ventilation (such as glove boxes and tanks). Even milliliter quantities of flammable liquids can cause the build-up of explosive mixtures in the confined space.

#### *11.4.1.5 Cabinets*

Storage cabinets must be designed and approved for the anticipated usage. Factory Mutual approved metal storage cabinets are available in various sizes from vendors. Not more than 120 gallons of Class I, Class II, and Class IIIA liquids, combined, may be stored in a storage cabinet. Of this total, not more than 60 gallons may be of Class I and Class II liquids, combined, and not more than three such cabinets may be located in a single fire-separation area.

#### *11.4.1.6 Refrigerators*

Ordinary domestic refrigerators must not be used for the storage of flammable liquids because they contain certain built-in ignition sources (such as electrical contacts). These sources of ignition may initiate a fire or an explosion if flammable vapors are present. Refrigerators are now available commercially that are specifically designed and approved for storage of flammable materials. Chemical refrigerators must bear a label which reads as below:

***CAUTION***

**REFRIGERATOR FOR CHEMICAL STORAGE ONLY. NO FOOD OR DRINK.**

#### *11.4.1.7 Allowable Quantities*

To adequately manage the exposure hazards in each building, or fire-separation area in each building, it is necessary to consider the needs of all users, and/or of user groups in aggregate, for each building or fire-separation area. The restrictions set forth below provide guidance for lower usage levels. In general, quantities in excess of one week of usage should not be stored. If the need for larger quantities is anticipated, contact the CHO for assistance.

The maximum allowable quantities of Class B combustibles outside designated and approved storage rooms or facilities are listed below:

1. Less than one gallon of Class I and Class II liquids combined, in glass or plastic containers, is the maximum allowed outside of approved storage cabinets when not actually in use.
2. One gallon is the maximum allowable container size for general dispensing of Class I and Class II liquids unless in an approved safety can.
3. Where more than one laboratory unit is located in a single fire-separation area, all Class I and Class II liquids must be stored in approved storage cabinets or approved safety cans. Ten gallons of Class I and Class II liquids, combined, in approved safety can, is the maximum allowable outside of approved storage cabinets. Five gallons of Class IIIA liquids is the maximum allowable outside of approved storage cabinets or safety cans.
4. For single fire-separation areas, 10 gallons of Class I and Class II liquids, combined, is the maximum quantity allowable outside of approved storage cabinets or approved safety cans.
5. For single fire-separation areas, 25 gallons of Class I and Class II liquids, combined, is the maximum allowable quantity outside of approved storage cabinets.
6. For single fire-separation areas, 60 gallons of Class IIIA liquids is the maximum allowable outside of approved storage cabinets.

### 11.4.2 Chlorinated Hydrocarbons

#### *11.4.2.1 Scope*

The chlorinated hydrocarbons as a whole have many industrial as well as laboratory uses. Examples are chloroform, dichloroethane and carbon tetrachloride.

#### *11.4.2.2 Hazards*

Most of these compounds have an anesthetic (narcotic) effect, causing workers to feel "drunk", become unconscious, or even die if the amount of inhaled vapor is excessive e.g. in a confined space. Individuals working around moving machinery can be subject to accidents when their judgment and coordination are impaired by the anesthetic effects of inhaled solvents. Usually it is the anesthetic effect that is responsible for sudden unconsciousness of persons exposed to solvents in tanks, pits, and other confined spaces.

Some, but not all, of the chlorinated hydrocarbons are strong poisons that damage the liver, kidneys, nervous system, and/or other parts of the body. This damage may be permanent or even cause death, although recovery from lesser exposures does occur.

Single exposures to higher concentrations of vapors, as well as repeated exposure to small concentrations can produce symptoms of poisoning. These symptoms most often come on gradually, with nausea, loss of appetite, vomiting, headaches, weakness, and mental confusion most often noted. Carbon tetrachloride is an example of a compound that is a strong poison.

All chlorinated hydrocarbons, on repeated contact with the skin, can cause rashes (dermatitis) because of their ability to remove the protective fats and oils from the skin. A few of these solvents are known to be capable of entering the body through contact with the skin. In addition, many of these compounds are highly irritating to the membranes around the eyes and in the nose, throat, and lungs. An example of a chlorinated hydrocarbon that has irritant properties is chloroform.

Some compounds are human suspect carcinogens, such as carbon tetrachloride and chloroform. In studies on laboratory animals, several chlorinated hydrocarbons have been linked to the production of cancer. These compounds are ethylene dichloride, perchloroethylene, and trichloroethylene. At present, there is no direct evidence associating these compounds with an increased risk of cancer in man.

When heated, these compounds can decompose, forming highly toxic fumes of phosgene, hydrochloric acid, and chlorine. Most of the chlorinated hydrocarbons are nonflammable; however, there are exceptions. Table 10-1 lists important characteristics of some of the common chlorinated hydrocarbon solvents. Because of their inherent properties, these compounds are harmful to varying degrees. For questions concerning the hazards of a specific compound, contact the CHO.

## Table 11-1 Chlorinated Hydrocarbon Data

| Common name | Chemical name | TLV (ppm)[a] | Volatility[b] (mm Hg) | Flammability |
|---|---|---|---|---|
| Acetylene dichloride | 1,2-dichloroethylene | 200 | 200 | Moderate |
| Carbon Tetrachloride | Tetrachloromethane | 5 | 115 | Nonflammable |
| Chloroform | Trichloromethane | 10 | 200 | Nonflammable |
| Ethylene dichloride | 1,2-dichloroethane | 10 | 80 | Moderate |
| Methyl chloroform | 1,1,1-trichloroethane | 350 | 132 | Nonflammable |
| Methylene chloride | Dichloromethane | 100 | 435 | Nonflammable |
| Perchloroethylene | Tetrachloroethylene | 50 | 18 | Nonflammable |
| Tetrachloroethane | 1,1,2,1-tetrachloroethane | 1 | 8 | Nonflammable |
| Trichloroethane | 1,1,2-trichloroethane | 10 | 25 | Nonflammable |
| Trichloroethylene | Trichloroethylene | 50 | 76 | Nonflammable |

[a]The threshold limit value (TLV) is expressed as parts of pure solvent vapors per million parts (ppm) of air. Refer to Section A.5, Allowable Airborne Concentrations, in this chapter for information on TLV.

[b]The vapor pressure at 77°F (25°C).

#### *11.4.2.3 Precautions*

The above table includes information on the TLV, the volatility, and the flammability of the compounds listed. These three characteristics always must be taken into careful consideration in selecting a compound in order to minimize the health hazards connected with its use. If there is a possibility of skin or eye contact, wear the appropriate protection equipment. Gloves made of impervious material should be worn for hand protection.

For high vapor concentrations, control by local exhaust ventilation or chemical fume hoods is necessary. Contact the CHO for an assessment of the airborne concentration. Chlorinated hydrocarbons should be stored in cool, dry, and well-ventilated areas. Containers should be checked for leaks because metal corrosion can occur from hydrochloric acid produced by the decomposition of the solvent. Decomposition may occur under conditions of high temperature, exposure to moisture, and exposure to ultraviolet light.

Compounds, both in the original containers and in containers used by faculty or staff, should be labeled so that the potentially injurious substances are plainly identified. Labels for can be obtained from the CHO.

Chlorinated hydrocarbons must be placed in a halogonated organic liquid waste can for disposal. When the waste can is in full, contact the EH&S to arrange for a pickup.

## 11.5 Ionizing Radiation

Ionizing radiation is electromagnetic radiation (x-ray or gamma-ray photons) or particulate radiation (alpha particles, beta particles, electrons, and neutrons) capable of producing ions either primarily or secondarily when passing through matter. Handling of ionizing radiation sources and use of machines must be performed in strict compliance with state-mandated procedures and be approved by the campus Radiation Safety Committee to ensure employee, environmental protection, and permit compliance.

The sources of ionzing radiation at SSU are outlined on the universities radiologic license, which is available through the Radiation Safety Officer within the School of Science and Technology.

## 11.6 Electrical Safety Hazards

Electrical safety hazards are common in the laboratory environment. All laboratory personnel must be familiar with electrical hazard precautions even if they do not presently work directly with electrified materials. Electrical safety actions are easily overlooked and may result in serious injury or death without necessary protection and good practices.

Make sure electrical systems are properly guarded, posted and grounded. Electrical safety can usually best be ensured by "designing-in" protection as an operation is first proposed. The most hazardous electrical situation comes from the risk of direct contact with exposed electrical circuitry. Trouble shooting, maintenance, and test activities often pose this risk. Follow Safe Work Practices when performing these tasks. Label all high voltage sources appropriately, do not leave electrical circuitry un-insulated, exposed, and/or unattended.

# Section Twelve

## References

The following is a list of References that pertain to chemical hygiene and safety in the laboratory. These references can be obtained from EH&S or CHO, (when available) or ordered to supplement available information on chemical and physical hazards for faculty and staff. Additionally several policies and programs such as the Injury Illness Prevention Plan, Hazardous Communication Plan, etc. can be obtained through EH&S or at http://www.Sonoma.edu/EHS. Contact EH&S or CHO for assistance:

### 12.1 Reference Location at SSU


1. National Research Council. Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, DC, 1983.
2. Recommends comprehensive procedures for the safe handling of hazardous chemicals in all types of laboratories. Addresses potential hazards from fire, explosion, and toxic substances.
3. Sax, N.I. Dangerous Properties of Industrial Materials, (Latest edition), New York: Van Nostrand Reinhold Co.
4. Contains brief hazard analysis information for over 10,000 substances. Emphasis is on flammability, explosivity, and reactivity data, but contains some toxicity information.
5. Sax, N.I. and Richard J. Lewis. Hazardous Materials Desk Reference. New York: Van Nostrand Reinhold Co., 1987.
6. Quick reference to 4500 chemicals and compounds. Sections include a concise review of toxicity and other hazards and useful references.
7. Proctor, Nick H. & James P. Hughes. Chemical Hazards of the Workplace, Philadelphia PA: J.B. Lippincott Co., 1978.
8. Steere, Norman V. CRC Handbook of Laboratory Safety, The Chemical Rubber Company, Cleveland, OH, 1971.
9. A reference on first aid, biohazards, chemical and radiation hazards.
10. Steere, Norman V. Safety in the Chemical Laboratory (Volumes 1-3)J. Chem Ed., American Chemical Society, Easlon, PA, 1981.
11. Young, Jay A. Improving Safety in the Chemical Laboratory, John Wiley & Sons, Inc., New York, 1987.
12. Includes information on how to recognize close calls and eliminate accidents, personal protective equipment, contingency eliminate training programs, equipment and emergency checklists, and how to make sure safety objectives are met.

13. NIOSH\OSHA Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No., 85-114, 1985.
14. Quick reference for 380 chemical hazards for which there are specific federal regulations. Contains data on exposure levels, properties, incompatibilities, personal protection, and health hazards.
15. The Matheson Company, Inc. Gas Data Book, (Latest edition).Excellent information on the safe use and handling of compressed gases, including health effects.
16. National Fire Protection Association. Fire Protection Guide on Hazardous Materials, (Latest edition), National Fire Protection Association, Battermarch Park, Quincy, MA. Guide to proper fire prevention and decision-making in emergencies.

# Appendix One

## California Code of Regulations (CCR) Title 8, Section 5191

### Occupational Exposure to Hazardous Chemicals in Laboratories

(a) Scope and application.

(1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(2) Where this section applies, it shall supersede, for laboratories, the requirements of Title 8 of the California Code of Regulations Section 5190 and Article 110, Regulated Carcinogens of the General Industry Safety Orders, except as follows:

(A) The requirement to limit employee exposure to the specific exposure limit.

(B) When that particular regulation states otherwise, as in the case of Section 5209(c)(6).

(C) Prohibition or prevention of eye and skin contact where specified by any health regulation shall be observed.

(D) Where the action level (or in the absence of an action level, the exposure limit) is exceeded for a regulated substance with exposure monitoring and medical surveillance requirements.

(E) The "report of use" requirements of Article 110, (Section 5200 et. seq.) Regulated Carcinogens regulations.

(F) Section 5217 shall apply to anatomy, histology and pathology laboratories.

(3) This regulation shall not apply to:

(A) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant regulations in Title 8, California Code of Regulations, even is such use occurs in a laboratory.

(B) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

1. Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

2. Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

(b) Definitions

Action level. A concentration designated in Title 8, California Code of Regulations for a specific substance, calculated as an eight (8)-hour time weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Carcinogen (see "select carcinogen").

Chemical Hygiene Officer. An employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. 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 employer which sets forth procedures, equipment, personal protective equipment and work practices that

(1) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular work place and

(2) meets the requirements of subsection 5191(e).

Chief. The Chief of the Division of Occupational Safety and Health.

Combustible liquid. Any liquid having a flashpoint at or above 100° F (37.8° C), but below 200° F (93.3° C) except any mixture having components with flashpoints of 200° F (93.3° C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas.

(1) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70° F (21.1° C); or

(2) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130° F (54.4° C) regardless of the pressure at 70° F (21.1° C); or

(3) A liquid having a vapor pressure exceeding 40 psi at 100° F (37.8° C) as determined by ASTM D-323-72.

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

Emergency. Any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee. An individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

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. A chemical that falls into one of the following categories:

(1) "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(2) "Gas, flammable" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air greater than 12 percent by volume, regardless of the lower explosive limit.

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

(4) "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 29 CFR 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint. The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

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

(2) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens closed tester), Z11.7 - 1979 (ASTM D 93-79) for liquids with a viscosity equal to or greater than 45 SUS at 100° F (37.8°C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(3) Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)). Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical. A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (Section 5194) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this regulation.

Laboratory. A facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale. Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

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

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

Laboratory use of hazardous chemicals. Handling or use of such chemicals in which all of 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, nor in any way simulate a production process; and

(4) "Protective laboratory practices and equipment" are available and in common use industry-wide to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation. A consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

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

Oxidizer. A chemical other than a blasting agent or explosive as defined in Section 5237(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard. A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment. Those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

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

Select carcinogen. Any substance which meets one of the following criteria:

(1) It is regulated by Cal/OSHA as a carcinogen; or

(2) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (1985 edition); or

(3) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (Volumes 1-48 and Supplements 1-8); or

(4) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;

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

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

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

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

(c) Exposure limits. For laboratory uses of Cal/OSHA regulated substances, the employer shall ensure that laboratory employees' exposures to such substances do not exceed the exposure limits specified in Title 8, California Code of Regulations, Group 16, Section 5139 et seq., of the General Industry Safety Orders.

(d) Employee exposure determination

(1) Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance exceed the action level (or in the absence of an action level, the exposure limit). The person supervising, directing or evaluating the monitoring shall be competent in industrial hygiene practice.

(2) Periodic monitoring. If the initial monitoring prescribed by subsection 5191(d)(1) discloses employee exposure over the action level (or in the absence of an action level, the exposure limit), the employer shall immediately comply with the exposure monitoring provisions of the relevant regulation.

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

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

(e) Chemical hygiene plan.

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

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

(B) Capable of keeping exposures below the limits specified in subsection 5191(c).

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

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

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

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

(C) A requirement that fume hoods comply with Section 5154.1, that all protective equipment shall function properly and that specific measures shall be taken to ensure proper and adequate performance of such equipment;

(D) Provisions for employee information and training as prescribed in subsection 5191(f);

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

(F) Provisions for medical consultation and medical examinations in accordance with subsection 5191(g);

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

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

1. Establishment of a designated area;

2. Use of containment devices such as fume hoods or glove boxes;

3. Procedures for safe removal of contaminated waste; and

4. Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

Note: Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan.

(f) Employee information and training.

(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area. Information and training may relate to an entire class of hazardous substances to the extent appropriate.

(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

(3) Information. Employees shall be informed of:

(A) The contents of this regulation and its appendices which shall be available to employees;

(B) The location and availability of the employer's Chemical Hygiene Plan;

(C) The exposure limits for Cal/OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable Cal/OSHA regulation;

(D) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

(E) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

(4) Training.

(A) Employee training shall include;

1. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

2. The physical and health hazards of chemicals in the work area; and

3. The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(B) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

(g) Medical consultation and medical examinations.

(1) The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances;

(A) Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

(B) Where exposure monitoring reveals an exposure level above the action level (or in the absence of an action level, the exposure limit) for a Cal/OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

(C) Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

(2) All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

(3) Information provided to the physician. The employer shall provide the following information to the physician;

(A) The identity of the hazardous chemical(s) to which the employee may have been exposed;

(B) A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

(C) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) Physician's written opinion.

(A) For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following;

1. Any recommendation for further medical follow-up;

2. The results of the medical examination and any associated tests, if requested by the employee;

3. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and

4. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

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

(h) Hazard identification.

(1) With respect to labels and material safety data sheets;

(A) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(B) Employers shall maintain in the workplace any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees during each work shift when they are in their work area(s).

(2) The following provisions shall apply to chemical substances developed in the laboratory;

(A) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in subsection 5191(b). If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under subsection 5191(f).

(B) If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement subsection 5191(e).

(C) If the chemical substance is produced for commercial purposes by another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (Section 5194) including the requirements for preparation of material safety data sheets and labeling.

(i) Use of respirators.

Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory

equipment. Respirators shall be selected and used in accordance with the requirements of Section 5144.

(j) Recordkeeping.

(1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this regulation.

(2) The employer shall ensure that such records are kept, transferred, and made available in accordance with Section 3204.

(k) Dates

(1) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than October 31, 1991.

(2) Subsection (a) (2) shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(l) Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

NOTE: Authority cited: Sections 142.3 and 9020, Labor Code. Reference: Sections 142.3, 9004(d), 9009 and 9020, Labor Code.

Appendix A
Appendix B

HISTORY

1. New section filed 3-25-91; operative 4-24-91 (Register 91, No. 17).

2. Editorial correction of printing errors (Register 92, No. 33).

3. Change without regulatory effect amending Appendix B subsections (b)1. and (c)1. filed 12-28-92 pursuant to section 100, title 1, California Code of Regulations (Register 93, No. 1).

4. Editorial correction of Appendix A subsection D.11.(b) (Register 95, No. 24).

# Appendix Two

## Chemical Storage/Incompatible Reactions

### Chemical Storage Classes

Storage of reactive chemicals by class (rather than alphabetically) ensures that individual chemicals receive the proper storage measures warranted by their reactivity. Incompatibilities between classes can be anticipated and protected against. Alphabetizing within a group, then, is acceptable. An added benefit to this type of storage is that knowledge of a chemical's reactivity is respected inside the storeroom and out. Once one recognizes a chemical's reactive class in the storeroom, the carry-over of this information to everyday laboratory exposure increases one's safety awareness.

**Acids**

Segregate acids from active metals such as sodium, potassium, magnesium, etc.

Segregate oxidizing acids from organic acids, flammable and combustible materials.

Segregate acids from chemicals which could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulfide, calcium carbide, etc. Segregate acids from bases.

Examples: Nitric acid, sulfuric acid, sodium dichromate, hydrofluoric acid.

**Bases**

Segregate bases from acids, metals, explosives, organic peroxides and easily ignitable materials. Segregate strong bases (e.g., NaOH) from chlorinated hydrocarbons (e.g. Freon).

Examples: Ammonium hydroxide, sodium hydroxide.

**Flammables**

Store in approved safety cans or cabinets.

Segregate from oxidizing acids and oxidizers.

Keep away from any source of ignition: heat, sparks, or open flames.

**Oxidizers**

Store in a cool, dry place.

Keep away from combustible and flammable materials.

Keep away from reducing agents such as zinc, alkali metals, and formic acid.

**Water Reactive Chemicals**

Store in a cool, dry place away from any water source.

Examples: Sulfuric Acid

**Light Sensitive Chemicals**

Store in amber bottles in a cool, dry, dark place.

**Peroxidizable Chemicals**

Store in airtight containers in a dark, cool, and dry place.

Label containers with receiving, opening, and disposal dates.

Periodically test for the presence of peroxides.

**Toxic Chemicals**

Store according to the nature of the chemical, using appropriate security where necessary.

(From "Safe Chemical Storage: A Pound of Prevention is Worth a Ton of Trouble" by David Pipitone and Donald Hedberg, Journal of Chemical Education, Volume 59, Number 5, May 1982 and "Fire Protection Guide on Hazardous Materials," NFPA, 1978.)

## Examples of Incompatible Chemicals

| Chemical | Is Incompatible With |
|---|---|
| **Acetic Acid** | Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchoric acid, peroxides, permanganates |
| **Acetone** | Concentrated nitric and sulfuric acid |
| **Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium)** | Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens |
| **Carbon tetrachloride** | Sodium |
| **Flammable liquids** | Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens |
| **Hydrocarbons (such as butane, propane, benzene)** | Fluorine, chlorine, bromine, chromic acid, sodium peroxide |
| **Hydrofluoric acid (anhydrous)** | Ammonia (aqueous or anhydrous) |
| **Hydrogen peroxide** | Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials |
| **Nitrates** | Sulfuric acid |
| **Nitric acid (concentrated)** | Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals |
| **Oxygen** | Oils, grease, hydrogen: flammable liquids, solids or gases |
| **Sulfuric acid** | Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium) |

From: "Safety in Academic Chemistry Laboratories", American Chemical Society

## Avoiding Laboratory Accidents Resulting From Chemical Incompatibilities

1. Know the properties of the chemicals you use. The chemical incompatibilities discussed on the following pages are by no means exhaustive. As result, it is crucial for laboratory personnel to thoroughly research the properties of the chemicals they are using. Safety Data Sheets (SDSs) all have sections on chemical incompatibility. While the quality of (SDSs) varies from one manufacturer to another, they should serve as a primary resource for information on avoiding contact with incompatible compounds. A more detailed reference is the *Handbook of Reactive Chemical Hazards*.
2. Avoid mixing incompatible waste materials. A number of serious laboratory accidents, including a death at the University of Washington in the early 1970's, have occurred when people have poured incompatible waste materials into hazardous waste containers. Use separate waste containers for each type of waste.

3. Store incompatible chemicals separately. We have found some common storage problems in University laboratories which could lead to mixing of incompatible chemicals. The most serious of these is the storage of acids (especially oxidizing acids) with flammable solvents. Contact of a concentrated oxidizing acid with a flammable solvent would likely result in a fire or an explosion. This is not an unlikely scenario in the event of an earthquake. Storage of chemicals in alphabetical order on shelves often results in incompatible chemicals being stored together. For example, alphabetical arrangement could result in hydrogen peroxide (a strong oxidizer) being stored next to hydrazine (a very strong reducer).

# Appendix Three

## Listing of Current Safe Work Practices for SSU

# Appendix Four

## Glove Selection/Use Matrix, Guidelines for PPE

### The Right Glove for the Job

The first step in choosing the right glove is determining your primary concern. Do you need protection from hazardous chemicals? Is dexterity crucial to your work? Is product protection of utmost importance?

Different glove materials offer different kinds of protection. Neoprene provides chemical/oil resistance while Nitrite adds abrasion resistance to that protection. Vinyl gives you economical flexibility as a natural rubber alternative. Natural rubber latex offers inherent elasticity and resiliency, plus the dexterity needed in food processing or pharmaceutical manufacturing.

Because a materials suitability may be affected by either degradation or permeation, both factors must also be considered when selecting appropriate gloves. Degradation is the reduction in one or more of the physical properties of a material due to chemical contact. Exposed gloves may swell, get harder or softer, stiffen or weaken or become brittle. Permeation is the passage of a chemical material even if the material is not susceptible to chemical attack. Permeation can occur even if there is no visible damage to the gloves being worn. Since there is usually no indication that a glove has been permeated, the person wearing gloves to handle hazardous chemicals can get a false sense of security.

The selection of appropriate gloves and other pieces of Chemical Protective Clothing (CPC) is generally done after consulting one or more chemical degradation guides. This appendix contains three such guides:

| | |
|---|---|
| Guide #1 | the physical properties of several materials. |
| Guide #2 | the degradation properties of several materials. |
| Guide #3 | the permeation properties of several materials. |

The following listing will help you understand the various glove related terms used in the guides:

**Natural Rubber**: A material (also called latex) that is inherently elastic and resilient, plus resists acids, alkalies, salts and ketones. Natural rubber gloves are suited for food processing, electronics assembly and laboratory chemical handling.

**Neoprene**: A synthetic rubber developed as an oil-resistant substitute for natural rubber. It also resists a broad range of chemicals. Neoprene gloves are used in petrochemical, degreasing and refining applications, and when handling acids, caustics, alcohols and solvents.

**Nitrile**: A synthetic rubber with superior puncture and abrasion resistance in addition to chemical protection. Nitrile gloves are suited for stripping and degreasing, as well as acid etching and chemical washing.

**PVC**: Also known as polyvinyl chloride or vinyl, PVC is a plastic material that resists acids and alcohols, but not petroleum products. Vinyl gloves are used for intricate assembly work, food processing, laboratory, research, and pharmaceutical menu.

**Viton**: A specially fluoroelastomer which has excellent resistance to oils, fuels, lubricants, most mineral acids, hydraulic fluids and aliphatic and aromatic hydrocarbons.

**CPE**: This chlorinated polyethylene has increased resistance to oil, ozone, heat and chemicals. It also provides low permeability to gases.

**Supported**: A supported glove has a fabric liner that is coated with a polymer. The liner is generally knit, and can be palm-coated or fully coated. Supported gloves deliver more durable hand protection.

**Unsupported**: Refers to gloves produced by dipping a glove form directly into a compound, yielding a glove that is 100% compound. Unsupported gloves offer better tactile sensitivity and dexterity.

# The use of Personal Protective Equipment in Sonoma State University Laboratories

Sonoma State University strives to create a safe and healthy work environment for all members of the campus community. Laboratories present special hazards to the individuals that work there, necessitating the application of engineering controls, administrative controls, and the use of personal protective equipment to protect against workplace hazards. The use of personal protective equipment is an integral part of minimizing hazards, but should only be considered after all other controls have been exercised.

The purpose of the Personal Protective Equipment (PPE) Program is to protect employees from risk of injury or death by creating a barrier against workplace hazards. The PPE program addresses eye, face, head, foot, and hand protection. Components of the SSU Respiratory Protection Program and the Hearing Conservation program are also a part of this program.

As an employer, Sonoma State University is responsible for performing hazard assessments and providing personal protective equipment to faculty, staff, and student employees engaged in potentially hazardous activities. Environmental Health & Safety implements the campus-wide Personal Protective Equipment Program.

Faculty members are responsible for conducting hazard assessments for the materials they use in student laboratories, selecting the appropriate personal protective equipment, and training students on how to protect themselves. This information should be incorporated into the individual laboratory exercises.

Sonoma State University's Personal Protective Equipment Program includes:

* A written policy and procedure on PPE distribution, use, and maintenance.

* Guidelines for performing hazard assessments and selection of PPE.

* Employee training.

These documents are available online from the Environmental Health & Safety Office at http://www.sonoma.edu/ehs/safety/equipment.html

# Appendix Five

## Using and maintaining the Safety Data Sheet

### Introduction to Safety Data Sheets

Safety Data Sheets are guidelines on the safe use, handling, and storage of chemicals. The Occupational Safety & Health Administration requires manufacturers to provide a Safety Data Sheet (SDS) with each chemical product that they distribute. SDS identify the manufacturer of the chemical, general product information, physical characteristics of the chemical, instructions for safe handling and use of the material, fire and emergency response procedures, reaction hazards, toxicity and health data, exposure limits, and other information on the chemical or product. The SDS specific to the product that you are working with should be carefully reviewed prior to handling that chemical.

Safety Data Sheets are maintained in hard copy by the Department technicians at their respective locations. In Darwin Hall, these include the Chemistry stockroom (D-313), the Physics stockroom (D-332), the Geology stockroom (D-127), the Biology stockroom (D-214), and the Biology Media Kitchen (D-235). Department Technicians are responsible for organizing SDS and replacing old copies with the latest version. As mentioned previously, it is recommended to use the electronic binder to store all safety data sheets. The link is located at https://web.sonoma.edu/ehs/hazmat/msds.html.

Safety Data Sheets are also available from a number of online sources. The Environmental Health & Safety Department has a dedicated safety data sheet database that should have any SDS required. This database can be accessed from any on campus computer at:

**http://www.sonoma.edu/ehs/hazmat/msds.html**

If the SDS cannot be found at this site, the manufacturer should be contacted to obtain a copy. In the event that a manufacturer does not provide a copy, a written request to the manufacturer should be sent via certified mail with a copy of the request to the local OSHA office. Any new SDS that is not on MSDS Online can be electronically forwarded to EH&S and be added to the online system.

# Role of Safety Data Sheets in the Harmonized System

Safety Data Sheets are an essential component of the GHS and are intended to provide comprehensive information about a substance or mixture for use in workplace chemical management.

In the GHS, they serve the same function that the Material Safety Data Sheet or MSDS does in OSHA's HazCom Standard.

They are used as a source of info about hazards, including environmental hazards, and to obtain advice on safety precautions.

The SDS is normally product related and not specific to workplace; nevertheless, the information on an SDS enables the employer to:

1. Develop an active program of worker protection measures, including training, which is specific to the workplace.
2. Consider measures necessary to protect the environment.

SDS also provides important source of information for other target audience in the GHS – so certain elements may be used for the transport of dangerous goods, emergency responders (including poison centers), and those involved in the professional use pesticides and consumers.

Criteria for Determining Whether an SDS Should be Produced

An SDS should be produced for substances and mixtures which meet the harmonized criteria for physical, health, or environmental hazards under the GHS and for all mixtures which contain ingredients that meet the criteria for carcinogenic, toxic to reproduction or specific target organ toxicity in concentrations exceeding the cut-off limits for SDS specified by the criteria for mixtures.

Competent authorities may also requires SDSs for mixtures not meeting the criteria for classification but containing hazardous ingredients in certain concentrations.

SDS Format

Information in the SDS should be presented using the following 16 headings in the order given below:

1. Identification
2. Hazard(s) identification

3. Composition/information on ingredients
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and Storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

SDS Content

SDSs should provide a clear description of the data used to identify the hazards. The minimum information for each section listed above should be included.

If specific information is not applicable or not available under a particular sub-heading, the SDS should clearly state this.

Some subheadings are national or regional in nature and SDSs should contain such information as is relevant for the area the SDSs are intended.

If you need assistance with obtaining or interpreting a Safety Data Sheet, contact the Environmental Health & Safety Office, x4-2318 or x4-2932.

# Appendix Six

## CCR Title 8 Section 5209. Carcinogens

(a) Scope and Application. This section applies to an area in which any of the substances listed below is manufactured, processed, used, repackaged, released, stored or otherwise handled but does not apply to solid or liquid mixtures with a content less than the percent specified below or to transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (e)(3) and (e)(4) of this section.

| *Chemical* | *Chemical Abstracts Registry number* | *Percent** |
|---|---|---|
| 2-Acetylaminofluorene | 53963 | 1.0 |
| 4-Aminodiphenyl | 92671 | 0.1 |
| Benzidine (and its salts) | 92875 | 0.1 |
| 3,3'-Dichlorobenzidine(and its salts) | 91941 | 1.0 |
| 4-Dimethylaminoazobenzene | 60117 | 1.0 |
| alpha-Naphthylamine ** | 134327 | 1.0 |
| beta-Naphthylamine ** | 91598 | 0.1 |
| 4-Nitrobiphenyl | 92933 | 0.1 |
| N-Nitrosodimethylamine | 62759 | 1.0 |
| beta-Propiolactone | 57578 | 1.0 |
| bis-Chloromethyl ether | 542881 | 0.1 |
| Methyl chloromethyl ether | 107302 | 0.1 |
| Ethyleneimine | 151564 | 1.0 |

* By weight or volume

** This section does not apply to these materials in operations involving the destructive distillation of carbonaceous materials, such as occurs in coke ovens.

(b) Definitions.

(1) Absolute Filter. A filter capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 micrometer particles.

(2) Authorized Employee. An employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) Chief. The Chief of the Division of Occupational Safety and Health, P.O. Box 420603, San Francisco, California 94142.

(4) Clean Change Room. A room where employees put on clean clothing and/or protective equipment in an environment free of carcinogens. This room shall be contiguous to, and have entry from, a shower room when shower facilities are otherwise required by this section.

(5) Closed System. Any operation involving a carcinogen where containment prevents release into regulated areas, nonregulated areas or the external environment.

(6) Decontamination. The inactivation of a carcinogen or its safe disposal.

(7) Disposal. The safe removal of a carcinogen from the work environment.

(8) Emergency. An unforeseen circumstance or set of circumstances resulting in the release of a carcinogen which may result in exposure to, or contact with, the carcinogen.

(9) External Environment. Any environment external to regulated and nonregulated areas.

(10) Isolated System. A fully enclosed structure, other than the vessel of containment of a carcinogen, which is impervious to the passage of the carcinogen and which would prevent the entry of the carcinogen into regulated areas, nonregulated areas or the external environment should leakage or spillage from the vessel of containment occur.

(11) Laboratory Type Hood. A device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed and maintained in such a way that an operation involving a carcinogen within the enclosure does not require the insertion of any portion of any employee's body other than hands and arms.

(12) Nonregulated Area. Any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) Open Vessel System. An operation involving a carcinogen in an open vessel which is not in an isolated system, in a laboratory type hood or in any other system affording equivalent protection against the entry of a carcinogen into regulated areas, nonregulated areas or the external environment.

(14) Protective Clothing. Clothing designed to protect an employee against contact with, or exposure to, a carcinogen.

(15) Regulated Area. An area where entry and exit is restricted and controlled.

(c) Regulated Areas. A regulated area shall be established by an employer where a carcinogen is manufactured, processed, used, released, stored or otherwise handled. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved:

(1) Isolated Systems. Employees working with a carcinogen within an isolated system such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.

(2) Closed System Operations. Within the regulated areas where a carcinogen is stored in sealed containers or is contained in a closed system, including piping systems with any sample ports or openings closed while a carcinogen is contained within:

(A) Access shall be restricted to authorized employees;

(B) With the exception of those cases in which the substance is beta-propiolactone, bis-chloromethyl ether, methyl chloromethyl ether, or ethyleneimine, employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit, and before engaging in other activities.

(3) Open Vessel System Operations. Open vessel system operations as defined in paragraph (b)(13) of this section are prohibited.

(4) Transfer From a Closed System, Charging or Discharging Point Operations, or Otherwise Opening a Closed System. In operations where a carcinogen is contained in a "closed system"

but is transferred, charged or discharged into other normally closed containers, the following provisions shall apply:

(A) Access shall be restricted to authorized employees.

(B) Each operation shall be provided with a "laboratory type hood" or with equivalent continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated. Clean makeup air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.

(C) Employees shall be provided with, and be required to wear, clean, full body protective clothing (smocks, coveralls or long-sleeved shirts and pants), shoe covers and gloves prior to entering the regulated area. Shoe covers are not required when the substance is bis-chloromethyl ether, methyl chloromethyl ether, or ethyleneimine.

(D) Employees engaged in the handling of carcinogens shall be provided with, and be required to wear and use as minimum protection, a half-face, filter type respirator for dusts, mists and fumes, or air purifying canisters or cartridges. Those employees engaged in the handling of beta-propiolactone, bis-chloromethyl ether, methyl chloromethyl ether, N-nitrosodimethylamine, or ethyleneimine shall be provided with, and be required to wear, a fullface, supplied air respirator of the continuous flow or pressure-demand type. A respirator affording higher levels of protection than these respirators may be substituted

(E) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and, at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of subsequent decontamination or disposal. The contents of such impervious containers shall be identified as required under paragraphs (e)(2), (e)(3) and (e)(4) of this section.

(F) Employees shall be required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities. Exception to this requirement is permitted when the substance is beta-propiolactone, bis-chloromethyl ether, methyl chloromethyl ether, or ethyleneimine.

(G) Employees shall be required to shower after the last exit of the day except in those cases in which the substance is beta-propiolactone, bis-chloromethyl ether, methyl chloromethyl ether, or ethyleneimine.

(H) Drinking fountains are prohibited in the regulated area.

(5) Maintenance and Decontamination Activities. In cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, or any operations involving work in an area where direct contact with a carcinogen could result, each authorized employee entering that area shall:

(A) Be provided with, and be required to wear, clean, impervious garments including gloves, boots and continuous air-supplied hood in accordance with Section 5144.

(B) Be decontaminated before removing the protective garments and hood.

(C) Be required to shower, including washing of the hair, upon removing the protective garments and hood.

(6) Laboratory Activities. The requirements of this paragraph shall apply to research and quality control activities involving the use of a carcinogen.

(A) Mechanical pipetting aids shall be used for all pipetting procedures.

(B) Experiments, procedures and equipment which could produce aerosols shall be confined to laboratory type hoods or glove boxes.

(C) Laboratory work surfaces on which a carcinogen is handled shall be protected from contamination.

(D) Contaminated wastes and animal carcasses shall be collected in impervious containers which are closed and decontaminated prior to removal from the work area. Such wastes and carcasses shall be incinerated in such a manner that no carcinogenic products are released.

(E) All other forms of a carcinogen shall be inactivated prior to disposal.

(F) Laboratory vacuum systems shall be protected with high efficiency scrubbers or with disposable absolute filters except that only high efficiency scrubbers shall be used with beta-propiolactone, bis-chloromethyl ether, methyl chloromethyl ether, or ethyleneimine.

(G) Employees, other than those engaged in animal support activities, shall be provided with, and shall be required to wear, a daily change of clean, protective laboratory clothing, such as a solid-front gown, surgical scrub suit or fully buttoned laboratory coat. The required change of clean, protective clothing for employees engaged in animal support activities shall include coveralls or pants and shirt, foot covers, head covers, gloves, and appropriate protective respiratory equipment or devices.

(H) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and, at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. Such impervious containers shall be identified as to their contents by labeling according to paragraphs (e)(2), (e)(3) and (e)(4) of this section.

(I) Employees shall be required to wash hands, forearms, face and neck upon each exit from the regulated area, close to the point of exit, and before engaging in other activities.

(J) Employees engaged in animal support activities shall be required to shower, including washing of the hair, after the last exit of the day.

(K) Air pressure in laboratory areas and animal rooms where a carcinogen is handled and bio-assay studies are performed shall be negative in relation to the pressure in surrounding areas. Exhaust air shall not be discharged to regulated areas, nonregulated areas or the external environment unless decontaminated.

(L) There shall be no connection between regulated areas and any other areas through the ventilation system.

(M) A current inventory of carcinogens shall be maintained.

(N) Ventilated apparatus such as laboratory type hoods shall be tested at least semi-annually, or immediately after ventilation modification or maintenance operations, by personnel fully qualified to certify correct containment and operation.

(d) General Regulated Area Requirements.

(1) Emergencies. Specific emergency procedures shall be prescribed and posted. In an emergency, immediate measures including, but not limited to, the requirements of subparagraphs (A), (B), (C), (D) and (E) of this paragraph shall be implemented.

(A) The potentially affected areas shall be evacuated as soon as the emergency has been determined.

(B) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.

(C) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and of any medical treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(D) Where an employee has a known contact with a carcinogen, such an employee shall be required to shower, including washing of the hair, as soon as possible unless contraindicated by physical injuries.

(E) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.

(F) In operations involving beta-propiolactone, or ethyleneimine, emergency deluge showers and eyewash fountains supplied with running potable water shall be located near, within sight of, and on the same level with locations where a direct exposure would be most likely to occur as a result of equipment failure or improper work practice.

(2) Hygiene Facilities and Practices.

(A) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, are prohibited in regulated areas.

(B) Where employees are required by this section to wash or shower, facilities shall be provided in accordance with Section 3260 (f)(1) and (f)(2) or Section 3260 (f)(1) and (f)(3), respectively.

(C) Where employees wear protective clothing and equipment, clean change rooms shall be provided in accordance with Section 3260 (g) for the number of such employees required to change clothes.

(D) Where toilets are in regulated areas, such toilets shall be in a separate room in accordance with Section 3260(e).

(3) Contamination Control.

(A) Regulated areas, except for outdoor systems, shall be maintained under pressure negative with respect to nonregulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.

(B) Any equipment, material or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in nonregulated areas or the external environment.

(C) Decontamination procedures shall be established and implemented to remove a carcinogen from the surface of materials, equipment and the decontamination facility.

(D) Dry sweeping and dry mopping are prohibited.

(e) Signs, Information and Training.

(4) Respirator program. The employer must implement a respiratory protection program in accordance with section 5144 (b) through (d) (except (d)(1)(C) and (E), and (d)(3)), and (e) through (m).

(1) Signs.

(A) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT
AUTHORIZED PERSONNEL ONLY

(B) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT EXPOSED IN THIS AREA
IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS
AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES
AUTHORIZED PERSONNEL ONLY

(C) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas informing employees of the procedures that must be followed in entering and leaving a regulated area.

(D) Prescribed emergency procedures shall be posted in an appropriate location.

(2) Container Contents Identification.

(A) Containers of a carcinogen and containers required under subparagraphs (c)(4)(E), (c)(6)(H) and (c)(7)(C) of this section which are accessible only to, and handled only by, authorized employees or other employees trained in accordance with paragraph (e)(5) may have the identification of their contents limited to a generic or proprietary name, or other proprietary identification, of the carcinogen and percent.

(B) Containers of a carcinogen and containers required under subparagraphs (c)(4)(E), (c)(6)(H) and (c)(7)(C) of this section which are accessible to, or handled by, employees other than authorized employees or employees trained in accordance with paragraph (e)(5), shall have contents identification which includes the full chemical name and Chemical Abstracts Service Registry number as listed in subsection (a) of this section.

(C) Containers shall display the following warning immediately under, or adjacent to, the contents identification:

CANCER-SUSPECT AGENT

(D) Containers which have carcinogen contents with corrosive or irritating properties shall have label statements warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body.

(3) Lettering. Lettering on signs required by subparagraphs (e)(1)(A), (B) and (C)of this section shall be a minimum height of 2 inches. Instructions required by subparagraphs (e)(1)(C) and (D) shall be legible and no smaller than standard pica type. The letter height of labels required on containers under this section shall be not less than one-half the size of the largest other lettering on the package, and not less than 8-point type in any instance, but no such required lettering need be more than 1 inch in height.

(4) Prohibited Statements. No statement shall appear on or near any required sign, label or instruction which contradicts or detracts from the effect of any required warning, information or instruction.

(5) Training and Indoctrination. Each employee, prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to, the information or requirements of this paragraph. (All materials relating to the training/indoctrination program shall be provided upon request to authorized representatives of the Chief and the Director of the Department of Health.)

(A) The nature of the carcinogenic hazards including local and systemic toxicity.

(B) The specific nature of the operation involving a carcinogen which could result in exposure.

(C) The purpose for, and application of, the medical surveillance program, including, as appropriate, methods of self examination.

(D) The purpose for, and application of, decontamination practices and procedures.

(E) The purpose for, and significance of, emergency practices and procedures.

(F) The employee's specific role in prescribed emergency procedures.

(G) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of a carcinogen.

(H) The purpose for, and application of, specific first-aid procedures and practices.

(I) The employee shall be familiarized with the prescribed emergency procedures and rehearsed in their application.

(J) This section shall be reviewed at the employee's first training and indoctrination program and annually thereafter.

(f) See section 5203.

(g) Medical Surveillance. At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.

(1) Examinations.

(A) Before an employee is assigned to enter a regulated area, a preassignment medical examination by a licensed physician shall be provided. The examination shall include the employee's personal history and that of the employee's family insofar as these are related to pertinent genetic, occupational and environmental factors.

(B) Authorized employees shall be provided periodic medical examinations, not less often than annually, following the preassignment examination.

(C) In all medical examinations, the physician shall consider whether factors exist, which would predispose the employee to increase risk, such as reduced immunological competence, treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking.

(2) Records.

(A) Employers of employees examined pursuant to paragraph (g)(1), above, shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or in the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director, National Institute for Occupational Safety and

Health. The employer shall also comply with any additional requirements involving the transfer of records set forth in Section 3204.

(B) Records required by this paragraph shall be provided upon request to employees, designated representatives, and authorized representatives of the Chief, in accordance with Section 3204, and the Director of the National Institute for Occupational Safety and Health.

(C) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. New section filed 8-1-74; effective thirtieth day thereafter (Register 74, No. 31). For former section and history, see Register 73, No. 43.

2. Amendment of subsection (d) filed 9-20-74 as procedural; effective upon filing (Register 74, No. 38).

3. Amendment filed 2-13-75; effective thirtieth day thereafter (Register 75, No. 7).

4. Amendment of subsections (a), (b)(3), and repealer of subsection (c)(7) filed 5-25-79; effective thirtieth day thereafter (Register 79, No. 21).

5. Amendment of subsection (f)(1) filed 6-15-79; effective thirtieth day thereafter (Register 79, No. 24).

6. Repealer of subsection (d)(1) and renumbering of subsections (d)(2)-(d)(4) filed 1-17-80; effective thirtieth day thereafter (Register 80, No. 3).

7. Amendment of subsection (g)(2) filed 3-20-81; effective thirtieth day thereafter (Register 81, No. 12).

8. Editorial correction of subsection (b)(3) filed 3-3-83 (Register 83, No. 10).

9. Amendment of subsection (c)(4)(D) filed 4-5-85; effective thirtieth day thereafter (Register 85, No. 14).

10. Change without regulatory effect amending subsection (b)(3) filed 3-4-92 pursuant to section 100, title 1, California Code of Regulations (Register 92, No. 19).

11. Amendment filed 8/25/98 (d)

12. Adopted on May 20, 1999; Approved on July 16, 1999; Effective on august 5, 1999.

# Appendix Seven

## General Information Regarding Reproductive Hazards

## Reproductive Hazards in the Laboratory

Basic laboratory chemical hygiene practices (such as wearing protective gloves and washing hands frequently) are always important when working with hazardous materials. These practices are even more important for women who work in laboratories while they are pregnant or attempting to become pregnant. Campus laboratories typically contain a number of dangerous chemicals, some of which may harm the reproductive system or pose a hazard to a developing fetus if exposure is not adequately controlled.

### Standard Precautions

Women who are pregnant or attempting to become pregnant should strictly apply the following standard exposure-control practices whenever they are working in a campus laboratory. These same precautions will help protect men from chemical exposures that might affect the male reproductive system and will help prevent contaminants being brought home to spouses on clothing.

1. Prevent accidental chemical ingestion or contamination by practicing basic hygiene in the laboratory. Never eat, drink, apply cosmetics, or make other hand-to-mouth contact in the laboratory. Always wash your hands with soap and water after handling chemicals and when leaving the laboratory.

2. Always handle volatile chemicals at least six inches inside a properly operating chemical fume hood with the sash placed between you and the material.

3. Wear appropriate personal protective equipment including a laboratory coat, closed-toe shoes, disposable impermeable gloves, and safety glasses (or goggles when using liquids). The specific protective equipment worn should be tailored to the task that is being performed. For example, face shields, rubber aprons, and heavy-duty gloves should be used for strong corrosives. For assistance in selecting the proper personal protective equipment, refer to the appropriate Material Safety Data Sheet, or contact the Chemical Technician at 664-2152.

4. Take a fresh look at the safety precautions spelled out in your laboratory procedures or other safety information provided by your professor.

### Special Precautions

Pregnant laboratory workers should discuss the work they perform and the hazardous materials they handle with their personal physicians to determine what, if any, work restrictions are needed. In some cases, certain chemicals may need to be substituted for other reagents-or- certain activities curtailed -for the duration of the pregnancy. Any restrictions

placed by the physician should be discussed with the Chemical Hygiene Officer immediately (chair of the Chemistry Department) or EH&S at 664-2318.

Specific federal and state regulations apply to pregnant workers' exposure to radiation. If you work with radiation-producing machines or radioactive materials, the Radiation Safety Officer in the Biology Department (664-2995) can provide you with information.

Remember, it is **always** important to adhere to proper laboratory safety practices to prevent unsafe chemical exposures. For women of childbearing age, it is particularly important because fetal damage from chemical exposure may occur prior to a woman realizing she is pregnant.

# Appendix Eight

## Glossary of Useful Terms

**-A-**

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

Acute effect - Symptom of exposure to a hazardous material that soon appears after a short-term exposure, coming quickly to a crisis.

Acute exposure - A single, brief exposure to a large dose of a toxic substance. Adverse health effects are evident soon after exposure.

Acute toxicity - Adverse biological effects of a single dose of a toxic agent.

Aerosol - A suspension of fine solid or liquid particles in air (e.g., paint spray, mist, fog).

Anesthetic - A chemical that causes drowsiness. Large doses of anesthetic chemicals can cause unconsciousness, coma, and death.

ANSI - American National Standards Institute. This privately funded, voluntary organization develops standards for the safe design and operation of equipment and safe practices or procedures for industry.

Asphyxiant - A chemical vapor or gas that replaces air and can, thereby, cause death by suffocation. Asphyxiants are especially hazardous in confined spaces.

**-C-**

Carcinogen - A chemical or physical agent that is known to cause cancer in humans or is thought possibly to cause cancer, based on evidence from experimental animals.

Cardiac - Term used to refer to the heart.

CAS Number - Chemical Abstract Service registry number, which is used to identify a specific chemical.

cc - Cubic centimeter. A metric-system volume measurement equal to a milliliter (ml). One quart is about 946 cc (946 ml).

Ceiling Limit - The maximum allowable exposure limit for an airborne chemical, which is not to be exceeded even momentarily. See also PEL and TLV.

Central nervous system - The part of the body made up of the brain, spinal cord, and nerves.

Chemical family - Chemicals with similar structural characteristics are grouped into a chemical family (e.g., ketones, alcohols, hydrocarbons).

Chemical Hygiene Officer - means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan.

Chemical Hygiene Plan - means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in the particular workplace.

Chronic exposure - Repeated exposure or contact with a toxic substance over a long period. Adverse biological effects from chronic exposure develop slowly, last a long time, and frequently recur.

Chronic effect - Symptom of exposure to a hazardous material that develops slowly after many exposures or that recurs often.

Chronic toxicity - Adverse biological effect of repeated doses or long-term exposure to a toxic agent.

Combustible - Able to catch on fire and burn. A liquid that will burn is called a "combustible liquid." Non-liquid substances that will burn, such as wood and paper, are called "ordinary combustibles." (See Flammables).

Combustible gas - means: (i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70$^{o}$F (21.1 $^{o}$C); or (ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 $^{o}$F (54.4 $^{o}$ C) regardless of the pressure at 70 $^{o}$F (21.1 $^{o}$C); or (iii) A liquid having a vapor pressure exceeding 40 psi at 100 $^{o}$F (37.8 $^{o}$C) as determined by ASTM D-323-72.

Concentration - The relative amount of a given substance present when mixed with another substance(s). Concentration is often expressed as parts per million (ppm), percent, or weight per unit volume, e.g., milligrams/cubic meter (mg/m$^{3}$).

Corrosive - A chemical that causes visible destruction of, or irreversible changes in living tissue by chemical action at the site of contact, or that has a sever corrosion rate on structural materials.

## - D -

Decomposition - The breakdown of a material into a simpler compound by chemical reaction, decay, heat, or other process.

Density - The mass of a solid per unit volume. The density of a substance is usually compared to water, which has a density of 1. Substances that float on water have densities of less than 1; substances that sink in water have densities greater than 1.

Dermal - Term used to refer to skin.

Dermatitis - An inflammation of the skin, which can be caused by irritation (chemical, physical, or mechanical) or allergic reaction.

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

Dose - The amount of a substance received during exposure.

## - E -

Epidemiology - The branch of medical science that deals with the incidence, distribution, and control of disease in a population.

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

## - F -

Flammable - A flammable substance is one that will catch on fire and burn rapidly under ordinary conditions; for example, liquids with a flash point below $100^{o}F$ and solids that ignite readily.

Flashpoint - means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.

Formula - The molecular composition of a chemical compound written in scientific symbols. Water is $H_2O$; hydrochConniec acid is HCl.

## - G -

g/kg - Grams per kilogram. A term used in experimental testing to indicate the dose of a test substance, in grams, given for each kilogram of the test subject's body weight.

## - H -

Hazard warning - The words, pictures, and symbols, or combination thereof, that appear on a label and indicate the hazards of the substance in the container.

Hazardous material/chemical - A chemical or mixture of chemicals that can produce adverse physical effects (e.g., fire, explosion) or health effects (e.g., dermatitis, cancer).

Health hazards - Substances for which there is evidence, from at least one scientific study, that acute or chronic health effects may occur in exposed persons. These chemicals

include carcinogens, toxic agents, reproductive toxins (mutagens and teratogens), irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents that damage the lungs, skin, eyes, or mucous membranes.

Hematopoietic system - The blood-forming organs of the body, including bone marrow and the spleen.

Hepatotoxin - A chemical that can cause liver damage (e.g., carbon tetrachloride).

**- I -**

IARC - International Agency for Research on Cancer. IARC publishes "Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man," one of the publications used to determine the cancer risk of a chemical.

Ignition temperature - The lowest temperature at which a substance will ignite and continue to burn. The lower the ignition temperature, the more likely the substance is to be a fire hazard.

Ingestion - Taking a material into the body through the mouth and swallowing it.

Inhalation - Taking a material in the form of a vapor, gas, dust, fume, or mist into the body by breathing it.

Inhibitor - A chemical added to a substance to prevent the occurrence of an undesirable chemical reaction.

Irritant - A substance that may not be corrosive but that can, with direct contact, cause a reversible effect on the skin, eyes, or respiratory system.

**- L -**

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

Lacrimation - Abnormal or excessive production of tears as a result of exposure of the eyes to an irritant.

$LC_{50}$ - The concentration of a substance in air that will kill half (50%) of the exposed test animals. A measure of acute toxicity.

$LS_{50}$ - The dose of a substance that will kill half (50%) of the treated test animals when given as a single dose. A measure of acute toxicity.

LEL or LFL - Lower Explosive Limit or Lower Flammable Limit.

Local exhaust - A ventilation method for removing contaminated air at the point where the contaminants are generated (e.g., a fume hood).

**- M -**

$m^3$ - Cubic meter. A volume measurement in the metric system. One $m^3$ is about 35.3 cubic feet or 1.3 cubic yards.

Mechanical exhaust - A powered device, e.g., a motor-driven fan, that removes contaminants from a work area or enclosure.

mg/kg - Milligrams per kilogram. A term used in experimental testing to indicate the dose of a test substance, in milligrams, that was given for each kilogram of body weight of the test animal.

$mg/m^3$ - Milligrams per cubic meter. A way of expressing the concentration of dusts, gases, aerosols, or mists in the air.

Mist - A suspension in air of finely divided particles of liquid.

Mucous membranes - A protective lining of cells found, for example, in the mouth, throat, nose, and other parts of the respiratory system.

Mutagen - A substance capable of causing damage to genes and chromosomes, particularly those of sperm or egg cells, resulting in mutations.

Mutation - A genetic alteration that can be inherited, thus affecting future generations.

**- N -**

Narcosis - A state of deep unconsciousness caused by the influence of a drug or other chemical.

Nephrotoxin - A chemical that causes kidney damage (e.g., uranium).

Neurotoxin - A chemical whose primary toxic effect is on the nervous system (e.g., carbon disulfide).

NFPA - National Fire Protection Association. This organization provides information on fire protection and prevention. The NFPA 704 "Standard of the Identification of the Fire Hazards of Materials" describes a hazard-warning placarding and labeling system.

NIOSH - National Institute for Occupational Safety and Health. This agency of the Public Health Service, U.S. Department of Health and Human Services (DHHS), tests and certifies respiratory devices, recommends occupational exposure limits, and assist OSHA by conducting research and investigations.

NTP - National Toxicology Program. Publishes "Annual Report on Carcinogens," listing substances either known or anticipated to be carcinogens.

## - O -

Odor threshold - The lowest concentration of a substance's vapor, in air, that a person can detect by smell. Odor thresholds are highly variable, depending on the individual and the nature of the substance.

Olfactory - Term used to refer to the sense of smell.

Oral - Term used to refer to the mouth.

Organic peroxide - A type of oxidizer that is very useful because of its reactive properties, considered by law (OSHA) to be a physical hazard.

OSHA - Occupational Safety and Health Administration. This government agency develops and enforces occupational safety and health standards for most industry and business in the U.S.

Oxidation - A reaction in which a substance combines with oxygen to cause chemical change (e.g., fire). In a broader sense, oxidation is a reaction in which electrons are lost and is accompanied by reduction -- a reaction in which electrons are gained.

Oxidizer - A material that causes the ignition of combustible materials without an external source of ignition. When mixed with combustible materials, an oxidizer increases the rate of burning of these materials when the mixtures are ignited. Oxidizers usually contain their own oxygen, can, therefore, burn in an oxygen-free atmosphere, are usually very unstable or reactive, and pose a serious fire hazard.

## - P -

PEL - Permissible Exposure Limit. The legal maximum amount of a substance allowed by OSHA in workplace air. This limit must not be exceeded.

pH - A measure of how acidic or basic (caustic) a substance is on a scale of 1 (very acidic) t 14 (very basic); pH 7 indicates that the substance is neutral.

Physical hazard - A substance that is a combustible liquid, a compressed gas, an organic peroxide, or an oxidizer and is explosive, flammable, pyrophoric, unstable (reactive), or water-reactive.

Polymerization - A chemical reaction in which individual molecules combine to form a single large molecule (a polymer). Hazardous polymerization is an uncontrolled reaction releasing large amounts of energy (heat).

ppb - Parts per billion. A term used to express very small concentrations of a given substance present in a mixture. Often used as a unit to measure the parts (by volume) of a gas or vapor in a billion parts of air.

ppm - Parts per million. A term used to express very small concentrations of a given substance present in a mixture. Often used as a unit to measure the parts (by volume) of a gas or vapor in a million parts of air.

Pulmonary - Term used to refer to the lungs.

Pyrophoric - A chemical that can catch on fire spontaneously in air at or below 130$^{o}$ F.

**- R -**

Reactivity - A term used to describe the ease with which a chemical can undergo change, usually by reacting with another substance or by breaking down. Highly reactive substance may explode.

Reproductive toxins - means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Respiratory protective equipment - Air cleaning or air supply respirators that protect against toxic materials in the air.

Route of entry - The way a toxic substance enters the body. For example, absorption through the skin, inhalation, ingestion. May also be called mode of entry.

**- S -**

Select carcinogen - means any substances which meets one of the following criteria:
(i) It is regulated by OSHA as a carcinogen; or
(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or
(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals.

Sensitizer - A substance that can cause an allergic reaction, which usually appears after repeated exposure.

Solubility in water - A term used to indicate the amount, in %, of a substance that will dissolve in water. Solubility information is important for determining spill-cleanup and firefighting procedures.

Solvent - A liquid that dissolves other substances. Some common solvents are water, alcohol, and mineral spirits.

STEL - Short Term Exposure Limit is the maximum concentration allowed in a continuous, 15-minute exposure. There may be no more than four such exposures each day with at least one hour between exposures. The daily TWA cannot be exceeded, however.

Suspect carcinogen - A substance that might cause cancer in humans but has not yet been proven to do so.

Synonym - Another name by which a chemical is known. For example, synonyms for methyl alcohol are methanol and wood alcohol.

Systemic poison - A substance that has a toxic effect upon several organ systems of the body.

**- T -**

Target organ effects - Effects on specific organs of the body caused by exposure to a hazardous chemical.

TLV - Threshold Limit Value. The airborne concentration of a substance below which no adverse health effects should occur. TLVs, established by the American Conference of Governmental Industrial Hygienists (ACGIH), are voluntary limits expressed in three ways (STEL, TLV-C, TWA).

TLV-C - Threshold Limit Value-Ceiling is the maximum concentration of a toxic substance for which exposure is allowed. This limit is not to be exceeded, even momentarily. The TWA must still be observed.

TWA - Time Weighted Average is the exposure limit averaged over a normal 8-hour workday or 40-hour workweek.

Toxic substance - A substance that causes harmful biological effects after either short-term or long-term exposure.

Toxicity - All of the adverse biological effects resulting from exposure to a harmful substance.

**- U -**

UEL - Upper Explosive Limit.

UFL - Upper Flammable Limit.

Unstable - A chemical is unstable if it tends to decompose or undergo other undesirable chemical changes during normal handling or storage.

**- V -**

Vapor - The gas given off by a liquid or solid at room temperature.

Ventilation - Term used to describe the method by which inside air is circulated.

Vertigo - Term meaning to be dizzy.

Viscosity - A term used to describe the rate at which a liquid flows or pours. A very viscous liquid, like molasses, flows slowly.

Volatile - A term used for liquid that evaporate at room temperature. Very volatile liquids, such as gasoline, form vapors (evaporate) quickly and are a breathing hazard.

**- W-**

Water-reactive - A chemical that reacts with water to release a flammable or toxic gas.