CHEMICAL HYGIENE PLAN

FOR LABORATORY WORKERS

UNIVERSITY OF CALIFORNIA

SAN FRANCISCO *Reviewed by:*

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CHEMICAL HYGIENE PLAN

TABLE OF CONTENTS

PREFACE

In the past few decades the progress in biomedical research and clinical diagnostics has necessitated the use of a wide range of chemicals to further our understanding of biological processes. The majority of the chemicals used in biomedical research laboratories are in types or quantities which pose only minimal hazards. However, there are a few chemicals which require special safe handling procedures.

Prudent Practices in the Laboratory, Handling and Disposal of Chemicals (National Research Council, 1995) defines the issues best by stating:

> ***The laboratory has become the center for acquiring knowledge and developing new materials for future use, as well as for monitoring and controlling those chemicals currently used routinely in thousands of commercial processes. Many of these chemicals are beneficial, but others have the potential to cause damage to human health and the environment, and therefore also to public attitude toward the chemical enterprise on which we all so heavily depend.***
>
> ***A growing recognition of moral responsibility and mounting public pressure has made institutions housing chemical laboratories accountable for providing safe working environments for those employed in them and complying with extensive regulation of transport of chemicals the laboratories and removal of waste from them....Laboratories have become safe places to work.***
>
> ***A new culture of safety consciousness, accountability, organization, and education has developed in the laboratories of chemical industry, government, and academe. To a degree that could have been scarcely foreseen 25 years ago, programs have been implemented to train laboratory personnel and to monitor the handling of chemicals from the moment they are ordered until their departure for ultimate treatment or disposal.***

The purpose of this plan is to assist laboratories to implement practices which will ensure the safety of all concerned and allow compliance with regulatory requirements.

CHEMICAL HYGIENE PLAN

INTRODUCTION TO THE PLAN

The purpose of this plan is to define the chemical safety policies and procedures for the University of California, San Francisco (UCSF). These policies and procedures were designed to safeguard personnel and the environment from chemically hazardous materials without unduly limiting academic freedom and to comply with federal and state regulatory requirements. All UCSF Principal Investigators (PIs) and laboratory workers must adhere to the campus chemical policies and procedures in the conduct of their research and the management of their laboratories.

For information about specific chemical safety programs for operations not covered in this Plan; contact the Chemical and Environmental Safety Committee (CESC) office or your Department Safety Advisor (DSA) at the UCSF Office of Environment Health and Safety (EH&S).

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Brian Smith
Associate Vice Chancellor, RIO

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John Kane, MD. PhD
Chair, CESC Committee

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CHAPTER 1

OVERVIEW OF REGULATIONS AND RESPONSIBILITIES

This plan provides a description of the policies and procedures that are expected of UCSF medical center, PIs and laboratory workers in managing their chemical laboratories and inventories, and in satisfying legislative and regulatory requirements of outside agencies. Our campus program has been developed to promote the safe use of chemicals without limiting academic freedom. The descriptions of the Hazard Communication Program, general laboratory procedures, and other information given in this plan are designed to minimize laboratory accidents and health problems through safe work practices and education, and to implement requirements as they have been interpreted by the Chemical and Environmental Safety Committee (CESC).

This plan is derived from the applicable sections of the California Occupational Safety and Health Act (Cal-OSHA), California Environmental Protection Agency (Cal-EPA) California Education Code, state and local Fire Codes, and state and local Health Code regulations. Accreditation standards with which UCSF must comply, such as those of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) are addressed as well as other requirements imposed by the City and County of San Francisco, County of San Mateo, and other agencies. Our campus program incorporates elements that attempt to satisfy all requirements.

This plan therefore constitutes the campus and departmental ***Chemical Hygiene Plan and Hazard Communication Program***.

A. RESPONSIBILITIES: THE ROLES OF INVOLVED PERSONS

The rules and procedures set forth in this Plan have one single, straightforward purpose - to protect UCSF patients, students, visitors, and employees against unnecessary and potentially harmful chemical exposure. For these rules and procedures to be effective, it is important to have a structured administrative format in place which defines the roles and responsibilities of each person, or administrative office.

High standards of laboratory practice are an essential element of excellence in the research, instructional and clinical settings. Clearly, the quality of both research and clinical data, and of the training of students and laboratory workers, depends upon observation of such high standards. Of primary importance are the health and safety of the members of the UCSF community who are directly affected by laboratory practices. Some of these may be the prerogatives of individual laboratory directors, but statutory and regulatory mandates, University policies, and institutional responsibility necessitate that some laboratory practices be determined at the campus wide level. Moreover, even while some practices remain largely discretionary within each laboratory, the institution has the responsibility and liability of providing guidance, advice and appropriate informational resources in support of the highest standards of laboratory practice.

The responsibility of UCSF is to take every reasonable precaution to provide a workplace that is free from hazards. More specifically, UCSF's responsibility is to make certain that all work practices, procedures, and policies necessary to protect employees working in laboratories, with consideration given to the chemical hazards present, are in place.

This responsibility is shared among the members of the University community: the Chancellor, the CESC, Deans and Department Heads, PIs, laboratory personnel, and EH&S.

1. CHANCELLOR RESPONSIBILITIES

The Chancellor has the ultimate responsibility for the safe handling of chemicals on the UCSF campus, for approval of all UCSF policies dealing with hazardous chemical operations, and for directing implementation of those policies. Acting for the Chancellor, the Executive Director of EH&S administers the UCSF's Chemical Safety Program.

2. CHEMICAL AND ENVIRONMENTAL SAFETY COMMITTEE (CESC)

Duties and Responsibilities of the CESC are as follows:

1. Provide expert advice to the Chancellor on issues related to chemical and environmental safety, and implementation of the UCSF Integrated Safety and Environmental Management System (ISEMS);
2. Review technical, environmental and safety-related aspects of laboratory research and the use of hazardous and toxic substances;
3. Continuously review and update UCSF's ISEMS and the laboratory safety manual;
4. Certify that facilities, procedures and practices have been reviewed and approved;
5. Promulgate a chemical and environmental safety program in conjunction with EH&S that encourages best laboratory practices that satisfies federal, state and local laws and regulations;
6. Arbitrate campus disagreements regarding laboratory practices and limit or revoke, as authorized by the Chancellor and investigator's authority to use hazardous or toxic materials if such use presents a hazard to individuals or violates health and safety codes.
7. Review a Chemical Use Authorization (CUA) process to ensure that all labs using Particularly Hazardous Chemicals (High Hazard Chemicals) develop standard operating procedures that describe how to safely handle PHC.

3. DEANS AND DEPARTMENT CHAIRPERSONS

Deans and Department Chairpersons are responsible for ensuring that individuals working with chemicals are adequately trained to understand the hazards associated with the chemicals and to understand procedures and policies used within the department. Deans and Department Chairpersons are responsible for assuring that adequate resources exist to comply with the UCSF safety policies and standards. They must also ensure that proper project/experiment designs and monitoring methods are in place to guarantee safe laboratory operations. They have the responsibility for correcting work practice errors and unsafe conditions that may lead to personal injury. These responsibilities may be delegated to a department safety representative.

4. PRINCIPAL INVESTIGATORS and LABORATORY SUPERVISOR

PIs are responsible for the safety of all employees reporting to them. PIs are responsible for ensuring that the laboratory environment of each individual user is kept safe. Other responsibilities include adequate planning prior to the conduct of an experiment protocol to determine the safety measures that will be required for that protocol, and to make certain that those safety measures are implemented. PIs must provide training to their employees in the safe use of the chemicals used in their procedures, provide access to this Plan, all manuals, procedures, flyers, and newsletters provided by EH&S. They must also ensure hazard assessment is done in their labs; proper personal protective equipment (PPE) is available and used by employees.

The online Chemical Use Authorization (CUA) provides PIs with a documented method for managing and training employees to work safely with Particularly Hazardous Chemicals (PHC). CUA is a web-based tool provisioned with hazard control plans for work with PHC.

To facilitate implementation of these requirements, the PI may designate an experienced staff member to serve as Chemical Safety Officer for his/her laboratory. This designee then becomes the primary contact for EH&S and CESC.

5. INDIVIDUAL EMPLOYEES AND STUDENTS

All employees and students are required to take all applicable training modules online provided by EH&S via the UC Learning Center. Although students are not explicitly covered by Cal/OSHA regulations, UCSF policy requires all students to comply with UCSF safety policies and regulations. Students shall also be provided information and personal protective equipment to protect themselves from laboratory hazards.

Individual employees are responsible for their own safety. All employees whose work involves the use of hazardous chemicals must accept the responsibility for operating in a safe manner, be certain that they are informed of the workplace hazards, and follow safe operating procedures for their tasks. Employees are also responsible for notifying their supervisors of accidents, incidents, and any unsafe working conditions encountered.

6. OFFICE OF ENVIRONMENT HEALTH AND SAFETY

OEH&S is responsible for implementation and oversight of the Laboratory Safety Program. It also provides technical guidance to personnel at all levels of responsibility on matters pertaining to laboratory use of hazardous chemicals and substances. OEH&S is also responsible in maintaining communications with regulatory agencies that includes preparation of reports, correspondence, maintaining records, and obtaining permits. The EH&S Executive Director acts for the Chancellor in this role.

7. THE EH&S CHEMICAL SAFETY OFFICER

The Chemical Safety Officer (CSO), a member of EH&S has primary responsibility for ensuring the implementation of all components of the Chemical Hygiene Plan (CHP). The CHO is responsible for the following:

1. Developing, updating and implementing policies and procedures on the proper use, handling, storage, and segregation of chemicals.

2. Assisting and guiding research community in maintaining full compliance with Cal/OSHA requirements for Chemical Hygiene Plan, Hazardous Materials Business Plan, Chemical Inventory and all applicable health and safety codes, standards and regulations.

3. Developing, updating and maintaining safety training. Conducting in person training if needed.

4. Conducting periodic quality assurance audits of overall laboratory safety inspection program in conjunction with the campus Radiation Safety, Biological Safety and Controlled Substance Officers

5. Assisting in reviewing plans for installation of engineering controls and new facility construction/renovation, as required.

6. Developing, implementing and maintaining Chemical Use Authorization (CUA) Program and ensuring strong reporting and functionality with the chemical inventory system.

7. Assisting PIs in writing lab specific SOPs, reviewing and approving SOPS and submitting to Chemical and Environmental Safety Committee for approval as needed.

8. Maintaining and updating Hazardous Materials Business Plans (HMBP) for all UCSF locations as required by California Health and Safety Code and California Fire Code. Elements of the HMBP program include chemical inventories, facility floor plans, and emergency response plans, all subject to annual renewal. Submitting to San Francisco Department of Public Health and UCSF Fire Marshal as required.

9. Maintaining the EH&S chemical library, user accounts and building locations. Quality control database information of the chemical as needed. Adding, modifying, and classifying new chemicals as required.

B. THE ROLE OF THE OFFICE OF ENVIRONMENT HEALTH AND SAFETY

EH&S is organized into four Programs. Although interdependent, they have been designed to individually address specific functional areas and campus needs. The four Programs are:

- Administration
- Clinical
- Campus (non-clinical)
- Hazardous Materials Management

Each Program is managed by a program manager and staffed with specialists. In addition, each Program draws upon expertise or services offered by other EH&S Programs (e.g. waste disposal, monitoring, etc.) rather than duplicating roles.

Each Program is fully responsible for all aspects of its services including, but not limited to, obtaining regulatory permits from outside agencies, issuing internal permits, conducting chemical / radiation / biological safety training and inspections, and developing policy and procedural manuals.

The following is a brief description of each Program in EH&S.

1. ADMINISTRATION PROGRAM

This Program is responsible for general administrative support to and for the EH&S office. There are a wide range of campus needs that cross the boundaries of all Administrative, Medical Center and Academic Groups of the Campus. This Program is organized to provide the needed EH&S Administrative services for these activities.

2. CLINICAL PROGRAM (Industrial Hygiene and Clinical Enterprise)

The “Clinical Program” is responsible for providing services in areas reflecting the needs of the Clinics and Medical Center.

This Program adopts and implements health and safety policies for the Clinics and Medical Centers as well as developing programs to meet the unique needs and requirements of Joint Commission on Accreditation of Healthcare Organizations (JCAHO), College of American Pathologist Laboratory Accreditation Program (CAP) and Clinical Laboratory Improvement Amendments (CLIA).

3. CAMPUS PROGRAM (Laboratory Safety)

This Program has similar goals, duties and responsibilities as the Clinical Program but provides services to all non-clinical areas of UCSF. To streamline communication and improve efficiency, this Program has adopted a Department Safety Advisor (DSA) approach that is unique to UCSF (Find your DSA).

a. Department Safety Advisor

To assist the Campus in achieving its health and safety goals, EH&S has assigned a professional staff member to each Department/Unit to act as its DSA. This individual is responsible for all safety needs of that Department/Unit. This DSA is the primary contact for ***all*** EH&S activities and is supported by the assistance or services of other EH&S staff. This concept provides basic advantages including:

i. The DSA’s ability to develop a working relationship with individual departments and personnel and thus be able to provide service on a more personal level.

ii. Departments have to contact only one (and always the same) person for all their EH&S needs.
iii. One EH&S professional staff member, a DSA, that will ensure requested information or services have been provided to the requester.
iv. The DSA concept has assured that EH&S operations become much more efficient than they have been in the past.

4. HAZARDOUS MATERIALS MANAGEMENT and ENVIRONMENTAL PROTECTION PROGRAM

This Program manages hazardous materials at UCSF. These include chemicals, research controlled substances, research medical waste, radioactive materials and clinical enterprise generated waste. This Program provides services for all of UCSF and collaborates with other EH&S Programs in the development of its procedures.

C. THE FUNCTION OF THE OFFICE OF ENVIRONMENT HEALTH & SAFETY

1. General surveillance of all chemicals in use, including both personnel and environmental monitoring.

2. Furnish consulting services to personnel at all levels of responsibility on all aspects of chemical safety.

3. Distribute and process personnel chemical monitoring devices when necessary. Keep records of any personnel exposure. Notify individuals and their supervisors of exposures approaching or exceeding the maximum permissible levels and recommending appropriate remedial action.

4. Instruct personnel in proper procedures for the use, storage, and disposal of chemicals.

5. Supervise and coordinate the chemical waste disposal program.

6. Maintain inventories of all chemicals at UCSF in accordance with local government agency requirements.

7. Supervise chemical decontamination when necessary.

8. Investigate accidents.

9. Maintain correspondence, permits and communications with regulatory agencies.

10. Maintain Safety Data Sheets (SDS)

D. AGENCIES, LAWS, AND REGULATIONS PERTAINING TO CHEMICAL SAFETY AT UNIVERSITY OF CALIFORNIA, SAN FRANCISCO

Over the past three decades there has been a proliferation of laws and regulations governing every aspect of chemical purchasing, use, storage, and disposal. Regulations have been enacted at the federal, state, city/county level and are implemented by agencies at these levels. It is unreasonable to expect researchers to be thoroughly familiar with the myriad of implementing agencies and their regulations. However, all workers must be aware of and have a basic understanding of agencies and the regulations which directly affect their work environment. The major programs are listed below.

1. CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (CAL/OSHA)

Cal/OSHA has been at the forefront of assuring worker safety, and often implements regulations prior to Fed OSHA; many regulations are more demanding than their federal counterparts.

Cal/OSHA and/or Fed OSHA regulations which significantly impact the UCSF research environment are identified below.

a. Occupational Exposure to Hazardous Chemicals in Laboratories (the Laboratory Standard)

This regulation is tailored to the safety of workers in the laboratory environment. For laboratory workers, it generally supersedes the Hazard Communication Standard discussed below. One requirement of this regulation is that employers (i.e., UCSF) prepare and implement a Chemical Hygiene Plan for the laboratories; this document is intended to satisfy that requirement. This Standard requires employers to designate a Chemical Hygiene Officer. At UCSF, this person is a member of EH&S. The Laboratory Standard requires SDSs (formerly SDS) be available to employees for all chemicals in the workplace. SDSs are available on-line. It also requires that employees be trained to recognize and control hazards in the laboratory; to detect the presence of or release of a chemical in the workplace, and to follow appropriate work practices for the chemicals and processes used. Additional requirements include a requirement to develop and follow Standard Operating Procedures for the laboratory, provision and use of personal protective equipment and engineering controls, medical surveillance when appropriate, proper labeling, and emergency planning. UCSF's implementation of each of the requirements is described in later sections of this plan.

b. Hazard Communication Standard

This Federal and California regulation, commonly called the worker's "right-to-know" standard, applies to all UCSF employees not covered by the Laboratory Standard such as custodial, material delivery and maintenance staff who service the laboratory. All non-laboratory operations "where chemicals are either used, distributed or are produced for distribution" are covered. It requires manufacturers and distributors of hazardous chemicals to provide certain information on the hazards associated with that chemical. (Specific requirements are addressed in sections on "SDSs" and "labeling". E*mployers* are required to provide information of hazards associated with chemicals in the workplace to *all employees* and must develop and implement a "written hazard communications program". This document is intended to satisfy these requirements. Training of all employees to recognize the hazards in their workplace is required. The HazCom standard requirements are, in some respects, more demanding than those of the Laboratory Standard. For example, the HazCom standard requires that each container of chemicals be labeled for the protection of uninformed or untrained personnel.

c. Carcinogens

Cal/OSHA requires users of listed carcinogens to file a report of use. At UCSF, a report of listed carcinogen users is identified using RIO chemical inventory. For the full list of carcinogens, refer to UCSF's Carcinogen Program. EH&S files a report of use as one institution. For regulated carcinogens (excluding the listed carcinogens), EH&S provides exposure monitoring of personnel and areas to reduce workplace exposure.

d. Injury and Illness Prevention Program

The California General Industry Safety Orders mandate that each employer doing business in the State of California must have an Injury and Illness Prevention Program (IIPP). This program must include several elements not addressed in the above regulations. Each employer must identify the person or persons with the authority and responsibility to implement the IIPP. At UCSF, these persons are the Chancellor, Deans, and Department Chairs. The Office of Environment, Health and Safety is charged with assisting with the implementation and oversight of the program. A system for ensuring that all employees comply with safe and healthful work practices are required; this is met through training, inspections, and disciplinary actions for noncompliance. There are strong requirements for communications with employees about safety matters. One means of meeting these requirements at UCSF is the use of Department Safety Committees. To review the IIPP template that is required to be on file with all UCSF Departments go to Injury and Illness Prevention Program.

2. UNITED STATED ENVIRONMENTAL PROTECTION AGENCY (EPA) AND CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY (CAL-EPA)

These agencies seek to protect the quality of air, water, land and other natural resources. Numerous environmental laws impact UCSF laboratory operations. Three main operational areas at UCSF impacted by the EPA regulations are: hazardous waste disposal,
release of hazardous material into the environment, maintenance and update of chemical inventory on campus.

a. Resource Conservation and Recovery Act (RCRA)

This law was passed by Congress to regulate the recycling and disposal of hazardous waste. The Resource Conservation and Recovery Act (RCRA) regulates hazardous materials from the point of generation to the final disposal destination. This law limits waste accumulation and storage in the laboratory area to 180 days. EH&S central waste facility is limited to 90 days of accumulation. Recycling, reuse, and waste minimization are strongly encouraged. It is the responsibility of the EH&S's Hazardous Materials Management Program to make certain that UCSF meets all RCRA requirements.

b. Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III

Although Title III has little to do with the Superfund program, it exists as an addition to Superfund Amendments and Reauthorization Act of 1986 (SARA). The intent of Title III is to help local and state agencies respond to hazardous releases. This law requires a record of comprehensive chemical inventory be maintained and accidental releases of hazardous materials above their threshold limits be reported to the appropriate agencies. In San Francisco, the implementing agencies are the San Francisco Department of Public Health (DPH), Occupational and Environmental Health, Hazardous Materials Unified Program Agency (HMUPA). The DPH has the right to conduct campus inspections and issue permits for handling and using hazardous chemicals.

c. Clean Air Act and Clean Water Act

These laws are intended to control emissions of hazardous materials into the air or water. The impact at UCSF is to limit materials that can be disposed through the San Francisco sewage system and through air emission.

d. Uniform Building Code and Uniform Fire Code

These codes affect the construction, renovation, and operations of facilities. The Office of the State Fire Marshal (a division of the California Forestry and Fire Protection Agency) is responsible for oversight of all State-owned buildings and facilities with regard to enforcement of these codes. One area of jurisdiction is the types and quantities of chemicals that can be kept in campus areas.

e. Toxic Substances Control Act

In 1976, the U.S. Congress passed the Toxic Substances Control Act (TSCA). The purpose of the act is to ensure that adequate data exists regarding the effects of chemical substances and mixtures on human health and the environment prior to the sale or distribution of said chemical for common usage. TSCA is administered by the U.S. Environmental Protection Agency, and currently covers over 64,000 separate chemicals manufactured and distributed within the United States. Data required for each chemical includes its health effects, ecological effects, physical and chemical properties, environmental fate characteristics, human exposure data and environmental release data.

At UCSF, TSCA ensures that all chemicals purchased for use in laboratories have been evaluated for the above properties, and that this data is available to the user. Safety Data Sheets for each chemical are the most common source for that information. TSCA provides that materials being manufactured for research and development, or being manufactured in quantities less than 1,000 kilograms, may be exempted. It is important to note that this may include experimental chemicals used in research at UCSF; therefore, users should exercise caution when working with materials for which exposure data does not exist.

EPA uses TSCA to control and regulate certain specific chemicals, including lead, radon, asbestos, and polychlorinated biphenyls.

3. U. S. DEPARTMENT OF TRANSPORTATION

Transportation Uniform Safety Act

The Department of Transportation has the authority to regulate packaging and transport of hazardous chemicals. Anyone transporting hazardous waste on public roads must comply with the requirements of the act. Provisions include the requirement for special training of all individuals involved in the transport. At UCSF, EH&S's Hazardous Materials Management Program handles this process.

CHAPTER 2

CHEMICAL PROCUREMENT, DISTRIBUTION, AND STORAGE

Controlling procurement, distribution and storage of chemicals is the essential part of the Chemical Hygiene Plan. Every laboratory must update the chemical inventory on an annual basis to include the chemicals identity, quantities on hand, and their location in the laboratory. The major areas include:

A. PURCHASING CHEMICALS

The decision to procure a specific quantity of a specific chemical is a commitment to handle it responsibly from receipt to disposal. Chemicals are procured on campus in at least three ways:

- Regular orders from campus storehouse or off-campus suppliers,
- Low-value blanket orders, and
- Personal acquisition, or transfer from other laboratories.

Irrespective of the route of procurement, the same safe procedures are required. Listed carcinogens and controlled substances are subject to strict legal requirements. Most of these chemicals present health and safety concerns. In this instance EH&S, and the CESC are authorized to limit the quantity, purchase, or specify the conditions of use of any chemical it deems hazardous.

For chemical storage and expiration purposes, EH&S recommends laboratory personnel to purchase chemicals in the quantity that is necessary for the protocol. All cylinders with the exception of lecture bottles must be returned to the manufacturer for recycle and/or reuse- even if product is still in the cylinder. Returns can be arranged through the supplier or distributor.

Users are expected to be knowledgeable about the hazards of the chemicals that they work with. SDS, see Appendix C, and other published safety information must be readily available for use in an emergency. This information should be requested from the manufacturer when purchasing the chemical if it is not already available. To access the available SDS, please visit http://ehs.ucsf.edu/safety-data-sheet-sds-1.

1. CHEMICAL INVENTORIES

Federal and California laws require the “cradle to grave” management of hazardous chemicals. In California, the California Department of Toxic Substances Control is the state’s lead agency in implementing these regulations. One regulation (Chapter 6.95 Sections 25500 et.seq. of the Health and Safety Code) requires each California business to submit a Business Plan, describing how the business plans to handle hazardous chemicals. This information is intended for use by local emergency agencies, such as fire and police, providing awareness of hazards to be encountered at that business.

This regulation is implemented at the city or county level; for UCSF the implementing agency is the City and County of San Francisco’s (CCSF) Department of Public Health (DPH). The CCSFDPH can establish “inventory reporting thresholds” for the businesses under its jurisdiction. For San Francisco, the reporting threshold is 25 grams or 100 milliliters of a chemical, or 100 cubic feet of compressed gases or liquids. Chemicals that present known hazards (toxic, carcinogenic, etc.) must be included regardless of the quantity present.

The requirements of the Business Plan include two major elements that directly affect the laboratories at UCSF:

- DPH will perform regular inspections of all laboratory areas.
- Each laboratory must submit an annual inventory of all chemicals in that laboratory.

EH&S is responsible for collecting and submitting the inventories to CCSF DPH; upon request each laboratory is expected to submit an updated inventory to EH&S. See Chapter 10 for more details.

B. TRANSPORTING CHEMICALS

Transporting chemicals inappropriately can result in spills and, in some instances, chemical exposures and fire hazards. The obvious preventive approach lies in ensuring that the chemical is packaged in an appropriate container, protected from external forces, and secured in an appropriate cart.

Chemicals are to be transported in containers made of materials that are compatible with the chemical. This is extremely important for waste chemicals that are removed through the Campus Chemical Waste Program.

Chemicals are expected to be transported through public corridors in boxes or external containers which can reasonably be expected to withstand moderate forces that might be expected with accidental dropping.

Chemicals are transported in freight or service elevators only. If necessary, chemicals can be transported on carts; consideration must be given to the weight and balance of the load. No loose bottles or containers of chemicals shall be carried by hand down public corridors or in elevators. Use leak resistant boxes and/or carts.

Note:
Off campus transportation of chemicals requires proper packaging and labeling, please contact EH&S for assistance.

Hazardous materials shall not be transported on UCSF Shuttle buses.

1. LABELING CHEMICALS

Many of the chemicals utilized in research laboratories are hazardous, while others may be hazardous only when mixed with other chemicals (see Glossary for definintion of hazardous material). Therefore, it is important that containers of hazardous chemicals or mixtures be properly labeled. Proper labeling informs laboratory personnel of the potential hazards that exist, prevents generation of unknowns, and facilitates emergency responses such as cleaning up spills and obtaining the proper medical treatment.

a. Laboratory Labeling Requirements

i. All chemical containers must be properly labeled.
ii. Chemical names must be written in English.
iii. If abbreviations such as formulas, structures, or acronyms are used, then a “key” to the abbreviations must be hung up in a conspicuous location.
iv. All peroxide-forming chemicals <u>should</u> have a label which indicates the expiration and opening dates. Be familiar with the hazards of peroxide-forming chemicals (see Appendix B3). EH&S recommends disposal in accordance to Appendix A6. For more information, see UCSF Chemical Safety Update “Peroxide Use Guidelines”.

For specifics on types and explanation of labeling see Chapter 7.

b. Portable (Secondary) Container Labels

Laboratory operations often require transferring or diluting chemicals from the original labeled container into a secondary container (e.g., beaker, flask, or bottle). Secondary container labels must contain two key pieces of information:

i. Identity of the hazardous chemical(s) in the container (e.g., chemical name)
ii. Hazard present

OEH&S has developed a label to satisfy these requirements set forth by Cal/OSHA Hazards Communications Standards, Title 8, Section 5194. The template is available on the EH&S website and distribution can be requested through the Department Safety Advisor. A label example is displayed on Appendix E7. Chemicals in the original container, as supplied by the manufacturer, are usually correctly labeled.

C. STORING CHEMICALS

1. GENERAL GUIDELINES

a. Do not store excessive quantities of chemicals in the laboratory. Purchase the minimum amount required and dispose of unneeded chemicals in a timely fashion (contact EH&S for support in disposing of chemicals).

b. All chemicals and chemical mixtures must be plainly and permanently labeled (see Labeling Requirements section above).

c. Each chemical in the laboratory should have a definite storage space, consistent with the properties of that chemical.

d. Stored chemicals must have secondary containment of sufficient volume to hold the bottle's contents should it leak, and of a material resistant to the effects of the chemical.

e. Store reagents in cabinets or on shelves. Store largest bottles of chemicals on the lower shelves. Do not allow bottles to extend over the edge of the shelf. Be mindful of earthquake risks when storing chemicals on shelves.

f. When storing chemicals above bench level, it is preferable to store them in cabinets with sliding doors; the next preferable location is in cabinets with latched doors.

g. Storing chemicals on open shelves requires that the shelves have a minimum of ¾ -inch lip. A solid metal, wood, or Lucite strip or strong wire may be used to modify shelves.

h. Do not store chemicals on bench tops. They are more readily knocked over and are unprotected from potential exposure to fire.

i. Chemicals requiring refrigeration should be properly labeled, and sealed to prevent escape of vapors. Only refrigerators designated and approved for chemical storage should be used (see Appendices E4 and E5).

j. Fume hoods should not be used for chemical storage. Such storage interferes with the air flow in the hood, causes clutter, and increases the fuel load in the event of a hood fire. Flammables and corrosives are prohibited from being stored in a fume hood. If small quantities of highly hazardous chemicals must be stored in the hood, they should be placed on an elevated shelf.

k. No chemicals (either reagents or waste chemicals) should ever be stored on the floor. Floor storage presents a major hazard because bottles can be knocked over and broken.

l. Flammable chemicals in quantities greater than 10 gallons must be stored in an approved flammable cabinet.

m. All corrosive chemical liquids, regardless of quantity, must be stored in approved cabinets when not in use.

n. Toxic chemicals must be stored in cabinets or on shelves with a two inch lip to preventing them from falling.

o. Highly toxic chemical liquids, such as carcinogens, cyanides, hydrofluoric acid and perchloric acid must be double-contained. The outer container must be properly labeled.

p. Flammable liquids requiring cold storage must be stored only in approved explosion-safe refrigerators or freezers. Do not refrigerate chemicals unnecessarily.

q. Volatile chemicals must be tightly closed when not in use.

r. Date bottles of chemicals when they are opened.

s. Peroxide-forming chemicals, such as ethyl ether and tetrahydrofuran, should be discarded within six months of opening the container.

t. Storage areas should be inspected periodically for damaged containers, such as cracked bottles or caps, or rusted metal containers. Loose or deteriorated labels must be replaced.

u. Plan chemical storage with personal safety in mind. Make certain all personnel will be able to exit the laboratory, should there be a spill or fire.

2. SECONDARY CONTAINMENT

Secondary containment is required in circumstances where there is a possibility that the chemicals may spill and contaminate the area. This containment can be achieved in a variety of ways, such as:

a. Use of chemical resistant trays, or other containers, placed under the chemical container.

b. Using storage cabinets which are designed to contain spilled chemicals.

As a general rule all chemicals should be stored with secondary containment. However, the following require mandatory secondary containment:

c. Waste storage containers.

d. Chemicals which are being poured into other containers.

e. Operations which require handling of large quantities of liquids (100's cc)

3. COMPATIBILITY OF STORED CHEMICALS

a. General Guidelines:

i. Do not store all chemicals in one area. Segregate chemicals according to the chemical and physical properties of the chemicals. Consult the SDS for reactivity information. **Do not store hazardous chemicals alphabetical.**
ii. Provide separate storage areas for corrosives, solvents, oxidizing agents, pyrophoric materials, and air or water-reactive chemicals.
iii. Acids should be stored separately from bases.
iv. Organic acids should be stored separately from inorganic acids.
v. Solvents should be stored separately from acids.
vi. Store ammonium hydroxide in a separate cabinet, preferably vented.
vii. Store oxidizers, including oxidizing acids such as nitric and perchloric acids separate from oxidizable compounds, such as acetic acid.
viii. Perchloric acid must be stored where it cannot come in contact with organic material.
ix. Cyanides and sulfides must be kept safe from any contact with acids. Store cyanides in closed cabinets, away from easy reach.
x. Dispose of cyanides which have no current use (contact EH&S for support).
xi. Store pyrophoric materials separate from flammable materials in a dry inert atmosphere (for example, a nitrogen-filled desiccator).
xii. Store highly toxic chemicals in unbreakable secondary containers prominently labeled with a description of the contents.

Table 2.1.A Suggested Shelf Storage Pattern – *Inorganic*

INORGANIC SULFUR, PHOSPOURS, ARSENIC, PHOSPORUS PENTOXIDE	INORGANIC ARSENATES, CYANIDES, CYANALES (Store away from any water)	INORGANIC
INORGANIC HALIDES, SULFATES, SULFITES, THIOSULFATES, PHOSPATES, HALOGENS, ACETATES	INORGANIC SULFIDES, SELENIDES, PHOSPHIDES, CARBIDES, NITRIDES	ACIDS, except NITRIC. Store Nitric Acid away from other acids unless your acid cabinet provides a separate compartment for Nitric Acid.
INORGANIC AMIDES, NITR ATES (Not AMMONIUM NITRATE) NITRITES, AZIDES (Store Ammonium Nitrate away from all other substances - *ISOLATE IT!)*	INORGANIC BORATES, CHROMATES, MANGANATES, PERMANGANATES	(Acids are best stored in dedicated cabinets) ACID
INORGANIC METALS & HYDRIDES (Store away from any water) (Store flammable solids in flammables cabinet)	INORGANIC CHLORATES, PERCHLORATES, CHLORITES, PERCHLORIC ACID, PEROXIDES, HYPOCHLORITES, HYDROGEN PEROXIDE	
INORGANIC HYDROXDES, OXIDES, SILICATES, CARBONATES, CARBON	MISCELANEOUS	If possible avoid using the floor

2.1.A Suggested Shelf Storage Pattern – *Organic*

ORGANIC ALCOHOLS, GLYCOLS, AMINES, AMIDES, IMINES, INIDES (Store flammables in a dedicated cabinet)	ORGANIC PHENOL CRESOLS	STORE SEVERE POISONS IN POISONS CABINET POISON
ALDEHYDES (Store flammables in a dedicated cabinet)	ORGANIC PEROXIDES, AZIDES, HYDROPEROXIDES	
ORGANIC ETHERS, KETONES, KETENES, HALOGENATED HYDROCARBONS, ETHYLENE OXIDE (Store flammables in a dedicated cabinet)	ORGANIC ACIDS, ANHYDRIDES, PERACIDS (Store certain organic acids in acid cabinet)	ORGANIC ALCOHOLS, GLYCOLS, ETC. ORGANIC HYDROCARBONS, ESTERS, ETC
ORGANIC EPOXY COMPOUNDS, ISOCYANATES	MISCELLANEOUS	ORGANIC ETHERS, KETONES, ETC
ORGANIC SULFIDES, POLYSULFIDES, ETC.	MISCELLANEOUS	STORE FLAMMABLES IN A DEDICATED CABINET FLAMMABLES

If possible avoid using the floor.

Table 2.1.B is intended to provide general information on chemical incompatibilities for storage. It is by no means a complete listing. Check the SDS for each particular chemical for more information.

Table 2.1.B

Chemical	Incompatible
Acetic acid	Chromic acid, ethylene glycol, hydroxyl-containing compounds, nitric acid, perchloric acid permanganates, and peroxides
Acetone	Bromine, chlorine, nitric acid, and sulfuric acid
Acetylene	Bromine, chlorine, copper, mercury, and silver
Alkaline and alkaline earth metals such as calcium, lithium, magnesium, potassium, and sodium	Carbon dioxide, chlorinated hydrocarbons, and water

Table 2.1.B – continued

Chemical	Incompatible
Aluminum and its alloys (particularly powders)	Acid or alkaline solutions, ammonium persulphate and water, chlorates, chlorinated compounds, nitrates, and organic compounds in nitrate/nitrite salt baths
Ammonia (anhydrous)	Bromine, calcium hypochlorite, chlorine, hydrofluoric acid, iodine, mercury, and silver
Ammonium perchlorate, permanganate, or persulfate	Combustible materials; oxidizing materials such as acids, chlorates, and nitrates
Ammonium nitrate	Acids, chlorates, lead, metallic nitrates, metal powders, finely divided organics or combustibles, sulfur and zinc
Aniline	Hydrogen peroxide or nitric acid
Barium peroxide	Combustible organics, oxidizable materials, and water
Barium rhodanate	Sodium nitrate
Bismuth and its alloys	Perchloric acid
Bromine	Acetone, acetylene, ammonia, benzene, and butadiene, butane and other petroleum gases, hydrogen, finely divided metals, sodium carbide, and turpentine
Calcium or sodium carbide	Moisture (in air) or water
Calcium hypochlorite	Ammonia, activated carbon
Chlorates or perchlorates	Acids, aluminum, ammonium salts, cyanides, phosphorus, metal powders, oxidizable organics or other combustibles, sugar, sulfides, and sulfur
Chlorine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, metal powders, sodium carbide, and turpentine
Chlorine dioxide	Hydrogen sulfide, methane, and phosphine
Chromic acid	Acetic acid (glacial), acetic anhydrine, alcohol, combustible materials, flammable liquids, glycerin, naphthalene, nitric acid, sulfur and turpentine
Cumin hydroperoxide	Acids (mineral or organic)
Cyanides	Acids or Alkalis
Fluorine	Most material
Hydrocarbons such as benzene,	Bromine, chlorine, chromic acid, fluorine, hydrogen
butane, gasoline, propane, turpentine, etc.	peroxide, and sodium peroxide
Hydrofluoric acid or anhydrous hydrogen-fluoride	Ammonia (anhydrous or aqueous)
Hydrocyanic acid or hydrogen cyanide	Alkalis and nitric acid

Table 2.1.B-continued

Chemical	Incompatible
Hydrogen peroxide 3%	Chromium, copper, iron, most metals or their salts
Hydrogen peroxide 30% or 90%	Same as 3% hydrogen peroxide plus aniline, any flammable liquids, combustible materials, nitromethane, and all other organic matter
Hydrogen sulfide	Fuming nitric acid or oxidizing gases
Iodine	Acetylene, ammonia (anhydrous or aqueous) and hydrogen
Lithium	Acids, moisture in air, and water
Lithium aluminum hydride	Air, chlorinated hydrocarbons, carbon dioxide, ethyl acetate, and water
Magnesium (particularly powder)	carbonates, chlorates, heavy metal oxalates or oxides, nitrates, perchlorates, peroxides, phosphates, and sulfates
Mercuric oxide	Sulfur
Nitrates	Combustible materials, esters, phosphorus, sodium acetate, stannous chloride, water and zinc powder
Nitric acid (conc.)	Acetic acid, aniline, chromic acid, flammable gases and liquids, Hydrocyanic acid, hydrogen sulfide, and nitratable substances
Nitric acid	Alcohols and other oxidizable organic material, hydroiodic acid (hydrogen iodide), magnesium or other metals, phosphorous and thiophene
Nitrites	Potassium or sodium cyanide
Nitro paraffins	Inorganic alkalis
Oxalic acid	Mercury or silver
Oxygen (liquid or enriched air)	Flammable gases, liquids, or solids such as acetone, acetylene, grease, hydrogen, oils and phosphorus
Peroxides (organic)	Acids (mineral or organic)
Phosphorus (Red)	Oxidizing materials
Phosphorus (White)	Air (oxygen) or other oxidizing materials
Perchloric acid	Ammonia heated with oxides or salts or heavy metals and friction with oxidizing agents
Potassium	Air (moisture and/or oxygen) or water
Potassium chlorate or perchlorate	Acids or their vapors, combustible materials, especially organic solvents, phosphorus and sulfur
Potassium permanganate	Benzaldehyde, ethylene glycol, glycerin, and sulfuric acid
Silver	Acetylene, ammonium compounds, nitric acid with ethanol, oxalic acid and tartaric acid
Sodium amide	Air (moisture and oxygen) or water

Table 2.1.B-continued

Chemical	Incompatible
Sodium chlorate	Acids, ammonium salts, oxidizable materials and sulfur
Sodium hydrosulfite	Air (moisture) or combustible materials
Sodium nitrite	Ammonia compounds, ammonium nitrate, or other ammonium salts
Sodium peroxide	Acetic acid (glacial), acetic anhydride, alcohols, benzaldehyde, carbon disulfide, ethyl acetate, ethylene glycol, furfural, glycerin, methyl acetate, and other oxidizable substances
Sulfur	Any oxidizing material
Sulfuric acid	Chlorates, perchlorates and permanganates
Water	Acetyl chloride and alkaline earth metals, their hydrides and oxides, barium peroxide, carbides, chromic acid, phosphorus oxychloride, phosphorus pentachloride, phosphorus pentoxide, sulfuric acid, and sulfur trioxide, etc.
Zinc chlorate	Acids or organic materials
Zinc (particularly powder)	Acids or water
Zirconium (particularly in powder form)	Carbon tetrachloride and other halogenated hydrocarbons, peroxides, sodium bicarbonate, and water

D. STORAGE OF SPECIFIC CLASSES OF CHEMICALS

1. FLAMMABLE LIQUID STORAGE

a. Definitions

i. *Flammable Liquid*: A liquid with a flash point below 100^0F (37^0C) (NFPA Class I liquids).
ii. *Combustible liquid*: A liquid with a flash point at or above 100^0 F (60^0 C) (NFPA Class II, Class IIIA and Class IIIB)

Note:
UCSF consists of many interconnected high-rise buildings. Because several of these are hospital patient areas, NFPA Class II liquids are treated as Class I liquids, i.e., flammable. Flash points of commercial and unknown chemical solutions can be obtained by request to your DSA or the Campus Fire Marshal.

b. General Guidelines

Class IA solvents, such as ethyl ether, should be purchased only in one gallon (4 liter) or smaller containers. If a larger quantity is required, purchase an additional one gallon container. Because of the extreme flammability of the Class I liquids, only quantities needed for immediate use should be stored.

Solvents such as acetone and ethanol that are stored in spigot plastic carboys for dispensing should be positioned with the spigot over a tray (secondary container) large enough to contain the entire contents of the carboy in the event of leakage from the spigot.

The *hazardous nature* of each chemical in this category must be considered individually with respect to reactivity and flammability, and in relation to other flammable chemicals which may be stored in the same area.

The *quantity* of chemicals stored is a consideration in fire prevention. The current fire control approach is directed toward limiting the quantity of unprotected chemicals. Amounts and types of chemicals to be stored are related to the structure of the facility, the availability of sprinklers and other fire protection, and the rated occupancy of the building. Assistance in developing a chemical storage plan is available from your DSA or the Campus Fire Marshal.

2. CONDITIONS FOR STORAGE AND USE OF FLAMMABLE CHEMICALS

a. General Guidelines:

i. Dispensing of flammable liquids from a shipping container greater than one gallon is not permitted.
ii. Dispensing of flammable liquids should be performed in a fume hood.
iii. Dispensing of flammable liquids near open fire or flame is prohibited.
iv. Refrigerators which are used for storage of flammable liquids must be approved as laboratory safe and so labeled.
v. Flammable liquids shall be stored in containers no larger than the following:

- **Glass Container:**
  - 1 pint of Class IA flammable liquids (flash point <73 degree F, boiling point <100 degree F)
  - 1 quart of Class IB flammable liquids (flash point <73 degree F; boiling point ≥100 degree F)
  - 1 gallon of Class IC flammable liquids (flash point ≥73 degree F, boiling point <100 degree F)

- **Metal Container:**
  - 1 gallon of all Class I and Class II liquids
  - > 1 gallon of all Class I and Class II liquids must be stored in approved safety containers.

- **Storage Volume:**
  - No more than 10 gallons in aggregate of flammable liquids shall be stored outside of an approved and labeled storage cabinet.
  - No more than 60 gallons of flammable liquids may be stored inside of an approved flammable liquid storage cabinet. The use of more than one flammable storage cabinet in the laboratory must be approved by the Campus Fire Marshal.

- **Flammable Liquid Storage Cabinets:**
  - Flammable liquid storage cabinets must meet approval requirements of Factory Mutual or Underwriters Laboratories. A list of approved flammable liquid storage cabinets is available from the Campus Fire Marshal. Such cabinets may be vented, but this is not required. If the cabinet is not to be vented, the vent openings should be sealed with the bungs supplied with the cabinet.
  - Storage of flammable and combustible liquids is regulated by fire codes.
  - Storage of flammable and combustible liquids must be in an approved flammable liquid storage cabinet.
  - The total volume of flammable and combustible liquids stored in the cabinet should not exceed the maximum quantities recommended by the manufacturer of the cabinet, or 60 gallons, whichever is less.
  - The combined total quantity of all liquids in a flammable cabinet shall not exceed 120 gallons.

- Quantities of flammable liquids greater than one liter should be stored in approved safety cans. Glass containers no larger than 1 gallon (4 L) are acceptable if purity would be adversely affected by storage in metal.

3. STORAGE OF CORROSIVE CHEMICALS

a. General Guidelines:

i. Storage areas should be constructed of materials that are resistant to the corrosive chemicals used. Fire Code requires that cabinets be constructed of metal and the interior must be treated, coated or constructed of materials that are non-reactive with the hazardous materials stored. The treatment coating, or construction must include the entire interior of the cabinet and the bottom of the cabinet must be tight to height of two inches. The doors must be well fitted, self-closing and equipped with a self-latching device.
ii. Corrosive chemicals may be stored under a fume hood; the fume hood should have vertical separations to provide for incompatible storage.
iii. Consult the SDS for information on incompatible storage.
iv. All corrosive compressed gases shall be stored in a chemical fume hood or approved ventilated cabinet.
v. Water sensitive corrosives should not be stored under sinks.

4. STORAGE AND HANDLING OF COMPRESSED GASES

a. General Guidelines

i. Mechanical failure of the cylinder, cylinder valve, or regulator can result in rapid dispersion of the pressurized contents into the atmosphere.
ii. Unsecured cylinders can be knocked over very easily, causing serious injury and damage.
iii. Impact can shear the valve from an uncapped cylinder, especially if a regulator is attached, causing a rocking or rocket action leading to personal injury.
iv. Gas cylinders containing flammable, toxic or corrosive gases, asphyxiant, or oxidizers must only be handled by trained personnel.
v. A label identifying the contents of the cylinder must be attached. Alternatively, the identification may be etched or printed on the cylinder.
vi. Do not accept a cylinder if the contents are not clearly identified.
vii. Do not rely on color coding to identify the contents of a gas cylinder; for a given gas the color coding is not standardized.
viii. Open cylinder valves slowly to prevent damage to the pressure regulator.
ix. Always use the proper regulator for the gas in the cylinder.
x. To transport a cylinder, use a hand truck equipped with a chain or belt for securing the cylinder.
xi. Make sure the protective cap covers the cylinder valve. Never move a cylinder while a regulator is attached.
xii. Do not move cylinders by carrying, rolling, sliding, or dragging them across the floor.
xiii. Do not transport oxygen and combustible gases at the same time.

b. Secure gas cylinders to prevent them from falling over:

i. Two chains or straps must be used to secure cylinders - one across the lower third and one across the upper third of the cylinder.
ii. Attach the chain(s) to a holding plate or rack which is securely fixed to structural membrane.
iii. Do not use bench side clamps.
iv. Base plates may be used for securing the cylinders.
v. Do not store incompatible gases together. Store cylinders of oxygen at least 20 feet away from cylinders of hydrogen or other flammable gases.
vi. Store cylinders away from heat (never in areas above 125 degree C). Heat sources may include steam or hot water pipes.
vii. Store cylinders away from areas where they might be subjected to mechanical damage. Store full and empty tanks separately, place “Empty” sign around the top of the empty tanks to avoid

accidental connection of an empty cylinder to a pressurized system, causing backflow into the tank.

viii. Electrically ground cylinders of combustible gases (e.g., to a water pipe) to prevent buildup of static electricity.

ix. Keep cylinders away from locations where they might form part of an electrical circuit.

x. Keep the protective cap on the cylinder when the cylinder is not in use. The cap prevents the cylinder valve from being damaged or broken.

xi. National Fire Protection Association (NFPA) codes specify maximum quantities and sizes of hazardous gas cylinders in laboratory areas. A typical laboratory in the department may have no more than:
- Three standard cylinders of flammable gases and/or oxygen
- Two standard cylinders of liquefied flammable gases
- Three 4'X15" cylinders (or volume equivalent) of gases with high Health Hazard Ratings (Gases with Health Hazard Ratings of 3 or 4, or a rating of 2 with no physiological warning properties), MUST be kept in a hood or other ventilated enclosure. If you are not sure about the Health Hazard Rating, refer to the SDS. No more than three cylinders with ratings of 3 or 4 may be kept in one enclosure.

xii. Corrosive or unstable gases should be ordered in the minimum quantities necessary and stored in a hood or other safe, dry area.

xiii. Corrosive gases, if stored for long periods, will corrode the valve internally and may be impossible to open, or if opened, may not close.

xiv. Cylinders not needed for current use should not be stored in laboratories. Recommended maximum retention periods for gases are:
- 36 months for liquefied flammable gases, flammable gases, and oxygen;
- 6 months for corrosive or unstable gases or those with a Health Hazard Rating of 3 or 4.

xv. When a cylinder is empty (preferably not less than 25 psi residual pressure):
- Close the valve to prevent air and moisture from entering the tank,
- Remove the regulator (purging it if necessary to safely remove toxic or corrosive gases),
- Replace the cylinder cap, and label the tank "EMPTY."
- Use a hand truck to return the cylinder to the gas cylinder storage area and secure it until it is removed.

xvi. Always use manufacturer-supplied valves and regulators. Do not mix-and-match valves and regulators from different units.

xvii. Use manufacturer recommended techniques and tools for installation and removal of valves, regulators, etc.

5. CRYOGENICS SAFETY

Cryogens are liquids with boiling points below 200K (-73 degree C). This extreme cold can cause some materials which come into contact with them to become brittle and lose their mechanical strength. Handling of cryogenic liquids requires special safety precautions. The following is a listing of some important precautions required.

a. Cryogenic liquids must be handled by personnel who are familiar with potential hazards.

b. Contact with skin can cause severe "cold burns"; therefore, use insulating gloves and wear lab coats when handling these liquids.

c. Use eye protection (goggles with side shields or face shields) when working with or handling cryogenics liquids.

d. Store and use cryogenic liquids in well ventilated areas to prevent excessive displacement of air.

e. Large liquid-to-gas ratios can cause a small spill to produce large volumes of gas. This, in turn, can displace air in confined spaces. ***Therefore, during spills be aware of potential oxygen deficiency.***

f. Use only approved cryogenic storage vessels with pressure relief mechanism.

g. In addition to producing an oxygen deficiency by displacement of air, CO_2 also affects the breathing rate. Therefore, it must be used in well ventilated areas.

h. Use special shatter-resistant containers for cryogenic liquids whenever possible.

i. If it is necessary to use standard containers such as glass Dewars, tape the outside to prevent glass fragments from scattering in the event of breakage.

j. Avoid transferring of flammable cryogenic liquids within the buildings. Perform the transfers away from the sources of ignition.

k. Icing on the valves and hoses is caused by the solidification of moisture in air. DO NOT use force to remove the icing.

l. Do not dispose of dry ice by dropping it in water.

For training on liquid nitrogen safety, please visit Lab Safety for Researchers at UC Learning Center.

6. CAL/OSHA REGULATED CARCINOGENS

In order to purchase, store or use any of these chemicals, the facility must submit a registration to Cal-OSHA. To provide maximum flexibility for operations, EH&S obtains site registrations for each Campus. This process requires that laboratories complete the application form and submit to EH&S for review and processing. UCSF's Carcinogen Program and refer to Appendix D1 for details of registration program.

Table 2.2 Chemicals on the California Occupational Safety and Health Administration's Registered Carcinogen List:

2-acetylaminofluorene
4-aminodiphenyl
Benzidine and its salts
3,3'-dichlorobenzidene and its salts
4-dimethylaminoazobenzene
alpha-Naphthylamine
beta-Naphthylamine
4-nitrobiphenyl
N-nitrosodimethylamine
beta-propiolactone
bis-chloromethyl ether
Methyl chloromethyl ether
Ethyleneimine
vinyl chloride
coke oven emissions
1,2-dibromo-3-chloropropane (DBCP)
Acrylonitrile
Inorganic arsenic
4,4'-methylenebis(2-chloroaniline)
Formaldehyde
Benzene
Ethylene Dibromide
Ethylene Oxide
Methylenedianiline
Chromium
Cadmium

Asbestos
1,3 Butadiene
Methylene Chloride

7. CONTROLLED SUBSTANCES

The use of Controlled Substances is governed by the US Drug Enforcement Agency and is subject to specific requirements outlined in UCSF Controlled Substances Manual. Please refer to the manual or contact your DSA for registration requirements. To take the Controlled Substances training, please visit the UC Learning Center.

CHAPTER 3
OCCUPATIONAL EXPOSURE MONITORING

In January of 1990 Cal/OSHA issued a Laboratory Standard (Lab Standard). This standard was created because Cal/OSHA realized that laboratory use of hazardous materials was quite different than industrial use. In the science laboratory, small quantities of many hazardous materials are used. The main requirement of the Lab Standard is that employers must control exposures to hazardous chemicals at safe levels established by Cal/OSHA. For laboratory workers, this standard supersedes the Hazard Communication standard. For non-laboratory UCSF employees, there are Cal/OSHA exposures limit with which we must comply. The best documentation of compliance is air monitoring to evaluate employee exposure levels.

A. MONITORING REQUIREMENTS

Cal/OSHA Laboratory Standards require employers to monitor hazardous material levels in the work area if there is concern that the exposure levels may exceed recognized safety limits (see Glossary for definition of hazardous material). Evidence that may suggest overexposure includes symptoms of overexposure, a hazardous materials accident, or monitoring that reveals routine levels exceeding permissible exposure levels. If such monitoring indicates that possible overexposure occurred, the employer must reduce those levels. The employer must re-monitor the hazardous levels after implementation of corrective action to make sure the problem has been abated. Occupational Exposure may include radiation, chemicals, biological, or be physical in nature. These include noise, chemical vapor, ergonomics, indoor air quality, electrical safety, radioactive waste, and others. EH&S can monitor for most air contaminants. Upon request, can provide air monitoring for labs using formaldehyde or other chemicals, and non-routine air monitoring.

B. REGULATED CARCINOGEN MONITORING

Cal/OSHA has also established special guidelines for workplace and employee monitoring in areas where regulated carcinogens are used. If you use Cal/OSHA regulated carcinogens, or are concerned with exposures, please contact EH&S for baseline exposure monitoring.

C. MEDICAL SURVEILLANCE

Medical surveillance is the process of using medical examinations, questionnaires and/or biological monitoring to determine potential changes in health as a result of exposure to a hazardous chemical or other hazards. Certain Cal/OSHA standards require clinical examination as part of medical surveillance when exposure monitoring exceeds an established Action level or PEL

Occupational Health Program (OHP) and/or outside vendors may provide medical surveillance services. Medical surveillance is required of employees who are routinely exposed to certain hazards as part of their job description (such as asbestos) and may be offered to other employees based upon quantifiable or measured exposure. Examples of hazards that are monitored through medical surveillance program may include:

- Asbestos
- Beryllium
- Formaldehyde
- Lead
- Methylene Chloride
- Noise (Hearing Conservation Program)
- Radioactive Materials (Bioassay Program)
- Respirator Use (Respiratory Protection Program)
- Other (Particularly Hazardous Chemicals)

Individuals with questions regarding work-related medical surveillance are encouraged to call OHP at (415) 885-7580 or EH&S at (415) 476-1300 for more information.

EMPLOYEE OPPORTUNITY FOR MEDICAL OPINION

Employers must provide employees with an opportunity to obtain a medical examination if they may have been overexposed to a hazardous chemical in the laboratory. The employer must provide this examination at no cost to the employee and at a time and place convenient for the employee. The employee and employer will be provided with the results of the exam including recommendations for follow-up.

MEDICAL EXAMINATION

All employees, student workers, medical health volunteers, or laboratory personnel who work with hazardous chemicals shall have the opportunity to receive a free medical examination or evaluation, including supplemental examinations which the examining physician determines necessary, under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which an employee may have been exposed in a laboratory;
- Where personal monitoring indicates exposure to a hazardous chemical is above a Cal/OSHA Action Level (AL) or Permissible Exposure Level (PEL) or recommended exposure levels established by the National Institute for Occupational Safety & Health (NIOSH) or the American Conference of Governmental Industrial Hygienists (ACGIH) in the event Cal/OSHA has not established an AL or PEL for a particular hazardous chemical;
- Whenever an uncontrolled event takes place in the work area such as a spill, leak, explosion, fire, etc., resulting in the likelihood of exposure to a hazardous chemical; or
- Upon reasonable request of the employee to discuss medical issues and health concerns regarding work-related exposure to hazardous chemicals.

All work-related medical evaluations and examinations will be performed under the direction of UCSF Occupation Health Program (OHP) by licensed physicians or staff under the direct supervision of a licensed physician.

INFORMATION TO PROVIDE TO PHYSICIAN

At the time of the medical evaluation, the following information shall be provided to OHP.

1. Personal information such as age, weight and UCSF ID number;
2. Common and/or IUPAC name of the hazardous chemicals to which the individual may have been exposed;
3. A description of the conditions under which the exposure occurred;
4. Quantitative exposure data, if available;
5. A description of the signs and symptoms of exposure that the employee is experiencing, if any;
6. A copy of the SDS of the hazardous chemical in questions;
7. History of exposure including previous employment and non-occupational (recreational) hobbies; and
8. Any additional information helpful to OHP is assessing or treating an exposure or injury such as a biological component of exposure or existence of an antitoxin.

PHYSICIAN"S WRITTEN OPINION

For evaluation or examinations required by Cal/OSHA, the employer shall receive a written opinion from the examining physician which shall include the following:

- Recommendation for further medical follow-up
- Results of the medical examination and any associated tests, if requested by the employer;

- 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
- 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.

CHAPTER 4

GENERAL SAFETY AND INSPECTION PROGRAM

A. PRUDENT PRACTICES FOR HANDLING CHEMICALS

The following recommendations were extracted from "Prudent Practices for Handling Hazardous Chemicals in Laboratories" (referred to below as "Prudent Practices"), which was published in 1995 by the National Research Council and is available from the National Academy Press, 2101 Constitution Avenue NW, Washington D.C., 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance, and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here take precedence over any of the legal requirements of current legislation. This merely presents pertinent recommendations from "Prudent Practices" organized into a form convenient for quick reference during operation of a laboratory facility and during application of the Chemical Safety and Hazard Communication Program. Users should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

1. GENERAL PRINCIPLES FOR WORKING WITH LABORATORY CHEMICALS

a. Minimize All Chemical Exposures

Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, in addition to specific guidelines for chemicals that present particular hazards. Contacts with the chemical by inhalation, ingestion, or skin contact should be avoided.

b. Avoid Underestimation of Risk

Even for substances of no known significant hazard, exposure should be minimized. For work with substances which present special hazards, special precautions should be taken. One should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are potentially toxic.

c. Provide Adequate Ventilation

The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of proper hoods and other local ventilation devices. General dilution through ventilation is much less effective, and may contaminate other neighboring laboratories or offices if any recirculation of air occurs. UCSF laboratory areas are designed to avoid recirculation.

d. Adhere to the UCSF Chemical Safety and Hazard Communication Programs

This mandatory program is designed to minimize exposures; it should be a regular, continuing effort, not merely a standby or short-term activity. These recommendations should be carefully followed by students in academic teaching laboratories as well as by full-time laboratory workers.

e. Ascertain that Exposures Are as Low as Technically Feasible

It is now generally recognized that the current permissible exposure limits (PELs) based on the Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) are not adequate to protect all workers from adverse health effects. The PELs may be used simply as a rough index of relative toxicity, and are the currently, legally enforced limits, but the most prudent policy is to reduce exposures to the lowest level possible.

2. BASIC RULES AND PROCEDURES FOR WORKING WITH CHEMICALS

The following **General Rules** are to be used for essentially all laboratory work with chemicals:

a. Accidents and Spills (See Chapter 8 for Specific Procedures):

i. *Eye Contact*. Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention.
ii. *Ingestion*. Call *Poison Control* at *1-800-222-2222* or immediately go to the nearest emergency room.
iii. *Skin Contact*. Remove contaminated clothing and promptly flush the affected area with water for at least 15 minutes and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.
iv. *Clean-Up*. Promptly clean-up spills, using appropriate protective apparel and equipment and dispose all waste materials generated during clean up properly.

b. Avoidance of Routine Exposure

i. Develop and encourage safety habits, avoid unnecessary exposure to chemicals by any route.
ii. Do not smell or taste chemicals. Vent any apparatus which may discharge toxic chemicals (e.g., vacuum pumps, distillation columns) into local exhaust devices (e.g., fume hoods). Do not exhaust into building ventilation system.
iii. Inspect gloves for tears or pinholes before use. Use appropriate gloves for the chemicals used.
iv. Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained re-circulated atmospheres.

c. Choice of Chemicals

Use the least toxic chemicals possible for the intended purpose. Use only those chemicals for which the quality of the available ventilation system is appropriate.

d. Eating, Drinking, Smoking, Applying Cosmetics

Eating, drinking, gum chewing, application of cosmetics, and manipulation of contact lenses is prohibited in areas where laboratory chemicals are present. Wash hands before conducting these activities. *Storage, handling, consumption of food or beverages* in areas where to the laboratory operations take place are prohibited.

e. Equipment and Glassware

Handle and store laboratory glassware with care to avoid damage. Do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur. Use equipment only for its designated purpose.

f. Exiting

Practice good hygiene and wash areas of exposed skin well before leaving the laboratory.

g. Horseplay

Avoid practical jokes or other behavior which might confuse, startle, or distract another worker.

h. Mouth Suction

Do not use mouth suction for pipetting or starting a siphon - use mechanical pipetting devices.

i. Personal Apparel

Confine long hair and loose clothing. Wear closed-top shoes at all times in the laboratory. Shorts are not recommended for laboratory workers.

j. Personal Housekeeping

Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day.

k. Personal Protection

i. Assure that appropriate eye protection is worn by all persons, including visitors, where chemicals are stored or handled.
ii. Wear appropriate gloves when the potential for contact with toxic materials exists; inspect the gloves before each use, if reusing gloves wash them before removal, and replace them periodically. Do not wear gloves outside laboratories.
iii. Use any other protective and emergency apparel and equipment as appropriate.
iv. Remove laboratory coats immediately upon significant contamination.

[*See Chapter 5 For Specific Information on appropriate Personal Protective Equipment (PPE)].*

l. Planning

Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation. Contact your DSA.

m. Unattended Operations

Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of the failure of a utility service (such as cooling water) to an unattended operation. Post your name and a phone number where you can be reached in case of an emergency.

n. Use of Hood

i. Use the hood for operations which might result in the release of toxic chemical vapors or dust.
ii. As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a PEL or TLV of less than 50 PPM (check the SDS for information).
iii. Confirm adequate hood performance before use; keep materials stored in hoods to a minimum and do not allow them to block vents or air flow.

o. Vigilance

Be alert to unsafe conditions and see that they are corrected when detected or reported to your safety committee or supervisor

p. Waste Disposal

i. Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures.
ii. *Do not discharge any hazardous materials into the sewer.*
iii. *Do not evaporate chemicals in fume hoods as means of disposal.*
iv. *Detailed Procedures for Chemical Waste Disposal are listed in Chapter 9.*

q. Working Alone

Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous.

3. SPECIFIC PROCEDURES WITH SELECTED CLASSES OF HAZARDOUS CHEMICALS

In addition to the general laboratory procedures recommended for all chemicals, the following specific procedures are recommended as supplementary precautions.

a. Allergens

When working with known or suspected allergens (e.g., diazomethane, isocyanates, bichromates) wear suitable gloves to prevent skin contact.

b. Embryotoxins

i. Use substances such as lead compounds or formamide only in hoods, while wearing appropriate protective apparel (especially gloves) to prevent skin contact.
ii. Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.
iii. Notify your supervisor of all incidents of exposure or spills immediately.

c. Chemicals of Moderate Chronic or High Acute Toxicity

i. Minimize exposure to these toxic substances (e.g., diisopropylfluorophosphate, hydrofluoric acid, hydrogen cyanide) by any route using all reasonable precautions.
ii. Use and store these substances only in areas of restricted access with special warning signs.
iii. Always use a hood for procedures which may result in the generation of aerosols or vapors of these substances.
iv. Avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate). Always wash hands and arms immediately after working with these materials.
v. Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved.
vi. Be prepared for accidents and spills.
vii. Ensure that at least two people are present at all times if a compound in use is highly toxic or of unknown toxicity.
viii. Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic-backed paper.
ix. If a major spill occurs outside the hood, evacuate the area; assure that clean-up personnel wear suitable protective apparel and equipment.
x. Thoroughly decontaminate contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion. If you cannot decontaminate, package them for disposal as chemical waste.
xi. Store contaminated waste in closed, suitably labeled, impervious containers.

d. Animal Work with Chemicals of High Chronic Toxicity

Contact EH&S and Laboratory Animal Resource Center (LARC) for proper safety precautions in use of high chronic toxicity chemicals in animals.

B. INSPECTIONS

Environment, Health and Safety will conduct periodic (at least annually) inspections of all laboratories using chemicals. A report of findings and corrective actions, if any, will be sent to Principal Investigators and/or Laboratory Supervisors. Principal Investigators are expected to respond promptly in writing to EH&S describing actions which have been taken to mitigate the hazard. Follow-up inspections may be

conducted. If necessary, a summary of all inspection results will be presented to the Chemical Safety Committee.

In addition to EH&S, the San Francisco Department of Public Health also conducts regular (annual or biannual) inspections of the laboratories and other chemical storage and use areas.

A copy of the inspection checklist and description is included as Appendix D2.

CHAPTER 5

ADMINISTRATIVE AND ENGINEERING CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT

Personnel exposures can be eliminated, or substantially minimized by use of proper protective controls. These controls can be divided into three categories: administrative controls, engineering controls, and personal protective equipment - each is discussed below.

A. ADMINISTRATIVE CONTROLS

Administrative controls are those written and verbal policies, plans, and procedures which provide general direction for safe work practices. This Chemical Hygiene Plan is one element of the administrative controls at the University of California, San Francisco (UCSF). Other documents which the Office of Environment, Health and Safety (EH&S) provides include the periodic newsletters, safety updates, flyers on specific topics of safety concern, and training manuals.

Many administrative controls are specific to the research being conducted, and are the responsibility of the Principal Investigator or the Laboratory Manager. This should include Standard Operating Procedures (SOPs) for all laboratory procedures done repeatedly. SOPs should include appropriate safety instructions, such as personal protective equipment to be used, special cautions for any highly hazardous chemicals, instructions to perform procedures in a fume hood.

Signs, labels, and other postings also are classified as administrative controls. Their presence in the laboratory provides workers and visitors with critical information concerning hazards present in that laboratory. Examples of signs and labels commonly used in laboratories can be found in Appendices E.

Training is yet another example of an administrative control. Principal Investigators or Laboratory Managers are responsible for training personnel in proper operations of all equipment, performance of laboratory procedures, and recognizing and dealing with other hazards in the workplace. Training is discussed further in Chapter 6. Failure to follow procedures is the most common cause of accidents.

B. ENGINEERING CONTROLS

Engineering controls are measures which are incorporated into the design of the facility to eliminate or reduce personnel exposure to chemicals. These measures are the preferred methods and must be used as primary means of achieving exposure control. Engineering controls are intended to protect all personnel working in the area.

1. VENTILATION

Adequate ventilation in a laboratory, or other chemical use or storage area, is critical in the exposure control program. The following is a general description of how this can be achieved. UCSF EH&S reviews construction plans to evaluate the specific needs of each facility.

2. GENERAL LABORATORY VENTILATION

This system should provide a source of air for breathing and for supply to local ventilation devices; it should *not* be relied upon for protection from toxic substances released in the laboratory. The general laboratory ventilation system should ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day; it should direct air flow into the laboratory (negative) from non-laboratory areas and out the exterior of the building.

3. LABORATORY FUME HOODS (LFH)

The primary form of protection from overexposure by inhalation in laboratories is LFH. Most laboratories are equipped with at least one negative pressure fume hood that pulls vapors of hazardous chemicals away from the user.

The Chemical Hygiene Plan (CHP) states that whenever exposure by inhalation is likely to exceed the threshold limits described in the SDS for that particular chemical, a LFH should be used. Therefore, before using a compound, check the SDS for that compound to determine whether it should be used exclusively in a fume hood.

a. Before Using a Fume Hood

LFH must be equipped with a quantitative airflow monitor that continuously indicates whether air is flowing into the exhaust system during operation. Monitors are attached to all fume hoods located in UCSF laboratories. Their function is to provide the user of the hood with important information concerning air flow and face velocity. Some monitors will alarm and alert the user when there is a problem with the air flow, others will only indicate whether or not the fume hood is operational before use. It is critical to check the LFH airflow monitor prior to use to control harmful exposure to toxic materials and to reduce the potential risk of fire and explosion. There are types of monitors found in UCSF laboratories: digital, magnahelic differential pressure gauge and inclined manometer. The incline manometer is the most commonly used. For more information, please visit Lab Safety for Researchers training module.

b. LFH Filtering Requirements

Certain chemicals require that the fume hood in which they are used have a filtered exhaust system. To determine if other chemicals require special filtration, the DSA at EH&S can be contacted to ascertain requirements.

Note that fume hoods used for radioisotope work (specifically iodination and / or xenon studies) at the Laurel Heights and Mount Zion locations must be filtered. The filter system must be approved by the Radiation Safety Officer prior to installation and use.

c. User Responsibilities

Ensure proper use. The quality of protection afforded by the fume hood is invariably affected by the manner in which the fume hood is used. A training video is available through EH&S. Viewing may be arranged by contacting your DSA.

i. Maintain sash and/or sash-panels in proper position.
ii. Never remove sliding sashes which are permanently installed on fume hoods.
iii. Make sure that the vertical sash is lowered to the marks that EH&S has indicated on the hood. This mark corresponds to a face velocity meeting the Cal/OSHA requirements.
iv. You may position the sash lower than the EH&S mark but not higher. The sash can also act as a shield and provide splash protection from the operation being performed.
v. The face velocity of the hood is dependent on the sash being in the proper position. If the face area of the hood is increased by sliding the sash too high, the face velocity will be lowered which reduces the capacity of the fume hood to capture and control airborne chemicals used inside of it. Decreasing the face area by pulling the sash down too low generally increases the face velocity. Increased velocities may create eddy currents around the body of the hood user and around articles inside the fume hood which may draw materials out of the hood and into the room, thereby compromising the protection the hood is designed to provide.
vi. Confirm that the flow is sufficient in the hood by checking the EH&S testing sticker and the airflow monitor. The testing sticker should show that the hood has been tested within the last year and that the indicated flow rate average air velocity is above 100 fpm (150 fpm for

carcinogen use). The airflow monitor should show a pressure consistent with previously observed acceptable readings (e.g. those readings that have a check mark in the column with the heading "OK").

vii. Do not put your head in the fume hood, particularly when there are contaminants in the hood.
viii. Perform work in a shallow tray if possible. If the hood does not have a recessed work area, minor spills will be contained in the tray or will serve to minimize spillage out onto the lab floor.
ix. Locate the procedure, experiment or apparatus as deeply as possible within the hood. This will act to maximize the efficiency of the hood.
x. Keep the fume hood free of extraneous materials. Only those materials necessary to the procedure or experiment should be in the hood while work is being conducted.
xi. Do not block the slots between the air flow distribution baffles by excess storage of containers in the hood. Blocking the baffles disrupts the air-flow distribution, an additional cause of poor fumehood performance.
xii. NEVER EVAPORATE PERCHLORIC ACID IN AN ORDINARY HOOD. Perchloric acid evaporation requires the use of a specifically designed hood with water-washdown capability (see Appendix F2 Safe Handling Guide for Perchloric Acid and Perchlorates). Failure to do this will result in the deposition of perchlorate crystals in the duct work, these crystals may detonate.
xiii. Never perform repairs or make mechanical connections to an existing fume hood, fume hood ducting, or other local exhaust ventilation systems. The ventilation system may not have sufficient flow to handle the additional effluent and may disrupt other fume hoods and their users.
xiv. Never remove distribution baffles (panels) installed in the exhaust systems and at the rear and top of the fume hood. The purpose of these baffles is to properly distribute air flow over the hood opening and work area.
xv. Never use a room or portable fan in a laboratory with a fume hood or local exhaust system. The air velocity developed by a room fan will disrupt the face velocity and overwhelm the ability of the fume hood to capture and control air contaminants generated inside.
xvi. If the door to the laboratory is difficult to open when the fume hood or local exhaust ventilation system is operating a "make-up" air problem may exist. This develops when an inadequate supply of air is delivered to the room to compensate for the air exhausted by the operating fume hood. Notify Facilities Management (FM) should this happen.
xvii. Do not paint or cover fume hood inspection stickers or sash opening indicators.
xviii. Do not locate a work station opposite a fume hood. Materials splattered or forced out of a hood during an accident could injure a person seated across an aisle from a hood.
xix. Do not locate a work station where the only egress from the work station requires passage in front of the hood. A fire or chemical accident, both of which often start in a fume hood, can block an exit rendering it impassable. For this reason all labs are required to maintain two unobstructed means of egress.
xx. Do not locate flammable/combustible storage cabinets directly under a fume hood. Storage of flammable and combustible liquids under a fume hood creates a potential fire hazard due to the uses of open flames and electrical devices in the fume hood.
xxi. Use of portable hoods which can be inserted inside fume hoods for iodination procedures must be specifically approved by the Radiation Safety Officer.

Contact EH&S at 476-1300 with any questions about user responsibilities or report any problems with the hood to FM.

4. OTHER LOCAL VENTILATION DEVICES

Use of ventilated storage cabinets, canopy hoods, snorkels, and other ventilation devices must be approved by EH&S prior to installation.

5. MODIFICATIONS

Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate. Contact EH&S for approval prior to making any modifications.

C. GENERAL FACILITY DESIGN

The chemical storage and usage areas should also incorporate certain design features to provide adequate safeguards. These include:

- Appropriate and adequate storage space for both flammable and corrosive chemicals being used. Storage cabinets shall be constructed of metal. The interior of cabinets shall be treated, coated or constructed of materials that are non-reactive with the hazardous material stored. The bottoms of cabinets utilized for the storage of liquids shall be liquid tight to minimum height of two inches. These cabinets shall be self-closing and self-latching to prevent release of hazardous materials.
- Adequate work space, with sufficient aisle space.
- Bench tops which are impervious to chemicals being used.
- Properly designed storage shelves with lip to prevent toppling of chemicals in the event of an earthquake.
- Continuous vinyl floor coverings (tiles are unacceptable) with 4 inch covings to the walls.
- Sink with foot or elbow operated faucets are recommended.

1. EMERGENCY DELUGE SHOWERS AND EYEWASHES

a. Deluge Showers

i. Location:

- Deluge showers are required "...at accessible locations that require no more than 10 seconds..." (CAL/OSHA requirement) for an injured person to reach in every laboratory using chemicals which are corrosive or severely irritating to the skin, or which are toxic to the skin, or toxic to other tissues by absorption through the skin.
- A deluge shower shall be installed within all acid glass washing areas.
- The path to the deluge shower must be unobstructed. A person with a chemical in his/her eyes cannot be expected to see well enough to open doors or avoid equipment.
- No obstructions, protrusions, or sharp objects shall be located within 32 inches from the center of the spray pattern of the emergency shower facility.
- No electrical outlets are permitted within 2.5 feet of the center of the spray pattern of the emergency shower facility.
- Deluge shower locations are to be determined after consultation with EH&S.

ii. User Responsibilities:

- All departments/institutes should ensure that their laboratories comply with the 10 second access requirement to the deluge shower.
- All supervisors/Principal Investigators are expected to inform their staff as to the location(s) of the accessible deluge shower(s) and the importance of removing contaminated clothing and flushing the contaminated area for at least 15 minutes should an accident occur. **(See Appendix F1, Safe Handling Guide for Corrosive Chemicals, for additional information.)**
- All supervisors/Principal Investigators are expected to train lab members in the use of a deluge shower. For assistance, contact your DSA.
- All supervisors/Principal Investigators should ensure that the testing tag on the deluge shower is current and that the activating mechanism is in proper working order. Contact EH&S, 476-1300, if a deluge shower needs to be tested.
- All supervisors/Principal Investigators should ensure that deluge showers are not blocked or obstructed.

iii. EH&S Responsibilities:

- Testing of deluge showers is the responsibility of EH&S.
- Showers must be activated monthly and checked for proper flow rate annually.
- Testing date is recorded on the tag and on the inspection/survey sheet.
- User and Mechanical/Performance Deficiencies:

- User Deficiency. If the deficiency resulted from improper use (see "user responsibilities") a deficiency notice will be issued to the user for correction. Repeat offenders will be reported to the DSA for appropriate action.
- Mechanical/Performance Deficiency. EH&S will attach an alert tag and issue a deficiency form. Facilities Management will be notified of the deficiency. Deficiency correction:
- Upon notification from Facilities Management, EH&S will retest the deluge shower within 24 hours of receipt of notice.
    - The shower will be recertified, if upon retesting the shower deficiencies have been corrected and no further deficiencies exist. If the corrections have not been properly made, Facilities Management will be re-notified.

iv. Facilities Management Responsibilities:

- Facilities Managers are responsible for repairs to the deluge shower and shower system.
- Facilities Management Staff making the correction are responsible for recording the repairs made on the survey form (sent to Facilities Managers by EH&S) and signing and dating the form when completed. The form must be returned to:

Emergency Eyewash/Shower Safety Program
EH&S, Box 0942
50 Medical Center Way

- Facilities Managers are responsible for notifying EH&S of all construction involving new or relocated showers.
- If general maintenance or repair requires the shut-down of a shower or shower system, Facilities Management is responsible for notifying the Principal Investigator or the Laboratory Supervisor of the time and duration of the shut-down. This shall be accomplished by sending a notice directly to the Principal Investigator or Laboratory Supervisor and posting a written notice on the shower to allow laboratory personnel to prepare in advance for the shutdown.

b. Eyewash

i. Location:

- Eyewash is required to be in "…accessible locations that require no more than 10 seconds…" (Cal/OSHA requirement) for an injured person to reach in every laboratory using chemicals which are corrosive or severely irritating to the skin, or which are toxic to the skin, or toxic to other tissues by absorption through the skin.
- The path to the eyewash must be unobstructed. A person with a chemical in his/her eye cannot be expected to see well enough to open doors or avoid equipment.
- The device must be designed so that users can activate the flow of water from the eyewash and have both hands free to keep the eye lids open during flushing.
- No electrical outlets or electrical apparatus should be in the vicinity of the device.
- No obstruction, protrusions, or sharp objects shall be located within 32 inches from the center of the eyewash.
- Eyewash locations are to be determined after consultation with EH&S.

ii. User Responsibilities:

- All departments should ensure that their laboratories comply with the 10-second access to the eyewash requirement.
- Principal Investigators/supervisors are ultimately responsible for the proper operation of all safety equipment, including eyewashes
- All Principal Investigators and supervisors are expected to inform their staff as to the location(s) of eyewash fountains and of the importance of flushing eyes for at least 15 minutes should an accident occur.
- All supervisors/Principal Investigators are expected to train lab members in the use of eyewash. For assistance, contact your DSA.

- All supervisors/Principal Investigators should ensure that the testing tag on the eyewash is current and that the activating mechanism is in proper working order. Contact EH&S, 476-1300, if an eyewash needs to be tested.
- All supervisors/Principal Investigators should ensure that eyewashes are not blocked or obstructed.
- It is always prudent for the PI/supervisor/user to test the eyewash before beginning any work with an eye or skin damaging material.

iii. EH&S Responsibilities:
- Testing of eyewashes is a service provided by EH&S. Eyewashes are flushed on a monthly basis, and checked for proper flow on an annual basis.
- EH&S is responsible for filling out the inspection date on the inspection record posted at the eyewash, and for recording the inspection in EH&S's eyewash testing records.

iv. Facilities Management Responsibilities:
- Facilities Managers are responsible for repairs to the eyewash and ancillary systems.

2. DRENCH HOSES

Drench Hoses **do not meet** regulation requirements for laboratory safety devices. Approved eye washes and deluge showers are required as described previously. Normally EH&S does not check drench hoses however on a case by case basis, EH&S checks drench hoses if there are no other safety devices in the room. Newer drench hoses have two heads that stay open when activated. Should a person choose to use a drench hose in an emergency, he / she must do so at personal risk. If drench hoses are used to supplement eyewashes and deluge showers, it is prudent that responsible people flush the drench hoses periodically (at least monthly) and check proper function.

3. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal Protective Equipment (PPE), the last line of defense against chemical exposure, is required to be worn when working directly, or adjacent to hazardous materials. PPE is not a substitute for engineering controls, administrative controls and good work practices. It is to be used in conjunction with these controls to ensure the safety and health of university employees and students.

Cal/OSHA OSHA Personal Protective Equipment Standard has the following requirements:

- Hazard assessment and equipment selection
- Employee training
- Record keeping requirements
- Guidelines for selecting PPE
- Hazard assessment certification

EH&S has developed a written Personal Protective Equipment policy to comply with the Cal/OSHA standard. *Refer to UCSF PPE Policy for details.*

The UCSF PPE policy outlines the basic PPE requirements are, but not limited to:

- Full length pants and close-toed shoes, or equivalent to be worn at all times when occupying the laboratory area
- Protective gloves, laboratory coats, eye protection when working with, or adjacent to hazardous materials
- Flame resistant laboratory coats for pyrophoric and flammable chemicals.

Principal Investigators need to conduct hazard assessments in the laboratory to determine what PPE is necessary to safely carry out the operations. PPE must be made available to laboratory workers to reduce exposures to hazardous chemicals in the lab. Proper PPE includes, but not limited to: gloves, eye protection, lab coats, face shields, aprons, boots, hearing protection, etc. PPE must be readily available and provided at no cost to the employee.

Careful consideration should be given to the comfort and fit of PPE to ensure that it will be used by laboratory personnel. All personal protective equipment and clothing must be maintained in a sanitary and reliable condition. If it becomes contaminated or damaged, it should be cleaned or repaired when possible, or discarded and replaced. Laboratory personnel should **NEVER** take contaminated clothing home for cleaning or laundering. Companies hired to clean contaminated clothing must be informed of potentially harmful effects of exposure to hazardous materials.

Laboratory personnel must be trained in the selection, proper use, limitations, care, and maintenance of PPE. Training requirements can be met in a variety of ways including videos, group training sessions, and handouts. Periodic retraining should be offered to both the employees and supervisors as appropriate. Examples of topics to be covered during the training include:

- When PPE must be worn.
- What PPE is necessary to carry out a procedure or experiment
- How to properly put on, take off, adjust, and wear PPE
- The proper cleaning, care, maintenance, useful life, limitations, and disposal of the PPE

PPE training must be documented. Training records must include names of the persons trained, the type of training provided, and the dates when training occurred. EH&S will maintain records of employees who attend EH&S training sessions.

Information on the specific PPE required to carry out procedures within the laboratory using hazardous chemicals must also be included in the lab specific SOPs.

Note: while EH&S can provide information, training, and assistance with conducting hazard assessments and the selection and use of proper PPE, the ultimate responsibility lies with the PI/Laboratory Supervisor or designee.

4. HEARING PROTECTION

The Environment, Health and Safety will respond to inquiries regarding noise exposure in the work place. Upon request, the staff of EH&S will conduct environmental noise and/or personal exposure dosimeter. Ear protection should be worn where the noise level is above 85 decibels (dBa), eight-hour time - weighted average. Areas where excessive noise is present should be posted with signs indicating ear protection is required. Ear protectors should be readily available and composed of rubber or plastic.

a. Types of Ear Protection Include:

i. *Ear plugs*. Ear Plugs provide basic protection to seal the ear against noise.
ii. *Ear muffs*. Ear Muffs provide protection against noise, and may be more comfortable than ear plugs.
iii. *Cotton inserts*. Cotton inserts are poor suppressers of noise and should be avoided.

5. EYE PROTECTION

The number one safety precaution is *Safety Goggles*. When working with hazardous materials, students, laboratory assistants, instructors, stockroom personnel, and visitors must wear safety goggles. Appropriate eye protection is necessary when there is a chance of spraying or splattering a chemical or exposure to UV light or LASER. When working with a dry powder reagent, a dusty situation could allow particulate matter to enter your eyes.

Wearing *contact lenses* in the lab is acceptable and does not create an additional hazard for the wearer. However, appropriate safety goggles must be worn. Some soft lenses do absorb organic vapors and corrosive vapors like hydrogen chloride or ammonia. If you are wearing contact lenses and notice any discomfort while working with volatile solvents, or corrosive liquids or gases then the lenses should be removed.

6. FOOT PROTECTION

Foot protection is designed to prevent injury from corrosive chemicals, heavy objects, electrical shock, as well as giving traction on wet floors. If a corrosive chemical or heavy object were to fall on the floor, the most vulnerable portion of the body would be the feet. When selecting footwear for the lab, choose sturdy leather shoes that cover the foot. These will provide the best protection.

The following shoe types should not be worn in the laboratory:

- Sandals
- Clogs
- High heels
- Shoes that expose the foot IN ANY WAY

Safety Toe Shoes (steel-toed) are recommended for activities such as lifting heavy objects, using power tools, etc. They can protect against crushing injuries caused by impact from any object during work activities.

7. HAND PROTECTION

Protective gloves must be worn when working with hazardous materials. Because certain glove types can dissolve in contact with solvents, it is important to match the type and material of the protective glove with the nature of the job. Before use, check to make sure the gloves (especially latex gloves) are in good condition and free from holes, punctures, and tears.

a. Glove Types and Removal

Gloves should be selected on the basis of the material being handled and the particular hazard involved.

i. *Plastic.* Plastic protects against light corrosives and irritants.
ii. *Latex.* Latex provides light protection against irritants.
iii. *Natural Rubber*. Natural Rubber protects against light corrosive material and electric shock.
iv. *Neoprene.* For working with solvents, oils, or light corrosive material.
v. *Cotton.* Cotton absorbs perspiration, keeps objects clean, and provides some fire retarding properties.
vi. *Zetex*. When handling small burning objects, these are a good replacement for asbestos gloves.
vii. *Viton Butyl, ChemTek, Silvershield*. When working with a mixture of chloroform and phenol.
viii. *Nitrile or neoprene*. When working with only phenol and not a mixture.
ix. *Silvershield, ChemTek*. When working with Methylene Chloride

When working with extremely corrosive material, wear thick gloves or more than one pair of gloves. Take extra precaution in checking for holes, punctures, and tears.

Care should be taken when removing gloves. Peel the glove off the hand, starting at the wrist and working toward the fingers. Keep the working surface of the glove from contacting skin during removal. Disposable gloves should be discarded in designated containers. Hand washing following glove removal is always prudent. Do not wear gloves outside lab areas.

8. RESPIRATORY PROTECTION

When engineering controls cannot successfully minimize or eliminate the potentially harmful fumes, a respiratory protection program should be established. Contact EH&S for assistance.

a. Respiratory Protection Program

A respirator program must cover many issues, including:

i. Medical evaluations.
ii. Education and training in the use of respiratory equipment.
iii. Proper storage and cleaning practices to ensure optimum protection.
iv. Equipment adjustment to assure the user of a proper fit and to maximize protection against fumes and contaminants.

If you think your lab procedures require respiratory protection, contact EH&S for assistance.

b. Respirator Types

There are many respirator types available to laboratory workers. These protective devices range from a disposable dust mask to full face respiratory to a self-contained breathing apparatus (SCBA).

Further information on specific types may be obtained from EH&S.

CHAPTER 6

INFORMATION AND TRAINING

A. REQUIREMENTS

CAL/OSHA Laboratory Safety Standard (CCR Title 8,Section 5191[f]) requires that employees be provided with training and information on hazards relating to their jobs when they are hired or assigned to a job involving hazardous materials. In compliance with the Standard, laboratory workers are required to complete "Laboratory Safety for Researchers" (LSR) training provided by EH&S. Additional training must be provided by the PI or lab supervisor when the employee is exposed to new hazards in the workplace.

It should be noted that this training requirement applies to all employees regardless of the type of hazards they are exposed to. In addition periodic retraining must be provided to insure employee's competency in safety. Currently LSR is not refreshed.

B. EH&S LABORATORY SAFETY TRAINING

All laboratory workers must receive laboratory safety training when they are first assigned to a work area where hazardous chemicals are present and before assignments involving new exposure situations. General laboratory safety training is provided by EHS. More specific training for particular materials or operations in a particular work area is provided by the Principal Investigators, laboratory managers and teaching assistants.

EH&S requires mandatory laboratory safety training online. To access, go to the UC Learning Center web site and complete Laboratory Safety for Researchers and other applicable trainings.

General Laboratory Safety for Researchers Training (LSR)

The general training offered by EH&S covers the following topics:

1. An overview of the Chemical Hygiene Plan.
2. The content and availability of the Laboratory Safety Manual, including the Chemical Hygiene Plan.
3. Use of administrative controls, engineering controls and personal protective equipment to mitigate hazards.
4. Signs and symptoms associated with exposures to hazardous chemicals
5. The availability of Material Safety Data Sheets (SDS) and how to use them and other referenced materials.
6. Chemical exposure monitoring and exposure limits for hazardous chemicals
7. Emergency procedures for fire, injury, chemical exposure, and chemical spill situations
8. Chemical waste disposal procedures at UCSF.
9. Information regarding employee exposure access and medical records

Departmental Information and Training

Each laboratory worker must be made aware of the following information by the PI and/or Laboratory Manager:

1. Location of the Chemical Hygiene Plan, IIPP, SDS(s) and other regulatory information
2. Review of IIPP and Emergency Management Plan, including location of safety equipment and exit routes.
3. Standard Operating Procedures
4. Proper handling, under all circumstances, of hazardous substances used in the laboratory

5. Location and availability of reference materials, including material safety data sheets (SDSs) for hazardous chemicals used or stored in the laboratory and potential health and safety risks of specific hazardous substances used by the laboratory worker.

Training Records

Laboratory workers training records for online courses are available through the UC Learning Center. PIs and DSAs have access to these records if needed. PIs or Lab Managers should keep the specific chemical training records of their laboratory workers. Lab specific SOP training prior to using Particularly Hazardous Chemicals must be submitted to EH&S.

In addition EH&S frequently provides training materials to the laboratories in the form of Safety Updates. It is the responsibility of the Principal Investigator/Laboratory Manager to assure that all workers in the laboratory read, understand, and comply with those materials.

For copies of Safety Updates, and / or a copy of A Safety Guide for Laboratory Employees, contact your DSA or visit the EH&S website at http:/ehs.ucsf.edu/

C. PRIOR APPROVAL OF HIGH HAZARD WORK

EH&S can assist in identifying circumstances when there should be prior approval before implementation of a particular laboratory operation. Due to the large variety of research being conducted in laboratories at the University, it is impossible to apply one prior approval process that can apply to all laboratories. Instead, high hazard types of activities especially when using Particularly Hazardous Chemicals should be identified by the Principal Investigator or person responsible for the work, and any type of approval process should be addressed in the laboratory's or department's standard operating procedures. For details on development and requirements of lab SOPs, refer to Chapter 11 and Appendix D3 of this manual.

The following circumstances require prior approval by the Principal Investigator or Laboratory Manager and EH&S Chemical Safety Officer.

- Working with Particularly Hazardous Chemicals (High Hazard Chemicals and Known Human Carcinogen);
- Working with pyrophoric chemicals, explosives, organic peroxides and unstable reactives;
- Any chemical use where SDS or labeling indicates severe harm can result;
- Implementing an SOP change

General guidelines and recommendations for the safe handling, use and control of high hazard materials can be provided through SDSs, and reference sources such as Prudent Practices in the Laboratory, Safety in Academic Chemistry Laboratories, and other resources.

CHAPTER 7

SIGNS AND LABELS

A. LABELING AND MARKING SYSTEM

1. SIGNS AND PLACARDS

Most manufacturers of hazardous materials use the standard National Fire Protection Association (NFPA) sign system. The sign is based on a simple color coding and numbering system (0 - 4) on a diamond-shaped placard, and can found be in Appendix E2. The following is a description of the color coding and hazards rating of each segment:

HEALTH (Blue)

4 Deadly: Even the slightest exposure to this substance could be life threatening. Only specialized protective clothing, for these materials, should be worn.

3 Extreme Danger: Serious injury would result from exposure to this substance. Do not expose any of the body surfaces to these materials. Full protective measures should be taken.

2 Dangerous: Exposure to this substance would be hazardous to health. Protective measures are indicated.

1 Slight Hazard: Irritation or minor injury would result from exposure to this substance. Protective measures are indicated.

0 No Hazard: Exposure to this substance offers no significant risk to health.

FLAMMABILITY (Red)

4 Flash Point Below 73 degree F: This substance is very flammable, volatile or explosive depending on its state. Extreme caution should be used in handling or storing these materials.

3 Flash Point Below 100 degree F: Flammable, volatile or explosive under almost all normal temperature conditions. Exercise great caution in storing or handling these materials.

2 Flash Point Below 200 degree F: Moderately heated conditions may ignite this substance. Caution procedures should be employed in handling.

1 Flash Point Above 200 degree F: This substance must be preheated to ignite. Most combustible solids are in this category.

0 Will Not Burn: Substances that will not burn.

REACTIVITY (Yellow)

4 May Detonate: Substances which are readily capable of detonation or explosion at normal temperatures and pressures. Evacuate area if material is exposed to heat or fire.

3 Explosive: Substances which are readily capable of detonation or explosion by a strong initiating source, such as heat, shock or water. Monitor from behind explosion-resistant barriers.

2 Unstable: Violent chemical changes are possible at normal or elevated temperatures and pressures. Potentially violent or explosive reaction may occur when mixed with water. Monitor from a safe distance.

1 Normally Stable: Substances which may become unstable at elevated temperatures and pressures or when mixed with water; approach with caution.

0 Stable: Substances will remain stable when exposed to heat, pressure or water.

Additional Markings (White)

This space is used to place codes or icons to identify additional hazards not covered by the three major categories above.

Examples of this might include:

- W with line through its center indicates material reacts violently with water.
- OXY indicates strong oxidizing chemical.
- "Rad" symbol indicates radioactive material.

B. LABELING OF CHEMICALS

Labeling of chemicals is an important factor in the safety protocols. Properly labeled containers inform the users of the content, health and physical hazards, special precautions and other pertinent information. Although currently there are no uniform labeling requirements, more and more manufacturers are using the standardized NFPA signs and symbols on their chemical containers.

The labeling requirements can be divided into two areas of responsibility:

1. MANUFACTURER'S RESPONSIBILITY

The manufacturer must provide the following information on all chemical containers:

a. Name and address of manufacturer.

b. Identity of hazardous components (e.g. name, synonym, etc.).

c. Appropriate hazard warnings (NFPA signs are the most common ones).

2. USER'S RESPONSIBILITY

a. Identity of hazardous components (if not included on the label).

b. Appropriate hazard warnings (if not provided by manufacturer).

c. Assure that manufacturer's label is not defaced or removed.

C. SIGNAGE AND POSTING

The NFPA system is also used for posting buildings and storage areas, including cabinets. Laboratory labels should:

1. Be posted at the entrance to provide adequate warning for personnel entering room. This is particularly important for emergency response personnel who need to have knowledge of what is stored in the room. EH&S is responsible for posting a Hazard Identification sign for laboratory areas. This posting identifies the PIs in the area as well as the types of hazardous materials they work with.

2. Indicate the basic PPE requirements.

D. OTHER POSTING REQUIREMENTS

1. Refrigerators must have a label indicating whether they are approved for the storage of flammable materials.

2. Location of fire extinguisher must be clearly posted.

3. Location of Emergency Eyewash/Showers must be clearly posted.

4. Exit door must have a clear exit sign (with emergency power supply).

NOTE:
There are specific code requirements for posting. Please consult with EH&S.

CHAPTER 8

EMERGENCY RESPONSE TO A CHEMICAL SPILL

IN AN EMERGENCY CALL 9-911
At San Francisco General Hospital (SFGH) CALL 206-8522

Hazardous materials such as chemicals, radionuclides and biohazards substances are widely used at UCSF in research, clinical, health care, teaching and support activities. On occasion, due to unforeseen circumstances, mishandling, damaged containers and/or accidents, hazardous materials are spilled.

Campus policy states that Principal Investigators and supervisors have the primary responsibility for insuring that hazardous materials are used safely and for informing their staff of the proper procedures to follow in the event of a hazardous material spill.

The Campus recognizes that these incidents can escalate and pose a hazard to employees and the environment. Therefore, EH&S has been directed to maintain hazardous materials spill response facilities. In addition, EH&S has prepared technical bulletins, available upon request, explaining how to deal with radioactive, chemical and biohazard material spills. These guidelines will help you decide on the appropriate course of action.

Your response to a hazardous materials incident depends on your knowledge and preparedness, and the size and character of the incident. Contact EH&S for information or training of a minor spill clean-up. If a spill occurs, you must decide whether to handle it yourself or request advice/assistance from EH&S.

A. HAZARDOUS MATERIALS EMERGENCY RESPONSE PROGRAM

EH&S has established the HazMat Emergency Response Program to provide 24-hour emergency response support to campus and satellite locations. The HazMat Responder is an EH&S specialist who is available seven days a week, 24 hours a day, to provide technical assistance to campus units, UC Police Department (UCPD) and the San Francisco Fire Department (SFFD). The HazMat Responder operates a vehicle equipped with a cellular phone and emergency response equipment and will respond to all requests for emergency support, either by telephone or in person.

The HazMat Emergency Response Program complements existing campus policy which specifies that supervisors and Principal Investigators are responsible for the cleanup of a minor spill. In addition, supervisors and Principal Investigators are responsible for initial and annual training of their staff for hazardous materials handling, use, and spill cleanup procedures.

B. REPORTING PROCEDURE

1. Alert persons in the immediate area to the spill to evacuate if necessary.

   Attend to injured or contaminated persons and remove them from exposure. Avoid unnecessary movement in order to prevent the spread of contamination. Bring injured personnel to the Emergency Room (ER) immediately. While injured personnel are en route, inform ER of the actions taken, the contaminate, and if additional decontamination will be needed. This allows ER to set up their triage/decontamination procedures prior to the arrival of the injured.

2. Call UCPD at 9-911. For off campus, call 476-1414, for SFGH, call 206-8522. Provide the following information:

   a. Name
   b. Phone number
   c. Location of incident
   d. Identity of material involved
   e. Quantity spilled

f. Any other pertinent information. UCPD or SFGH Facilities Management will then contact the EH&S HazMat Responder.

4. Close doors and restrict access to affected area.

5. Have person knowledgeable of incident and affected area assist the EH&S HazMat Responder.

C. MINOR HAZARDOUS MATERIAL SPILL

A minor spill of a hazardous material (chemical, radioactive, or biological) is defined as one for which the staff has the confidence and capability to clean up without the assistance of emergency personnel. A small area is affected and a small number of personnel may need to leave the area until the spill is cleaned up.

The supervisor within the department has the responsibility to clean up a minor spill. Additional information for the cleanup of a minor spill may be obtained from campus safety manuals, Material Safety Data Sheets (SDSs) or by calling EH&S at 476-1300.

You should call for help if:

1. You have not been trained in the specific procedures to follow.

2. You feel it is unsafe to clean up the spill.

3. You don't know what the spilled material is.

4. You lack the necessary protection or clean-up materials to do the job safely.

5. The spill is large.

6. The spilled material is highly toxic.

7. You or co-workers feel any physical symptoms of exposure (eye irritation, difficulty breathing, coughing, dizziness, nausea, skin irritation).

8. The substance involved is regulated (carcinogen, biohazard, radioactive).

D. PROCEDURE TO CLEAN UP A MINOR SPILL

1. Alert persons in immediate area of spill.

2. Wear protective equipment, including safety goggles, gloves and long-sleeve lab coat.

3. If there are vapors from the spill call 9-911. Avoid breathing vapors from spill.

4. Confine and contain spill to small area.

5. Use appropriate materials to absorb or clean up spill. Clean “from the outside in”. Do not spread contamination. Collect residue, place in container, label container and dispose as chemical waste.

6. After removal of all contamination, wash area with clean water.

E. SPILL RESPONSE FACILITIES

EH&S maintains three types of spill response facilities:

1. SPILL CABINETS - 2'x 2' wall mounted cabinets containing a universal absorbent for small spills of non-radioactive chemicals.

2. SPILL CLOSETS - telephone-booth-size closets containing a universal absorbent, protective equipment and clean-up equipment. The closets also contain a kit for treating radionuclide spills.

3. SPILL CENTERS - small rooms with more specialized equipment for emergency responders (EH&S, UCPD, SFFD).

Spill cabinets and spill closets are for campus personnel to use as needed and are left unlocked to provide easy access. When materials are used, please contact EH&S at 476-1300 to replace them. Spill centers are for the exclusive use of emergency responders (EH&S, UCPD, SFFD) and are kept locked.

F. SPILL CABINETS

EH&S maintains "spill cabinets" throughout the UCSF's campuses in areas where laboratories are concentrated. They are intended to provide labs with easy access to absorbent materials to control small (up to 1 liter) spills of non-radioactive chemicals. Protective equipment is not included in the spill cabinet since laboratory personnel who work with chemicals are expected to have eye protection, chemical-resistant gloves and a lab coat in their laboratories. Each cabinet contains spill pads made of a universal absorbent which is capable of picking up any liquid including hydrofluoric acid, and a 12" x 18" plastic bag for disposal of the spill pads.

The following sections need to be updated by HMM to reflect current locations and types of supplies at each location.

1. LOCATION

All hazardous spill cabinets are located in the corridors next to the following rooms:

HSW	HSE	Med. Sci.	Surge	Radio Bio.	Clin. Sci.
451	414	664	103	106	
		758	213	209	
		857			
892	693	955			
		1058			
		1156			
	1164	1206			
1509		1255			
		560			
		455			

G. SPILL CLOSETS

When the spill requires clean up supplies, more absorbent and/or greater personal protective equipment, these materials will be found in the "spill closets." Spill closets also contain a kit to treat radionuclide spills and bleach to disinfect biological materials. Respiratory protection equipment is not available as wearing respiratory protection entails medical approval, fit-testing, and training. If you think you need respiratory protection to clean up the spill, **DO NOT** attempt the cleanup. Call the campus emergency number at 9-911 and remain in the general area to provide information to the HazMat Responder.

Spill closets are listed below, however, inventories may vary slightly depending on closet size and location.

1. LOCATION

BLDG	FLOOR	ROOM	LOCATION
HSE	5	500EC	Main Corridor, Northeast of Tower Elevator
HSE	14	1400EC	Main Corridor, Northeast of Tower Elevator
U	2	253	Main Corridor, East of Emergency Shower
U	4	430	Main Corridor, Northeast of Elevator
K	2	299JA	West of Main Elevator
K	3	323	Main Corridor
LPPI	3	A319	South Corridor, East End
GH	2	N232	Main Corridor
GH	2	S223	Main Corridor
GH	3	N332	Main Corridor
GH	3	S323	Main Corridor
GH	4	N432	Main Corridor
GH	4	S423	Main Corridor
GH	5	N532	Main Corridor
GH	5	S523	Main Corridor
Rock Hall	2	276	
Rock Hall	3	338	
Rock Hall	4	438	
Rock Hall	5	538	
Byers Hall			
Byers Hall			
Byers Hall			
Byers Hall			
Diller			
Diller			
Diller			
Diller			

Diller			
MTZ CC	1	N131	
MTZ CC	1	N175	
MTZ CC	1	S184	
MTZ CC	2	N252	
MTZ CC	2	S262	
MTZ CC	3	N352	
MTZ CC	3	S362	
MTZ CC	4	N452	
MTZ CC	4	S467	

H. SPILL CENTERS

"Spill centers" are intended for the exclusive use of emergency personnel (EH&S, UCPD, and SFFD). As with the spill closets; inventories in each center may vary slightly with size and location.

1. LOCATION

BLDG	FLOOR	ROOM	LOCATION
HSW	B	204B	HSW Basement
GH	1	N128	Main Corridor
LHts	1	150	East Corridor, Opposite Suite 150
INCIN	Lower Level		In Front of Incinerator Bldg.

I. SPILL BUCKETS

In addition to EH&S maintained spill cabinets and closets for campus personnel use, EH&S recommends that each chemical user reserve a small space (2' x 2') for a "spill bucket" containing spill material and personal protective equipment. This "spill bucket" is inexpensive and portable and will allow you to respond quickly to minor spills of non-radioactive chemicals.

CHAPTER 9

UCSF GUIDE FOR DISPOSAL OF HAZARDOUS (CHEMICAL) WASTE

UCSF generates hazardous (chemical) waste from all areas of the campus: specifically from research, teaching, and clinical laboratory activities; department workshops and facilities maintenance operations; patient care activities; and administrative units. Even though the responsibility for waste management begins with the individual, laboratory or operation, the volume and complexity of waste material and the variety and number of generators at the many campus locations dictate the need for a comprehensive campus-wide HAZARDOUS (CHEMICAL) WASTE Program.

This chapter describes the guidelines for the classification, segregation, identification, packaging, notification and disposal of HAZARDOUS (CHEMICAL) WASTE.

Generally, the disposal costs for HAZARDOUS (CHEMICAL) WASTE produced as a result of normal and routine operations are paid by EH&S; however, the costs of removing chemicals left by previous occupants due to lab moves or lab close outs and certain other types of hazardous materials may be the responsibility of individual departments and or units. Usually, EH&S does not pay disposal costs without prior written approval from the Director of EH&S in the following situations:

- HAZARDOUS (CHEMICAL) WASTE generated from construction maintenance, renovation, demolition, and/or construction operations.
- HAZARDOUS (CHEMICAL) WASTE left by a previous occupant or research venture.
- HAZARDOUS (CHEMICAL) WASTE requiring special disposal procedures or which have unusually high disposal costs. Examples include potential explosives, lecture bottles and/or compressed gas cylinders, and several "forbidden" chemicals for transport.
- HAZARDOUS (CHEMICAL) WASTE resulting from a fire or chemical accident.
- HAZARDOUS (CHEMICAL) WASTE resulting from Power Plant operations and Faculty Practices.
- Abandoned HAZARDOUS (CHEMICAL) WASTE.
- Special analytical laboratory costs to determine the chemical components of unknown waste.

A. GUIDELINES FOR THE PREPARATION OF WASTE AT UCSF

To properly prepare waste for disposal, EH&S recommends identifying the waste materials as either radioactive, biological, or chemical. Solid or liquid chemicals must never be placed in the ordinary trash or poured into a drain for disposal unless this procedure has been approved by EH&S in advance.

B. SPECIAL CONSIDERATION AND/OR HANDLING

Certain types of waste require special consideration and/or handling: Feel free to call EH&S at 476-1480 if you have questions or need assistance.

1. **LECTURE BOTTLES CYLINDERS** incur very high disposal costs. To minimize costs, purchase cylinders from Matheson Gas and/or Sigma Aldrich. Both companies accept disposable cylinders like lecture bottles for return. Call them directly and ask for their “Return Cylinder Information” prior to purchase.

2. **AEROSOL CONTAINERS** such as spray paint cans must be disposed of as hazardous waste.

3. **UNKNOWN CHEMICALS** require special handling. The responsible department must make every effort to classify the materials, which are being disposed. Basic waste analysis procedure is shown in Appendix A6.

4. **POTENTIAL CHEMICAL EXPLOSIVES** which are shock sensitive, explosive, or highly reactive chemicals require that removal arrangements be made with a qualified hazardous (chemical) waste vendor specializing in handling these types of chemical. Potential chemical explosives are very costly to dispose. The generating department through EH&S pays for this disposal. See Attachment 2 for partial listing of the potential explosives.

5. **EMPTY CONTAINERS** of 5-gallons or less must be placed in ***a hard sided container*** before disposal in the trash. The container must not have any liquid or residue when tilted at any orientation and labels must be defaced. EH&S recommends that chemical containers be saved and re-used to hold compatible hazardous (chemical) waste.

   Other empty containers of 5-gallons or more cannot be disposed in regular trash but must be returned to the original distributor either for reuse, reconditioning, and/or to reclaim scrap value.

6. **CONTROLLED SUBSTANCES** with expired dates and/or which are unwanted must be disposed through EH&S in accordance with the policies and procedures approved by the U.S. Drug Enforcement Administration.

7. **EXPIRED PHARMACEUTICAL DRUGS** (i.e. over the counter medications or prescription drugs) may be accepted for processing and destruction by a local pharmaceutical or medical waste vendor. A listing of the drugs along with the National Drug Code (NDC) number, manufacturer name, and trade or brand name must be provided to the vendor.

   Expired pharmaceutical drugs that exhibit the hazardous (chemical) waste characteristic of toxicity should be managed as hazardous (chemical) waste.

8. **PHOTOGRAPHIC HAZARDOUS (CHEMICAL) WASTE** (spent photographic fixer) produced during photo processing should be collected for silver recovery and not released to the sanitary sewer. Call EH&S at 476-0544 for information on collection and disposal

   Certain photographic developers, activators, and stabilizers such as those produced in the Electron Microscopy laboratory must also be disposed of as hazardous (chemical) waste.

9. **BATTERIES** are considered a major source of toxic metal pollution due to air emissions from incinerators and leaching into soils from landfills. Regulations required that batteries be separated into several categories (general purpose, button, rechargeable, and lead-acid) for collection and disposal.

10. **METALLIC MERCURY** containing materials such as old manometers, broken thermometers, blood pressure apparatus, and vapor lamps should be collected by EH&S. **Do not place broken thermometers inside sharps containers.**

11. **10% FORMALIN**: Tissues or organs immersed in 10% formalin must be separated before disposal. After the separation, the tissues and organs should be red bagged for medical waste disposal.

12. **CHEMOTHERAPY WASTE**: **"TRACE AMOUNT"** of chemotherapy waste includes empty containers of chemotherapy (may contain residual solution), used IV tubing, and any contaminated personal protective equipment worn when handling chemotherapy (i.e. gloves, gowns, masks, goggles). Also includes soiled pads and diapers of patients receiving chemotherapy from start of therapy to 48 hours after last dose. **TRACE CHEMOTHERAPY** waste is disposed as medical waste for incineration.

CONCENTRATED chemotherapy waste includes partially used containers used in chemotherapy procedures (bags, drug vials and syringes containing visible and pourable material and solutions of chemotherapy). **CONCENTRATED CHEMOTHERAPY** waste is managed as hazardous (chemical) waste.

13. HAZARDOUS MEDICATIONS - Although any chemical used therapeutically may be referred to as Hazardous Medications, this term is currently used in both the medical and lay communities to mean drug therapy of cancer and other diseases.

14. **BLACK POWDER TONERS** containing styrene/acrylate polymer, acrylic resin, carbon black and polyolefin may be placed in the trash for disposal. In general, laser cartridges should not be placed in the trash for disposal. Call the manufacturer or distributor for recycling. Color toners containing heavy metals must be disposed through EH&S.

15. **ETHIDIUM BROMIDE** generated waste (gels, buffer solutions, debris) must be disposed through EH&S.

16. **DENTAL AMALGAM** is mixture of mercury with silver tin alloy. CAL/EPA considers this as scrap metal for recycling rather than as hazardous (chemical) waste.

17. **FLUORESCENT TUBES and HIGH INTENSITY DISCHARGE LAMPS** contain mercury and require recycling.

18. **FLUORESCENT LIGHT BALLASTS,** which contain Polychlorinated Biphenyls (PCBs) are considered hazardous (chemical) waste and are regulated by the CAL/EPA. Ballasts manufactured after January 1, 1978 do not contain PCBs, and should be labeled “No PCBs” on the ballast.

19. **POISON INHALATION HAZARD CHEMICALS** require special transportation arrangement from UCSF to the designated treatment facility. See Appendix A8 for partial listing.

20. **RICIN** is labeled extremely toxic. It is used as a tool in cancer research studies wherein the ricin is injected into the sheep's lower lung lobe. EH&S must collect the ricin contaminated lung material for proper disposal.

21. **URANYL COMPOUNDS** are received at UCSF as chemical rather than as a radioactive material. Examples of such compounds are uranyl acetate and uranyl nitrate. Collection and disposal, however, is done through the EH&S Radioactive Waste Program. Please call 476-1771 (Parnassus Campus) or 514-4107 (Mission Bay Campus) for pick-up. If your laboratory does not have Radioactive Use Authorization, you will need to provide an account and fund for disposal.

22. **DIOXIN and DIOXIN-LIKE COMPOUNDS** are compounds from a group of halogenated aromatic hydrocarbons that have molecules shaped like 2,3,7,8-tetrachlorodibenzo-*p*-dioxin or TCDD. These compounds produce similar toxic effects like other chlorinated dibenzo-*p*-dioxins (CDDs) and certain chlorinated dibenzofurans (CDFs), polychlorinated biphenyls (PCBs), polybrominated biphenyls (PBBs), brominated dibenzo-*p*-dioxins (BDDs), and brominated dibenzofurans (BDFs).

C. SEGREGATION

Please follow the following procedures for hazardous (chemical) waste storage and segregation.

Set up a disposal area so that your waste is collected and segregated as it is generated. This will prevent the occurrence of incompatible mixtures. The waste container should be placed in a secondary container (e.g. a large plastic pan) which is large enough to catch the contents of the waste container should a spill occur.

1. SEGREGATE BY CHEMICAL CATEGORY ACCORDING TO THESE RULES:

a. Segregate all potential explosive chemicals from all other chemicals. A potential explosive chemical is a material that may ignite as a result of conditions that normally exist in the ambient environment, such as heat, light, shock, friction and the presence of water or result from long-term storage in the environment. Package the chemicals separately in such a way as to contain and isolate any ignition that may occur. These chemicals are not removed with normal hazardous (chemical) waste. Contact EH&S at 476-0544 to arrange special removal by a licensed hazardous (chemical) vendor.

b. Segregate strong oxidizers from all organics and package separately.

c. Segregate acids and bases and package separately.

d. Segregate heavy metal solutions and salts and package separately.

e. Segregate chemical carcinogens and package separately.

f. Segregate cyanides containing materials and package separately.

g. Segregate vacuum pump oil for recycling and package separately.

h. Segregate compressed gasses and aerosol containers and package separately.

i. Do not mix waste hydrocarbon solvents in the same container with halogenated solvents. The hydrocarbon solvents can be recycled if not contaminated with halogens.

j. Segregate all alkali metal solutions and water reactive chemicals from moisture, water, and other chemicals. Package separately. Protect from water. Place warning labels on the packages.

k. Segregate peroxide-forming chemicals from all other combustible materials and mineral acids. Package separately. Separation may be from a distance or barrier.

Keeping waste materials segregated from each other requires only a reasonable amount of forethought and effort, and should be required of **EVERY** individual in the laboratory. A list of incompatibles is available from EH&S.

D. IDENTIFICATION

1. PROPERLY IDENTIFY AND LABEL THE CONTENTS OF EACH WASTE CONTAINER

Attach a **HAZARDOUS (CHEMICAL) WASTE TAG (HWT)** to each waste container that identifies its contents and specifies the amount of every waste constituent. Include the identity of commercial products as well as chemical reagents. Labels such as **"NON-FLAMMABLE WASTE'** or **"ORGANIC SOLVENT WASTE"** are not acceptable. HWTs are now available on-line. See Appendix A4 for the Online WASte Program and User Manual.

ALL CONSTITUENTS in mixtures (solid or liquid) must be identified and their concentrations stated (%, ppm, M). Acids and bases other than pure material in its original container must be analyzed and their strengths given in normality, molarity, or weight percent.

2. IDENTIFY WASTE MATERIALS ON THE HAZARDOUS (CHEMICAL) WASTE TAG IN ONE OF THE FOLLOWING THREE WAYS:

a. **Chemical Name.** If material is a mixture, provide the concentrations of all its hazardous constituents. Concentrations may be stated in molarity (gram or pound moles per liter or moles per gallon), percent by weight or volume (percent is assumed to be by weight unless volume is stated), weight per volume (grams or milligrams per liter), or parts per million or billion.

b. **Manufacturer and Product Name.** Include all hazardous materials listed in the Safety Data Sheet (SDS). SDS's can be downloaded from one of the SDS Databases on the EH&S website.

c. **Complete Generic Description of Material.** Use the GENERIC DESCRIPTION ONLY if the material is a mixture of a well-known standard composition. The generic description must be complete enough to adequately characterize the waste material.

E. PACKAGING

Proper packaging is extremely important. Place every hazardous chemical waste in an appropriate container. **INCORRECT PACKAGING COULD RESULT IN AN ACCIDENT OR SPILL** during transport to the waste storage facility.

The following requirements must be met before hazardous (chemical) waste is collected and disposed of by EH&S.

1. Chemicals must be segregated into compatible groups as discussed in Chapter 2.

2. Liquid waste must be contained in screw cap bottles. Stopper or corked flasks and bottles without proper lids will not be picked up.

3. Chemically contaminated debris must be placed in transparent plastic bags. For ease of handling, place these bags inside a **HARD-SIDED CONTAINER** (e.g., recycled carton box) whenever possible. Bags with protruding glass or needles will not be picked up. Colored plastic and paper bags are not acceptable.

4. Semi-solid materials such as gels and paraffin wax must be placed in wide mouth plastic jars or bottles with screw caps.

5. Leaking containers can be placed inside larger screw top bottles or plastic buckets with snap-on lids. Leaking containers will not be picked up.

6. **Chemically-contaminated sharps** (e.g., needles, syringes, glass slides, razor blades, scalpel blades, microtome blades, glass Pasteur pipettes, capillary pipettes) must be placed inside rigid puncture-proof containers.

7. Each waste container must be properly identified and labeled with a Hazardous (Chemical) Waste Tag.

F. WASTE REMOVAL

To provide for the efficient removal of hazardous (chemical) waste, send notification to EH&S via the online WASTe Program. Simply log on to your account at https://ehs.ucop.edu/waste/#/login and select the containers as ready for disposal. HAZARDOUS (CHEMICAL) WASTE is picked up in accordance with the scheduled given on Appendix A1.

The following steps will ensure that your HAZARDOUS (CHEMICAL) WASTE is efficiently collected:

1. Completed hazardous (chemical) waste tag is attached to each waste container.

2. Store waste containers in designated places on the scheduled pick-up day. **DO NOT PLACE HAZARDOUS (CHEMICAL) WASTE CONTAINERS IN CORRIDORS, HALLWAYS, OR OTHER SIMILAR PUBLIC ACCESS AREAS.**

CHAPTER 10

CHEMICAL INVENTORIES

Federal and California laws provide for “cradle to grave” regulation of hazardous chemicals. In California, the California Department of Toxic Substances Control is the state’s lead agency in implementing these regulations. One regulation (Chapter 6.95 Sections 25500 et.seq. of the Health and Safety Code) requires each California business to submit a Business Plan, describing how the business plans to handle hazardous chemicals. This information is intended for use by local emergency agencies, such as fire and police, providing awareness of hazards to be encountered at that business.

This regulation is implemented at the city or county level; for UCSF the implementing agency is the City and County of San Francisco’s Department of Public Health (DPH). The DPH can establish “inventory reporting thresholds” for the businesses under its jurisdiction. For San Francisco, the reporting threshold is 25 grams or 100 milliliters of a chemical, or 100 cubic feet of compressed gases or liquids. Chemicals that present known hazards (toxic, carcinogenic, …) must be included regardless of the quantity present.

The requirements of the Business Plan include two major elements that directly affect the laboratories at UCSF:

- DPH will perform regular (annual or biannual) inspection of all laboratory areas.
- Each laboratory must submit an annual inventory of all chemicals in that laboratory.

Information required for the inventory for each chemical is:

- The chemical name and CAS number
- The container capacity
- The maximum quantity on hand
- The amount on hand
- The number of containers
- The container type
- The measurement unit and
- The physical state

EH&S is responsible for collecting and submitting the inventories; upon request each laboratory is expected to submit the updated inventory to EH&S. EH&S personnel are available to assist Principal Investigators or supervisors in preparing the annual inventory. See Appendix A for Chemical Inventory Instructions and Form.

The annual inventory process is an excellent time for laboratory personnel to review their use of each chemical and to consider:

- Alternate, less hazardous chemicals as substitutes.
- Purchase of smaller containers of chemicals to decrease quantities on hand.
- Disposal of chemicals which have not been used.
- Disposal of outdated chemicals.
- Verifying that purchase date has been written on each container.
- General housecleaning.

CHAPTER 11

INFORMATION ABOUT UCSF'S PARTICULARLY HAZARDOUS CHEMICALS

Cal/OSHA established a category of chemicals known as **PARTICULARLY HAZARDOUS CHEMICALS (PHC)** for which additional precautions may be required. Particularly hazardous chemicals include select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity.

At UCSF, PHC is further expanded to include hazardous chemicals listed in:

- Case No.: BA392069 PROSECUTION ENFORCEMENT AGREEMENT ADMINISTRATIVE ENFORCEMENT TERMS AND CONDITIONS PENAL CODE SECTION 1385 APPENDIX A
- California Code of Regulations, Title 22 Section 66261.126 Appendix X (extremely hazardous waste)
- 40 CFR Protection of Environment Part 355 Appendix A (extremely hazardous substances)
- California Code of Regulations, Title 8 Article 110 Regulated Carcinogens
- National Toxicology Program 12th Report (known to be human carcinogens)
- World Health Organization - International Agency for Research on Cancer (Agents Classified as Group 1, 2A & 2B)
- Proposition 65 Reproductive and Developmental Toxins

A list of UCSF's Particularly Hazardous Chemicals is available on EH&S website.

NOTE: Prior to using Particularly Hazardous Chemicals, the PI must develop, review and approved a lab SOP. Also, all lab personnel working with PHC must have access to the lab SOP and provided safety training. A copy of the lab SOP and training documentation must be submitted to EH&S.

A. ACUTE TOXINS

Substances that have a high degree of acute toxicity are substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. They can be defined as:

1. A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm. each;

2. A chemical with a median lethal dose (LD50) of 200 mg or less per Kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 Kg each; and

3. A chemical that has a median lethal concentration (LC50) in air or 5000 ppm by volume or less of gas or vapor, or 50 mg per liter or less of mist, fume, or dust when administered continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm. each.

B. REPRODUCTIVE TOXINS

Reproductive toxins include any chemical that may affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogens). See link for list of Reproductive Toxin Chemicals

C. SELECT CARCINOGENS

Carcinogens are chemical or physical agents that cause cancer. Generally, they are chronically toxic substances, that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period.

The term “Regulated Carcinogen” means a recognized cancer causing substance, compound, mixture, or product regulated by Cal/OSHA sections 1529, 1532, 1532.2, 1535, 8358, 8359 or Article 110, sections 5200-5220.

The term “Listed Carcinogen” refers to a specific list of 13 chemicals regulated by Cal/OSHA and Federal OSHA and has specific use and handling requirements. See link forListed and Regulated Carcinogens.

The term “Select Carcinogen” refers to category of chemicals where the available evidence strongly indicates that the substances cause human carcinogenicity. A select carcinogen 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 by the National Toxicology Program (NTP); or
3. It is listed under Group 1- “carcinogenic to humans” – by the International Agency for Research on Cancer (IARC); or
4. Is listed in either Group 2A or Group 2B by the IARC or under the category “reasonably anticipated to be carcinogens” by the 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 10mg/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.

Particularly Hazardous Chemicals also include material identified as "select agents" by the United States Department of Agriculture (USDA) and/or the Department of Health and Human Services. These agents have very strict controls for acquisition, storage and use under the Public Health Security and Bioterrorism Preparedness and Response Act of 2002. At the time of implementation of this act, the campus submitted a Statement of Non-Possession to the Centers for Disease Control and Prevention. Any future use of these agents must be approved by the Biological Safety Committee prior to acquisition. A list of these agents is available from EH&S. Contact EH&S Biosafety Officer at 514-2824.

Prior to working with a particularly hazardous chemical, laboratory workers must take all applicable online training modules, receive lab specific SOP training from the Principal Investigator. Lab specific training must be documented. The following points must be addressed prior to working with PHCs:

Laboratory Evaluation

- Establish the "Designated Area".
- Contact EH&S if exposure monitoring is needed.
- Establish the need for medical surveillance.
- Establish the need for specialized training.
- Identify the controls and personal protective equipment needed

Establishment of Designated Areas

- Segregate PHC in designated areas.
- A designated can by an entire laboratory, specific work bench, or hoods.
- Access shall be restricted to trained personnel aware of the potential hazards associated with the materials.
- Keep the laboratory door closed at all times.

Use of Containment Devices and Protective Equipment

- Don appropriate PPE such as, but not limited to: gloves, safety goggles, lab coat, long pants and closed toe shoes.
- Read the SDS for the chemicals used: Know special precautions to be taken.
- All work which may result in an airborne hazard shall be conducted in hoods or glove boxes which have been tested and approved by EH&S.
- All PPE, including lab coats, shall be removed before leaving the laboratory area.

Decontamination Procedures

- Decontaminate the area when work is complete.
- Clean up spills promptly in a manner which does not create an airborne hazard.
- All materials shall be decontaminated before being moved from the designated area.
- Wash thoroughly prior to leaving the area and after any procedure involving PHC.

Waste Disposal Procedures

- Dispose all chemically contaminated waste through EH&S.

Chemical Use Authorization(CUA)

To facilitate compliance, OEH&S developed a Chemical Use Authorization (CUA) system, via Research Information Online (RIO) to identify PHCs from each laboratory's chemical inventory. Furthermore, the CUA provides an online repository for SOP submission and real- time submission status for reporting compliance purposes.

If a reagent is "not in use", an SOP is not required. Laboratories can choose from two available options: disposed via WASTe or tagged as for future use. Inactive chemicals must be tagged with an "inactive" label, (see Appendix E8). At UCSF, EH&S encourages laboratories to explore the option of using CLS Surplus Share for reagents that are no longer in use, instead of disposing as hazardous waste.

CHAPTER 12

CHEMICAL HAZARDS

Chemicals can be broken down into hazard classes and exhibit both physical and health hazards. It is important to keep in mind, that chemicals can exhibit more than one hazard or combinations of several hazards. Several factors can influence how a chemical will behave and the hazards the chemical presents, including the severity of the response:

- Concentration of the chemical.
- Physical state of the chemical (solid, liquid, gas).
- Physical processes involved in using the chemical (cutting, grinding, heating, cooling, etc.).
- Chemical processes involved in using the chemical (mixing with other chemicals, purification, distillation, etc.).
- Other processes (improper storage, addition of moisture, storage in sunlight, refrigeration, etc.).

The following sections describe general information and safety precautions about specific hazard classes. The chemical hazards listed are based on the Department of Transportation (DOT) hazard class system.

It is important to note that the following sections are general guidelines. Laboratory personnel should always review SDS and other resources FIRST, before working with any chemical.

A. EXPLOSIVES

CAL/OSHA Laboratory Standard defines an explosive as a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. Under the Department of Transportation (DOT) hazard class system, explosives are listed as hazard class 1.

Fortunately, most laboratories do not use many explosives; however, there are a number of chemicals that can become unstable and/or potentially explosive over time due to contamination with air, water, other materials such as metals, or when the chemical dries out.

If you ever come across any chemical that you suspect could be potentially shock sensitive and/or explosive, do not attempt to move the container as some of these compounds are shock, heat, and friction sensitive. In these instances, you should contact your DSA at 476-1300.

Explosives can result in damage to surrounding materials (hoods, glassware, windows, people, etc.), generation of toxic gases, and fires. If you plan to conduct an experiment where the potential for an explosion exists, first ask yourself the question; “Is there another chemical that could be substituted in the experiment that does not have an explosion potential?” If you must use a chemical that is potentially explosive, or for those compounds that you know are explosive, (even low powered explosives) you must first obtain prior approval from the Principal Investigator to use such chemicals. After obtaining prior approval from your Principal Investigator, thoroughly read the SDSs and any other chemical resources elated to the potentially explosive compound(s) to ensure potential incidents are minimized.

Whenever setting up experiments using potentially explosive compounds:

- Always use the smallest quantity of the chemical possible.
- Always conduct the experiment within a fume hood and use in conjunction with a properly rated safety shield.
- Be sure to remove any unnecessary equipment and other chemicals (particularly highly toxic and flammables) away from the immediate work area.
- Be sure to notify other people in the laboratory what experiment is being conducted, what the potential hazards are, and when the experiment will be run.
- Do not use metal or wooden devices when stirring, cutting, scraping, etc. with potentially explosive compounds. Non-sparking plastic devices should be used instead.

- Ensure other safety devices such as high temperature controls, water overflow devices, etc., are used in combination to help minimize any potential incidents.
- Properly dispose of any hazardous waste and note on the hazardous waste tag any special precautions that may need to be taken if the chemical is potentially explosive.
- Always wear appropriate PPE, including the correct gloves, lab coat or apron, safety goggles used in conjunction with a face shield, and explosion-proof shields when working with potentially explosive chemicals.
- For storage purposes, always date chemical containers when received and opened. Pay particular attention to those compounds that must remain moist or wet so they do not become explosive (ex. Picric acid, 2,4-Dinitrophenyl hydrazine, etc.). Pay particular attention to any potentially explosive compounds that appear to exhibit the following signs of contamination:
    - Deterioration of the outside of the container.
    - Crystalline growth in or outside the container.
    - Discoloration of the chemical.

If you discover a potentially explosive compound that exhibits any of these signs of contamination, call your DSA at 476-1300 for more assistance.

Examples of explosive and potentially explosive chemicals include:

- Compounds containing the functional groups azide, acetylide, diazo, nitroso, haloamine, peroxide, and ozonide
- Nitrocellulose
- Di- and Tri-nitro compounds
- Peroxide forming compounds
- Picric acid (dry)
- 2,4-Dinitrophenylhydrazine (dry)
- Benzoyl peroxide (dry)

B. FLAMMABLE AND COMBUSTIBLE LIQUIDS

CAL/OSHA Laboratory Standard defines a flammable liquid as any liquid having a flashpoint below 100 degrees F (37.8 degrees C), except any mixture having components with flashpoints of 100 degrees F (37.8 degrees C) or higher, the total of which make up 99% or more of the total volume of the mixture.

Flashpoint is defined as the minimum temperature at which a liquid gives off enough vapor to ignite in the presence of an ignition source. The risk of a fire requires that the temperature be above the flashpoint and the airborne concentration be in the flammable range above the Lower Explosive Limit (LEL) and below the Upper Explosive Limit (UEL).

CAL/OSHA Laboratory Standard defines a combustible liquid as any liquid having a flashpoint at or above 100 degrees F (37.8 degrees C), but below 200 degrees F (93.3 degrees C), except any mixture having components with flashpoints of 200 degrees F (93.3 degrees C), or higher, the total volume of which make up 99% or more of the total volume of the mixture. OSHA further breaks down flammables into Class I liquids, and combustibles into Class II and Class III liquids. Please note this classification is different than the criteria used for DOT classification. This distinction is important because allowable container sizes and storage amounts are based on the particular OSHA Class of the flammable liquid.

Classification	Flash Point	Boiling Point
Flammable Liquid		
Class IA	<73 degrees F	<100 degrees F
Class IB	<73 degrees F	>=100 degrees F
Class IC	>=73 degrees F, <100 degrees F	>100 degrees F
Combustible Liquid		
Class II	>=100 degrees F, <140 degrees F	--
Class IIIA	>=140 degrees F, < 200 degrees F	--
Class IIIB	>=200 degrees F	--

Under the Department of Transportation (DOT) hazard class system, flammable liquids are listed as hazard class 3.

Flammable and combustible liquids are one of the most common types of chemicals used at UCSF and are an important component in a number of laboratory processes. However, in addition to the flammable hazard, some flammable liquids also may possess other hazards such as being toxic and/or corrosive.

When using flammable liquids, keep containers away from open flames; it is best to use heating sources such as steam baths, water baths, oil baths, and heating mantels. Never use a heat gun to heat a flammable liquid. Any areas using flammables should have a fire extinguisher present.

Always keep flammable liquids stored away from oxidizers and away from heat or ignition sources such as radiators, electric power panels, etc.

When pouring flammable liquids, it is possible to generate enough static electricity to cause the flammable liquid to ignite. If possible, make sure both containers are electrically interconnected to each other by bonding the containers, and connecting to a ground.

Always clean up any spills of flammable liquids promptly. Be aware that flammable vapors are usually heavier than air (vapor density > 1). For those chemicals with vapor densities heavier than air (applies to most chemicals), it is possible for the vapors to travel along floors and, if an ignition source is present, result in a flashback fire.

C. FLAMMABLE SOLIDS

CAL/OHSA Laboratory Standard defines a flammable solid as a “solid, other than a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited, burn so vigorously and persistently to create a serious hazard.” An example of a flammable solid is gun powder.

Under the DOT hazard class system, flammable solids are listed as hazard class 4. Flammable solids are further broken down into three subcategories:

- Flammable Solids – Class 4.1
- Spontaneously Combustible – Class 4.2
- Dangerous When Wet – Class 4.3

Many of the same principles for handling and storage of flammable liquids apply to flammable solids. Always keep flammable solids stored away from oxidizers, and away from heat or ignition sources such as radiators, electric power panels, etc.

D. SPONTANEOUSLY COMBUSTIBLE (PYROPHORICS)

Spontaneously combustible materials are also known as pyrophoric; these chemicals can spontaneously ignite in the presence of air, some are reactive with water vapor, and most are reactive with oxygen. Two common examples are tert-Butyllithium under Hexanes and White Phosphorus. In addition to the hazard of the spontaneously combustible chemical itself, many of these chemicals are also stored under flammable liquids. In the event of an accident, such as a bottle being knocked off a shelf, the chemical can spontaneously ignite and a fire can occur. Extra care must be taken when handling spontaneously combustible chemicals. When transporting these chemicals, it is best to use a bottle carrier and carts. Refer to the following safety information and Procedures:

- Safe Handling of Organolithium Compounds in the Laboratory (American Chemical Society)

- UCSF Procedures for Safe Use of Pyrophoric Organolithium Reagents
- Handling Pyrophoric and Other Highly Reactive Materials (UCSD)
- UCLA Pyrophoric Fatality video

E. DANGEROUS WHEN WET

Dangerous when wet compounds react violently with water to form toxic vapors and/or flammable gases that can ignite and cause a fire. Please note, attempting to put out a fire involving dangerous when wet materials with water will only make the situation worse. Special "Class D" fire extinguishers are required for use with dangerous when wet compounds. Common examples include sodium metal and potassium metal.

It is important to note that any paper toweling, gloves, etc., that have come into contact with these materials need to be quenched with water before disposing of in metal trash cans in order to prevent potential fires.

If you are using dangerous when wet compounds and do not have a Class D fire extinguisher present, then please call your DSA at 476-1300 for more assistance.

F. OXIDIZERS AND ORGANIC PEROXIDES

CAL/OSHA Laboratory Standard defines an oxidizer as "a chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases." Under the DOT hazard class system, oxidizers are listed as hazard class 5.1 and organic peroxides are listed as hazard class 5.2.

The OSHA Laboratory Standard defines organic peroxide as "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 have been replaced by an organic radical."

Oxidizers and organic peroxides are a concern for laboratory safety due to their ability to promote and enhance the potential for fires in labs.

As a reminder of the fire triangle (now referred to as the fire tetrahedron), in order to have a fire, you need:

- A fuel source.
- An oxygen source.
- An ignition source.
- A chemical reaction.

Oxidizers can supply the oxygen needed for the fire, whereas organic peroxides supply both the oxygen and the fuel source. Both oxidizers and organic peroxides may become shock sensitive when they dry out, are stored in sunlight, or due to contamination with other materials, particularly when contaminated with heavy metals. Most organic peroxides are also temperature sensitive.

As with any chemicals, but particularly with oxidizers and organic peroxides, quantities stored on hand should be kept to a minimum. Whenever planning an experiment, be sure to read the SDS and other reference documents to understand the hazards and special handling precautions that may be required, including use of a safety shield. Also be aware of the melting and autoignition temperatures for these compounds and ensure any device used to heat oxidizers has an over temperature safety switch to prevent the compounds from overheating.

Laboratory staff should be particularly careful when handling oxidizers (especially high surface area oxidizers such as finely divided powders) around organic materials.

Avoid using metal objects when stirring or removing oxidizers or organic peroxides from chemical containers. Plastic or ceramic implements should be used instead. Laboratory personnel should avoid friction, grinding, and

impact with solid oxidizers and organic peroxides. Glass stoppers and screw cap lids should always be avoided and plastic/polyethylene lined bottles and caps should be used instead.

If you suspect your oxidizer or organic peroxide has been contaminated (evident by discoloration of the chemical, or if there is crystalline growth in the container or around the cap), then dispose of the chemical as hazardous waste or call your DSA at 476-1300. Indicate on the hazardous waste tag that the chemical is an oxidizer or organic peroxide and that you suspect contamination.

G. PEROXIDE FORMING COMPOUNDS

Many commonly used chemicals; organic solvents in particular, can form shock, heat, or friction sensitive peroxides upon exposure to oxygen. Once peroxides have formed, an explosion can result during routine handling, such as twisting the cap off a bottle – if peroxides are formed in the threads of the cap. Explosions are more likely when concentrating, evaporating, or distilling these compounds if they contain peroxides.

When these compounds are improperly handled and stored, a serious fire and explosion hazard exists. The following guidelines should be adhered to when using peroxide forming chemicals:

1. Each peroxide forming chemical container MUST be dated when received and opened. A list of common peroxide forming compounds can be found in APPENDIX A9. Those compounds in the appendix listed in Table A should be disposed of within 3 months of opening and those compounds in the appendix listed in Tables B, C, and D should be disposed of within 12 months of opening.

2. Each peroxide forming chemical container must be tested for peroxides when opened and at least every 6 months thereafter. The results of the peroxide test and the test date must be marked on the outside of the container.

3. Peroxide test strips can be purchased from a variety of safety supply vendors, such as VWR and Laboratory Safety Supply. An alternative to peroxide test strips is the KI (potassium iodide) test. Prudent Practices in the Laboratory outline ways to test for peroxides and ways to remove them if discovered. When using the test strips, if the strip turns blue, then peroxides are present. Light blue test results may be acceptable for use if your procedure does not call for concentrating, evaporating or distilling. Containers with darker blue test results must be deactivated or disposed of. You can test older test strips for efficacy with a dilute solution of hydrogen peroxide.

4. Due to sunlight's ability to promote formation of peroxides, all peroxidizable compounds should be stored away from heat and sunlight.

5. Peroxide forming chemicals should not be refrigerated at or below the temperature at which the peroxide forming compound freezes or precipitates as these forms of peroxides are especially sensitive to shock and heat. Refrigeration does not prevent peroxide formation.

6. As with any hazardous chemical, but particularly with peroxide forming chemicals, the amount of chemical purchased and stored should be kept to an absolute minimum. Only order the amount of chemical needed for the immediate experiment.

7. Ensure containers of peroxide forming chemicals are tightly sealed after each use and consider adding a blanket of an inert gas, such as Nitrogen, to the container to help slow peroxide formation.

8. A number of peroxide forming chemicals can be purchased with inhibitors added. Unless absolutely necessary for the research, labs should never purchase uninhibited peroxide formers.

9. Before distilling any peroxide forming chemicals, always test the chemical first with peroxide test strips to ensure there are no peroxides present. Never distill peroxide forming chemicals to dryness. Leave at least 10-20% still bottoms to help prevent possible explosions.

While no definitive amount of peroxide concentration is given in the literature, a concentration of 50 ppm should be considered dangerous and a concentration of >100 ppm should be disposed of immediately. In both cases,

procedures should be followed for removing peroxides or the containers should be disposed of as hazardous waste.

***However, compounds that are suspected of having very high peroxide levels because of age, unusual viscosity, discoloration, or crystal formation should be considered extremely dangerous. If you discover a container that meets this description, **DO NOT** attempt to open or move the container. Notify other people in the lab about the potential explosion hazard and notify your DSA at 476-1300 immediately.

For those compounds that must be handled by an outside environmental "bomb squad" company, the cost for such an operation can result in charges of >$1000 per container. However, if laboratory staff follow the guidelines listed above, the chances for requiring special handling for these types of containers or for an explosion to occur is greatly diminished.

Please note **APPENDIX A9** is not all-inclusive, there are numerous other chemicals that can form peroxides. Be sure to read chemical container labels, SDS and other chemical resources

H. POISONS

For the purpose of this manual the word "Poison" will be used interchangeably with the word "Toxic". CAL/OSHA defines "Toxic" as a chemical falling within any of the following categories:

- A chemical that has a median lethal dose (LD50) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

- A chemical that has a median lethal dose (LD50) of more than 200 milligrams per kilogram, but not more than 1000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

- A chemical that has a median lethal concentration (LC50) in air of more than 200 parts per million, but not more than 2000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

OSHA draws a distinction between toxic chemicals and acutely toxic chemicals. For more information on acutely toxic chemicals, see Chapter 11 Information on Particularly Hazardous Chemicals. OSHA also provides definitions for other health hazards on their website. Under the DOT hazard class system, poisons are listed as hazard class 6.

As a general rule of thumb, all chemicals should be treated as poisons and proper procedures such as maintaining good housekeeping, use of proper PPE, good personal hygiene, etc., should be followed. When working with known poisons, it is very important to have thought an experiment through, addressing health and safety issues before working with poisons. Safety Data Sheets (SDS) and other chemical references should be consulted before beginning the experiment. Some questions to ask before working with poisonous chemicals:

- Do I need to use the poisonous chemical or can a less toxic chemical be substituted?
- What are the routes of entry into the body for the poison (inhalation, ingestion, injection, or skin absorption)?
- What are the signs and symptoms of potential chemical exposure?
- What are the proper PPE required (type of glove, safety glasses vs. splash goggles, face shield, etc.)?
- Does the chemical require any special antidote?
- What are the emergency procedures to be followed?

When working with highly toxic chemicals, you should not work alone. Always wear proper PPE and always wash

your hands with soap and water when finished, even if gloves were worn. Be aware that poisonous mixtures, vapors, and gases can be formed during an experiment. Be sure to research both the reactants and products of the chemicals you will be working with first. Additional information can be found in Chapter 3 Occupational Exposure Monitoring section of this plan.

If you think you may have received an exposure to a poisonous substance, or may have accidentally ingested a chemical, seek medical attention immediately and/or call the Occupational Health Program at 885-7580 or UCPD at 9-911 from a campus phone or 476-1414 from a cell phone. If possible, bring a copy of the SDS with you. Upon completion of seeking medical attention, complete a Supervisor Injury Report (SIR).

I. CORROSIVES

CAL/OSHA defines a corrosive as "a chemical that causes visible destruction of, or irreversible alterations in living tissue by chemical action at the site of contact." Under the DOT hazard class system, corrosives are listed as hazard class 8.

Corrosive chemicals can be further subdivided as acids and bases. Corrosives can be in the liquid, solid, or gaseous state. Corrosive chemicals can have a severe effect on eyes, skin, respiratory tract, and gastrointestinal tract if an exposure occurs. Corrosive solids and their dusts can react with moisture on the skin or in the respiratory tract and result in an exposure.

Whenever working with concentrated corrosive solutions, splash goggles should be worn instead of safety glasses. Splash goggles used in conjunction with a face shield provides better protection. Please note that a face shield alone does not provide adequate protection. Use of rubber gloves such as butyl rubber and a rubber apron may also be required.

Corrosive chemicals should be handled in a fume hood to avoid breathing corrosive vapors and gases.

When mixing concentrated acids with water, always add acid slowly to the water (specifically, add the more concentrated acid to the dilute acid). Never add water to acid, this can result in a boiling effect and cause acid to splatter. Do not pour the acid directly into the water; it should be poured in a manner that allows it to run down the sides of the container. Never store corrosive chemicals above eye level and always use a protective bottle carrier when transporting corrosive chemicals.

Some chemicals can react with acids and liberate toxic and/or flammable vapors. When working with corrosive materials, ensure spill cleanup material is available for neutralization, such as Calcium carbonate for acids and Citric acid for bases.

Wherever acids and bases are used, an eyewash and shower must be available. If any corrosive chemical gets splashed in the eyes, immediately go to an eyewash station and flush your eyes for at least 15 minutes. The importance of flushing for at least 15 minutes cannot be overstated! Once the eyewash has been activated, use your fingers to hold your eyelids open and roll your eyeballs in the stream of water so the entire eye can be flushed. After flushing for at least 15 minutes, seek medical attention immediately and complete a Supervisor Injury Report (SIR).

For small splashes of corrosives to the skin, remove any contaminated gloves, lab coats, etc., and wash the affected area with soap and water for at least 15 minutes. Seek medical attention afterward, especially if symptoms persist.

For large splashes of corrosives to the body, it is important to get to an emergency shower and start flushing for at least 15 minutes. Once under the shower, and after the shower has been activated, it is equally important to remove any contaminated clothing. Failure to remove contaminated clothing can result in the chemical being held against the skin and causing further chemical exposure and damage. After flushing for a minimum of 15 minutes, seek medical attention immediately and complete a Supervisor Injury Report (SIR).

Please note some chemicals, such as Hydrofluoric acid, require the use of a special antidote (such as

Calcium gluconate gel) and special emergency procedures. Read the SDSs for any chemical(s) you work with to determine if a special antidote is needed if a chemical exposure occurs.

J. HYDROFLUORIC ACID

Hydrofluoric Acid (HF) is one of the most hazardous chemicals used at UCSF. Small exposures to HF can be fatal if not treated properly. The critical minutes immediately after an exposure can have a great effect on the chances of a victim's survival.

HF is a gas that is dissolved in water to form Hydrofluoric acid. The concentration can vary from very low such as in store bought products up to the most concentrated 70% form (anhydrous), with the most common lab use around 48%. The liquid is colorless, non-flammable and has a pungent odor. The OSHA permissible exposure limit is 3 ppm, but concentrations should be kept as low as possible. HF is actually a weak acid by definition and not as corrosive as strong acids such as Hydrochloric acid (HCl). However, corrosivity is the least hazardous aspect of HF. The toxicity of HF is the main concern.

HF is absorbed through the skin quickly and is a severe systemic toxin. The fluoride ion binds calcium in the blood, bones and other organs and causes damage to tissues that is very painful and can be lethal. At the emergency room, the victim is often given calcium injections, but pain medication is not generally given since the pain subsiding is the only indication that the calcium injections are working.

Due to the serious hazard of working with HF, the following requirements and guidelines are provided:

- All users of HF must receive EH&S Hydrofluoric Acid Safety training as well as training by their supervisor.
- A Standard Operating Procedure (SOP) must be written for the process in which HF is used. This SOP should be posted or readily available near the designated area where HF use will occur.
- HF should only be used in a designated fume hood and the fume hood should be identified by posting a HF designated area sign.
- Spill Kits - An HF spill kit must be available with calcium compounds such as Calcium carbonate, Calcium sulfate or Calcium hydroxide. Sodium bicarbonate should never be used since it does not bind the fluoride ion and can generate toxic aerosols.
- Prior approval - Before anyone uses HF they must have prior approval from the Principal investigator. The names of lab personnel should be added to an HF Prior Approval Form showing that they have are familiar with the following:
    - Has read the SDS for HF
    - Has read the HF Use SOP developed by the lab
    - Has read the Hydrofluoric acid section in this Lab Safety Manual
    - Is aware of the designated area for HF use
    - Knows the first aid procedure in case of an HF exposure
    - Knows what to do in case of an HF spill
- Personal Protective Equipment (PPE) – The following PPE is required for HF use:
    - Rubber or plastic apron
    - Plastic arm coverings
    - Gloves
        - Incidental use - double glove with heavy nitrile exam gloves and re-glove if any exposure to the gloves
        - Extended use – heavy neoprene or butyl over nitrile or silver shield gloves
    - Splash goggles in conjunction with a fume hood sash
    - Closed toed shoes
    - Long pants and a long sleeve shirt with a reasonably high neck (no low cut)

The following are safe practice guidelines when working with HF:

- Never work alone with HF but have a buddy system.
- Use a plastic tray while working with HF for containment in case of a spill.
- Keep containers of HF closed. HF can etch the glass sash and make it hard to see through (if the hood sash becomes fogged and hard to see though due to etching, then please contact EH&S at 255-8200 about installing a polycarbonate sash)
- Safety Data Sheet (SDS) – A SDS for HF must be available.
- All containers of HF must be clearly labeled. EH&S recommends labeling all non-original containers.
- The stock HF should be stored in plastic secondary containment and the cabinet should be labeled. HF should be stored in lower cabinets near the floor.
- Wash gloves off with water before removing them.

K. PERCHLORIC ACID

Perchloric acid is a strong oxidizing acid that can react violently with organic materials. Perchloric acid can also explode if concentrated above 72%. For any work involving heated Perchloric acid (such as in Perchloric acid digestions), the work must be conducted in a special Perchloric Acid fume hood with a wash down function. If heated Perchloric acid is used in a standard fume hood, the hot Perchloric acid vapors can react with the metal in the hood ductwork to form shock sensitive metallic perchlorates. When working with Perchloric acid, be sure to remove all organic materials, such as solvents, from the immediate work area. Due to the potential danger of Perchloric acid, if possible, try to use alternate techniques that do not involve the use of Perchloric acid. If you must use Perchloric acid in your experiments, only purchase the smallest size container necessary.

Because Perchloric acid is so reactive, it is important to keep it stored separate from other chemicals, particularly organic solvents, organic acids, and oxidizers. All containers of Perchloric acid should be inspected regularly for container integrity and the acid should be checked for discoloration. Discolored Perchloric acid should be discarded as hazardous waste. Perchloric acid should be used and stored away from combustible materials, and away from wooden furniture. Like all acids, but particularly with Perchloric acid, secondary containment should be used for storage.

CHAPTER 13

UCSF GUIDE FOR MANAGING AND DISPOSING UNIVERSAL WASTE

Universal waste is generated from laboratory operations, construction and renovation activities, facilities operations and maintenance and a variety of other activities at UCSF. Universal waste is a particular class of hazardous waste, which, if improperly managed can also poses a substantial threat or potential hazard to human health and the environment. Examples of Universal waste are mercury thermostats, batteries, lamps, cathode ray tubes (CRT's) and consumer electronic devices (CED's). These wastes are regulated because of their chemical properties.

The handling and storage of Universal Waste is subject to specific regulations to ensure that uniform and consistent waste identification, labeling, storage and disposal procedures are followed by persons trained in the proper management of theses wastes. This guideline describes how Universal Waste will be handled, stored and disposed.

Definitions:

1) Mercury thermostats – are those thermostats that normally contain small glass capsules of mercury, a shiny liquid metal, to make electrical contact.

2) Batteries – are devices consisting of one or more electrically connected electrochemical cells which are designed to receive, store, and deliver electric energy. Examples are those batteries that exhibit a characteristic of a hazardous waste include rechargeable nickel-cadmium batteries, silver button batteries, mercury batteries, small sealed lead acid batteries (burglar alarm and emergency light), most alkaline batteries, carbon-zinc batteries, which also exhibit the characteristic of corrosivity. Spent lead acid batteries of the automotive type are not Universal Waste.

3) Lamps – Lamp, also referred to as "universal waste lamp" is defined as the bulb or tube portion of an electric lighting device. A lamp is specifically designed to produce radiant energy, most often in the ultraviolet, visible, and infra-red regions of the electromagnetic spectrum. This includes (but not all, fluorescent tubes, high intensity discharge lamps, and high pressure sodium lamps.

4) Cathode Ray Tubes (CRT's) - are vacuum tubes or picture tubes used to convert an electrical signal into a visual image. Examples are those found in most computer monitors, television sets, camcorders, cash registers, and oscilloscopes.

5) Consumer Electronic Devices (CED's) – are electronic devices that are normally used by consumers such as microwaves, cell phones, fax machines, etc.

Universal Waste Storage and Disposal

General Requirements:

1. Segregate all universal waste materials by type before placing into waste containers. Contact EH&S at 476-1480 for detailed information, or information not covered in this document.

2. Do not place universal waste and universal waste containers in corridors, hallways, or other public access spaces.

3. Do not place universal waste into the regular trash without consulting with EH&S to ensure regulatory compliance.

General Storage Requirements

1. Designate a specific place in the workroom for waste collection. Label the area with a "DANGER: Universal Waste" sign.

2. Label all waste containers properly. Procure Universal Waste Tags from the EH&S. Securely attach the Waste Tag to the container *at the time you begin using it* for waste collection. Regulations require the accumulation start date to be entered on the universal waste tag when the waste is placed into the container.

3. Fill out all information requested on the tag**. EH&S** waste handlers rely on waste tag information when they make decisions on waste compatibility and handling. Their safety depends on accurate information! Accurate information is the responsibility of the waste generator filling out the waste tags.

4. Universal wastes should not be stored for longer than 60 days before requesting collection by EH&S.

Specific Procedures:

1. Mercury Thermostats

   a) Place in container (drum with lid, hard-sided carton box, etc.) to prevent releases into the environment.
   b) Label or mark clearly the container with any one of the following phrases: "Universal Waste – Mercury Thermostats, or "Waste Mercury Thermostats," or "Used Mercury Thermostats" to identify the universal waste type.
   c) Contain releases of mercury residues, if any, or call EH&S at 476-0544 for immediate pick-up.

2. Batteries

   d) Place in container (drum with lid, hard-sided carton box, etc.) to prevent releases into the environment.
   e) Label or mark clearly the container with any one of the following phrases: "Universal Waste – Batteries, or "Waste Batteries," or "Used Batteries" to identify the universal waste type.
   f) Contain releases of battery residues, if any, or call EH&S at 476-0544 for immediate pick-up.

3. Lamps

   g) Place in container (drum with lid, hard-sided carton box, etc.) to prevent releases into the environment.
   h) Label or mark clearly the container with any one of the following phrases: "Universal Waste – Lamps, or "Waste Lamps," or "Used Lamps" to identify the universal waste type.
   i) Contain releases of mercury residues, if any, or call EH&S at 476-0544 for immediate pick-up.

4) Cathode Ray Tubes (CRT)

   a) CRTs that are still functional, although obsolete, may be managed as surplus and shipped to Material Management for resale or recycling. If the CRT has a UC Tag Number, please complete the Equipment Inventory Modification Form (http://acctg.ucsf.edu/files/pdf/eqmod.pdf). If the CRT does not have a UC tag number (i.e., initial value was less than $2,500), please complete the Material Management Campus Storehouse Requisition form (http://acctg.ucsf.edu/files/pdf/shreques.pdf). When either form is completed, please fax it to Materiel Management at 502-7983. If you have questions, contact Materiel Management at 502-3086.
   b) CRTs that are no longer usable or are broken are considered a hazardous waste. Call the EH&S at 476-0544 to arrange for pick-up. CRTs so designated must be labeled with a Universal Waste CRT label, including the date that the CRT was determined no longer usable. CRTs should be accumulated no longer than 60 days at your location.

5) Consumer Electronic Devices (CED)

a) CEDs that are still functional, although obsolete, may be managed as surplus and shipped to Material Management for resale or recycling. If the CED has a UC Tag Number, please complete the Equipment Inventory Modification Form (http://acctg.ucsf.edu/files/pdf/eqmod.pdf). If the CED does not have a UC tag number (i.e., initial value was less than $2,500), please complete the Material Management Campus Storehouse Requisition form (http://acctg.ucsf.edu/files/pdf/shreques.pdf). When either form is completed, please fax it to Materiel Management at 502-7983. If you have questions, contact Materiel Management at 502-3086.

b) CEDs that are no longer usable or are broken are considered a hazardous waste. Call EH&S at 476-0544 to arrange for pick-up. CEDs so designated must be labeled with a Universal Waste CED label, including the date that the CED was determined no longer usable. CEDs should be accumulated no longer than 60 days at your location.

6) Appliance Recycling

a) Some materials removed from appliances are hazardous waste; some of these hazardous wastes have reduced handling standards under the Universal Waste Rule. Materials that require special handling are materials when removed from a discarded appliance may not be disposed of in the garbage or at a solid waste facility. A Certified Appliance Recycler must remove materials that require special handling from major appliances. Major appliances include: washer or dyer, refrigerator or freezer, water and space heaters, furnace or boiler, air-conditioner or dehumidifier, trash compactor, and oven, stove or microwave. If you plan to discard or surplus any of the listed appliances, please contact your DSA are assistance.

Universal Waste Collection Procedures and Requirements

1. You must completely fill out a Hazardous Waste Collection form in order for EH&S to collect your universal waste.

2. You can mail your EH&S Hazardous Chemical Waste Request Form by campus mail, Box 0942 or fax them at 476-0581 (Parnassus Campus); 502-1199 (Mt. Zion Campus) and 514-4160 (Mission Bay Campus).

INTRODUCTION TO APPENDICES

The following Appendices are intended to provide reference information about a wide range of chemical safety-related matters. If you need additional copies of any forms or flyers that are shown in these Appendices, they can be downloaded from the Office of Environmental Health and Safety Web site..

APPENDIX A

CHEMICAL WASTE FORMS AND APPLICATIONS

APPENDIX A1

ONLINE WASTe PROGRAM DESCRIPTION

Federal and state regulations require all chemical waste containers to have a fully completed hazardous waste tag at the time of generation. The tag must include the name and address of the generator, chemical composition, date of generation, and physical and hazardous properties of the waste. To reduce the incidence of non-compliance and streamline the tagging and disposal process of chemical waste, the Office of Environmental Health and Safety (EH&S) has instituted an online hazardous waste tag system called the Online Program called WASTe http://WASTe.ucsf.edu. The UC WASTe program offers many advantages over traditional hazardous waste tags including:

a. EH&S is automatically notified when a container has reached the 60 day storage limit and is ready for disposal. When a container is ready for disposal, an email is sent to the lab contact(s) notifying the lab that the container is ready for disposal and will be picked up by EH&S technicians. To arrange to have a container picked up before the 60 day storage limit is reached, simply log on to your account http://WASTe.ucsf.edu and select the containers as ready for disposal.

b. Waste generators do not have to complete hazardous waste labels by hand. The information is completed online and printed on your printer. The paper label can then be attached to the container using an EH&S provided, adhesive-backed, plastic envelope. The program automatically fills in repetitive identifying information for you from your account data.

c. Creating tags of routinely generated waste is more efficient. Laboratories have the ability to create waste profiles of routinely generated waste and save the profiles in the system.

d. The program catches and corrects common errors of omission, so every tag you print is a complete tag.

More information about the Online WASte Program including a user's manual, frequently asked questions section and information on creating an account for your laboratory can be found on the EH&S website.

APPENDIX A2

ONLINE WASTe PROGRAM INFORMATION FOR LABORATORIES

https://ehs.ucop.edu/waste/#/login

APPENDIX A2A

EH&S HAZARDOUS (CHEMICAL) WASTE ON-LINE TAG PROGRAM

A. Online WASte Program Account Sign Up

Principal Investigator:				Date:	
	Last	First	M.I.		
Department:					
Campus:		Building		Waste Storage Room	
Laboratory Contact:			E-mail Address:		
	Last	First			
Phone: ( )			Mailbox Number		
Additional Contact:			E-mail Address:		
	Last	First			
Additional Contact:			E-mail Address:		
	Last	First			

Please e-mail the completed form to WASTe@ehs.ucsf.edu or fax to (415) 476-0581

APPENDIX A3

HAZARDOUS DRUGS & CHEMOTHERAPY WASTE PICK-UP FORM
PARNASSUS & MT. ZION MEDICAL CENTERS

All hazardous and chemotherapy drugs are to be disposed in the yellow hazardous and chemotherapy waste container. All trace and concentrated hazardous and chemotherapy drugs must be disposed in the yellow bins (including empty bags and tubing).

1. Hazardous drugs and Chemotherapy waste containers are picked up between the hours of 9:00 AM and 2:00 PM. Complete and attach this request form to the waste container prior to EH&S pick-up. Those units on ***"as needed"*** schedule need to call EH&S at 476-0544 for pick-up. **IF THERE IS NO REQUEST FORM on the container, THERE IS NO WASTE PICK-UP**.

2. **The requesting unit packages the waste**. Obtain the yellow rigid Chemotherapy waste container from the Medical Center's Material Services.

3. When the container is 3/4's full, lock the lid in place to close and seal the container and attach this form.

4. **DO NOT STORE THE CONTAINER IN CORRIDORS**, **HALLWAYS, or other similar PUBLIC ACCESS areas.** For unusual problems or technical assistance call x 6-0544.

HAZARDOUS DRUGS & CHEMOTHERAPY WASTE PICK-UP FORM
PARNASSUS & MT. ZION MEDICAL CENTERS

DEPARTMENT:_____ DATE:
REQUEST BY: _____ PHONE NO:
BUILDING:_____ROOM NO: _____CAMPUS:(P or Z)
TAG #: (to be completed by EH&S):_____MANIFEST # (to be completed by EH&S):_____

MARK (X) NEXT TO HAZARDOUS/CHEMOTHERAPY DRUG AS YOU DISPOSE INTO CONTAINER:

	ALDESLEUKIN		CARBOPLATIN		ESTRAMUSTINE		LIPOSOMAL DOXORUBICIN		PEGYLATED INTERFERON-ALFA-2b		TOREMIFENE CITRATE
	ALEMTUZUMAB		CARMUSTINE (BCNU)		ETOPOPHOS		LIPOSOMAL VINCRISTINE		PEGYLATED INTERFERON-ALFA-2a		TGF-PE- 38 FUSION PROTEIN
	ALTRETAMINE		CCI-779		ETOPOSIDE		LOMUSTINE (CCNU)		PENTOSTATIN		TRASTUZUMAB
	AMINO-GLUTETHIMIDE		CHLORAMBUCIL		EXEMESTANE		MAFOSFAMIDE		PLICAMYCIN		TRIMETREXATE
	ANASTRAZOLE		CIDOFOVIR		FLAVOPIRIDIOL		MARIMASTAT		PRINOMASTAT		TRIPTORELIN PAMOATE
	ANGIOZYME		CISPLATIN		FLOXURIDINE		MECHLORETHAMINE		PROCARBAZINE		VALGANCICLOVIR
	APC- 8015		CLADRIBINE		FLUDARABINE		MEGESTROL		R115777		VIDARABINE
	ARA- G (506U78)		CYCLOPHOSPHAMIDE		FLUOROURACIL (5FU)		MELACINE		REVIMID		VINBLASTINE
	ARSENIC TRIOXIDE		CYCLOSPORINE (CSA)		FLUTAMIDE		MELANOMA VACCINE POLYVALENT		RIBAVIRIN		VINCRISTINE
	ASPARAGINASE		CYTARABINE (ARA-C)		GANCICLOVIR (DHPG)		MELPHALAN		RITUXIMAB		VINDESINE
	AUGMEROSEN		DACARBAZINE (DTIC)		GEMCITABINE		MERCAPTOPURINE (6-MP)		SCH-66336		VINORELBINE
	AZACYTIDINE		DACTINOMYCIN		GEMTUZUMAB (MYELOTARG)		METHOTREXATE (MTX)		SIROLIMUS		
	AZATHIOPRINE		DAUNORUBICIN (DAUNOMYCIN)		HOMOHARRINGTONINE		MITOMYCIN		SL-11047		
	BEVACIZUMAB		DECITABINE		HYDROXYUREA		MITOTANE		STREPTOZOTOCIN		
	BEXAROTENE		DENILEUKIN DIFTITOX		IDARUBICIN		MITOXANTRONE		SURAMIN		
	BICALUTAMIDE		4-DEOXYDOXORUBICIN		IFOSFAMIDE		MoAb 17-1A		SV-5416 (INV)		
	BLEOMYCIN		DEXRAZOXONE		IL-13 PE38QQR		MUTOGUAZONE		T-138067 (INV)		
	BMS-18867		DIFLUORO-METHYLORNITHINE		IMATINIB MESYLATE		MYCOPHENOLATE MOTETIL		TACROLIMUS		
	BMS-224818		DOCETAXEL		INTERFERON-ALFA		MYCOPHENOLATE SODIUM		TEMOZOLOMIDE		
	BROMO-DEOXYURIDINE		DOXORUBICIN		IODODEOXYURIDINE		NILUTAMIDE		TENIPOSIDE (VM-26)		
	BUSULFAN PHOSPHOLIPID		DTI-015		IRINOTECAN		9-NITRO-CAMPTOTHECIN		TESTOLACTONE		
	BUSULFAN		EMD-121974		LETROZOLE		OSI-779		THALIDOMIDE		
	BUTHIONINE SULFOXIMINE		ENDOSTATIN		LEUPROLIDE		OXALIPLATIN		THIOGUANINE		
	CARBOXYAMINO-IMIDAZOLE		EPIRUBICIN		LIPOSOMAL CYTARABINE		PACLITAXEL (TAXOL)		THIOTEPA		
	CAPECITABINE		ERWINIA ASPARAGINASE		LIPOSOMAL DAUNORUBICIN		PEGASPARAGINASE		TOPOTECAN		

APPENDIX A4: UCSF Environmental Health and Safety Project Request/Approval Form

To: **Environmental Health & Safety** Mail: **Box 0942** Fax: **476--0581**		Req Date: Date Needed:		Dept. Reference # Start Date:	EH&S Project # End Date:
From: Department Name		Box #: '0894	Dept.#	Contact Name/Phone #	Special Instructions:
Billing Copy to:		Box #:	Dept. #	Contact Name/Phone #	

Payment Information

NCA	Fund	DPA	PROG	FY	Departmental Expense Authorization Signature

Location and Description of Work

Bldg. Name:	Room #	Description: [ ] Additional Information Attached (i.e. floor plans, equip details, etc.)
Bldg. Name:	Room #	
Bldg. Name:	Room #	

Estimated Cost

Program	Type	Hours	Service Category/Description	Unit Cost	Estimated Cost	Actual Hours	Actual Cost
HMM	Program Mgr.			$ 85.33			
	Specialist			$68.64			
	Technician			$ 45.45			
Subtotal							
Materials/ Outside Consulting Services: Quantity and Description							
Subtotal				**Grand Total**			

~~EH&S Use Only~~

~~Project Review & Authorization:~~	~~Prepared By:~~	
Program Manager:	Date:	Administration:
~~Project Completion Review:~~	~~Date Completed:~~	~~Preparer:~~

Cost Estimate: $	Actual Cost $	Percent of Variance**	Variance Explanation:
Amount Reimbursed:	Date:	Administration Review:	Director Approval:**

** Director approval required for variances in excess of 15%

Rev. Date: 07/01/09

Filename: Project

CHP80

Revised 01/01/13

http://www.ehs.ucsf.edu/

APPENDIX A5

UNKNOWN CHEMICAL DETERMINATION

A. UNKNOWN CHEMICAL DETERMINATION

Disposal of unknown chemicals is extremely expensive. It is the laboratory's responsibility to identify unknown chemicals prior to request for removal. Here are some simple ways to identify unknown chemicals:

CORROSIVITY Dip pH paper into a small sample of the material, then compare to the key for that pH paper. If the material is a solid, add a small portion to a small amount of water and analyze the pH of the liquid. If the pH is above 12, the material is a corrosive base. If the pH is less than 2, the material is a corrosive acid.

FLAMMABILITY Pass a small amount of the material (less than 1/4 teaspoon) over a flame. If it ignites, it is considered to be flammable.

OXIDIZER Use a strip of potassium iodide paper. Dip the paper in 1M HCl, and then into the material being determined. If the paper turns purple, the material is either an oxidizer or organic peroxide. Solids may need to be moistened with the acid solution.

WATER REACTIVE Wet a small amount (less than 1/4 teaspoon) of the material with water. If a reaction is noted, then the material is water reactive.

EH&S can assist in this process. If it is necessary to send the sample to an outside vendor for analysis, the cost will be charged to the lab. This is the reason why it is important to conduct periodic inventory and disposal of unwanted chemicals.

APPENDIX A6
PEROXIDE FORMING COMPOUNDS

SAFE STORAGE PERIODS FOR PEROXIDE FORMERS	
Unopened chemicals from manufacturer	18 months or (expiration date)
Opened containers:	
Chemicals in Table A	3 months
Chemicals in Tables B and D	12 months
Uninhibited chemicals in Table C	24 hours
Inhibited chemicals in Table C (Do not store under an inert atmosphere)	12 months

A. Chemicals that form explosive levels of peroxides without concentration		
Butadiene[a]	Isopropyl ether	Sodium amide (sodamide)
Chloroprene[a]	Potassium metal	Tetrafluoroethylene[a]
Divinylacetylene	Potassium amide	Vinylidene chloride
B. Chemicals that form explosive levels of peroxides on concentration		
Acetal	Diethyl ether	4-Methyl-2-pentanol
Acetaldehyde	Diethylene glycol dimethyl ether (diglyme)	2-Pentanol
Benzyl alcohol	Dioxanes	4-Penten-1-ol
2-Butanol	Ethylene glycol dimethyl ether (glyme)	1-Phenylethanol
Cumene	4-Heptanol	2-Phenylethanol
2-Cyclohexen-1-ol	2-Hexanol	2-Propanol
Cyclohexene	Methylacetylene	Tetrahydrofuran
Decahydronaphthalene	3-Methyl-1-butanol	Tetrahydronaphthalene
Diacetylene	Methylcyclopentane	Vinyl ethers
Dicyclopentadiene	Methyl isobutyl ketone	Other secondary alcohols
C. Chemicals that may autopolymerize as a result of peroxide accumulation		
Acrylic acid[b]	Methyl methacrylate[b]	Vinyl chloride
Acrylonitrile[b]	Styrene	Vinylpyridine
Butadiene[c]	Tetrafluoroethylene[c]	Vinyladiene chloride
Chloroprene[c]	Vinyl acetate	
Chlorotrifluoroethylene	Vinylacetylene	
D. Chemicals that may form peroxides but cannot clearly be placed in sections A-C		
Acrolein	p-Chlorophenetole	4,5-Hexadien-2-yn-1-ol
Allyl ether[d]	Cyclooctene[d]	*n*-Hexyl ether
Allyl ethyl ether	Cyclopropyl methyl ether	*o,p*-Iodophenetole
Allyl phenyl ether	Diallyl ether[d]	Isoamyl benzyl ether[d]
p-(*n*-Amyloxy)benzoyl chloride	*p*-Di-n-butoxybenzene	Isoamyl ether[d]
n-Amyl ether	1,2-Dibenzyloxyethane[d]	Isobutyl vinyl ether
Benzyl *n*-butyl ether[d]	*p*-Dibenzyloxybenzene[d]	Isophorone[d]
Benzyl ether[d]	1,2-Dichloroethyl ethyl Ether	*B*-Isopropoxypropionitrile[d]
Benzyl ethyl ether[d]	2,4-Dichlorophenetole	Isopropyl 2,4,5-trichloro-phenoxy- acetate

Benzyl methyl ether	Diethoxymethane[d]	Limonene
Benzyl 1-napthyl ether[d]	2,2-Diethoxypropane	1,5-*p*-Methadiene
1,2-Bis(2-chloroethoxy) Ethane	Diethyl ethoxymethylene-Malonate	Methyl *p*-(*n*-amyloxy)-benzoate
Bis(2 ethoxyethyl)ether	Diethyl fumarate[d]	4-Methyl-2-pentanone
Bis(2-(methoxyethoxy)-ethyl) ether	Diethyl acetal[d]	*n*-Methylphenetole
Bis(2-chloroethyl)ether	Diethyketene[f]	2-Methyltetrahydrofuran
Bis(2-ethoxyethyl)adipate	*m,o,p*-diethoxybenzene	3-Methoxy-1-butyl acetate
Bis(2-ethoxyethyl)phthalate	1,2-Diethoxyethane	2-Methoxyethanol
Bis(2-methoxyethyl)-Carbonate	Dimethoxymethane[d]	3-Methoxyethyl acetate
Bis(2-methoxyethyl) ether	1,1-Dimethoxyethane[d]	2-Methoxyethyl vinyl ether
Bis(2-methoxyethyl) Phthalate	Dimethylketene[f]	Methonxy-1,3,5,7-cyclo-octa-tetraene
Bis(2-methoxymethyl) Adipate	3,3-Dimethoxypropene	B-Methoxypropionitrile
Bis(2-n-butoxyethyl) Phthalate	2,4-Dinitrophenetole	m-Nitrophenetole
Bis(2-phenoxyethyl) ether	1,3-Dioxepane[d]	1-Octene
Bis(4-chlorobutyl) ether	Di(1-propynyl)ether[f]	Oxybis(2-ethyl acetate)
Bis(chloromethyl) ether[e]	Di(2-propynyl)ether	Oxybis(2-ethyl benzoate)
2-Bromomethyl ethyl ether	Di-*n*-propoxymethane[d]	*B,B*-oxydipropionitrile
B-Bromophenetole	1,2-Epoxy-3-isopropoxy-propane[d]	1-Pentene
o-Bromophenetole	1,2-Epoxy-3-phenoxy-propane	Phenoxyacetyl chloride
p-Bromophenetole	*p*-Ethoxyacethophenone	*a*-Phenoxypropionyl chloride
3-Bromopropyl phenyl ether	2-Ethoxyethyl acetate	Phenyl *o*-propyl ether
1,3-Butadiyne	(2-Ethoxyethyl)-o-benzoyl benzoate	*p*-Phenylphenetone
Buten-3-yne	1-(2-Ethoxyethoxy)ethyl acetate	*n*-Propyl ether
tert-Butyl ethyl ether	1-Ethoxynaphthalene	*n*-Propyl isopropyl ether
tert-Butyl methyl ether	o,p-Ethoxyphenyl isocyanate	Sodium 8,11,14-eicosa-tetraenoate
n-Butyl phenyl ether	1-Ethoxy-2-propyne	Sodium ethoxyacetylide[f]
n-Butyl vinyl ether	3-Ethoxyopropionitrile	Tetrahydropyran
Chloroacetaldehyde diethylacetal[d]	2-Ethylacrylaldehyde oxime	Triethylene glycol diacetate
2-Chlorobutadiene	2-Ethylbutanol	Triethylene glycol diprop-ionate
1-(2-Chloroethoxy)-2-phen-oxyethane	Ethyl *B*-ethoxypropionate	1,3,3-Trimethoxypropene[d]
Chloroethylene	2-Ethylhexanal	1,1,2,3-Tetrachloro-1,3-butadiene
Chloromethyl methyl ether[e]	Ethyl vinyl ether	4-Vinyl cyclohexene
B-Chlorophenetole	Furan	Vinylene carbonate
o-Chlorophenetole	2,5-Hexadiyn-1-ol	Vinylidene chloride[d]

NOTES:

[a] When stored as a liquid monomer.

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

APPENDIX A7

CHEMICAL INVENTORY

General: A Hazard Materials Inventory is to be completed on a **room by room basis.**

- Chemical inventory is submitted through RIO Chemical Inventory Online database, accessible via MyAccess
- Chemical inventories are listed under the "Chemical Inventory and Use Authorization" link.
- For step by step instructions on using RIO Chemical Inventory, please contact your DSA.

Reporting is required for the following amounts:

for San Francisco County (per room):

solids - 25 grams (0.06 pounds) or more.
liquids - 100 ml (0.025 gallons) or more.
compressed gas or compressed liquids - 10 cubic feet or more at standard temperature and pressure.

for San Mateo County or Alameda County (per facility):

solids - 500 pounds or more.
liquids - 55 gallons or more.
compressed gas or compressed liquids - 200 cubic feet or more at standard temperature and pressure.

Chemical/Product Name: If the material is a commercial product, enter the complete name which appears on the label of the container.

- Match the name of your compound with the exact name displayed on the Chemical Inventory Online database pick list (accessible from the Chemical Inventory Item Detail screen). Note concentration where available / applicable.
- If your compound does not appear on the pick list, contact the database administrator (by clicking on the link at the bottom of the page) with detailed information about the chemical, so that it may be added to the master list.

L / S / G: Enter the physical state of the material; liquid (L), solid (S), and gas (G).

Container Type (s): Enter the codes from the table below. If the product is packed in several containers, record "type" of the container/material closet to the product.

Code	Type	Code	Type
A	Above Ground Tank	J	Bag
B	Underground Tank	K	Box
C	Tank Inside a Building	L	Cylinder
D	Steel Drum	M	Glass Bottle or Jug
E	Plastic / Nonmetallic Drum	N	Plastic Bottle or Jug
F	Can	O	Tote Bin
G	Carboy	P	Tank Wagon
H	Silo	Q	Rail Car
I	Fiber Drum	R	Other

Quantity Stored: Enter the amount of material that is present in the room at the time of the inventory.

Maximum Quantity Stored At Any Time: Enter the estimated maximum quantify of the material which will be present in the room at any time during the year. Be sure to include the correct units (e.g. gallons, pounds, cubic feet, grams or liters).

Storage Pressure: Enter the storage pressure of the material (example: a compressed gas cylinder is listed as "greater than ambient pressure")

Storage Temperature: Enter the storage temperature of the material (example: a compound stored in a freezer is listed as "less than ambient temperature")

Units: Enter the units of measurement

Largest Container Capacity: Enter the largest container capacity. Final quantities will be calculated automatically based on this container.

Amounts: "On Hand" and "Max Stored at One Time" are calculated automatically. Volumes may be modified manually to more accurately reflect actual amounts if desired. All compressed gas cylinders are considered full. Compressed gas volumes cannot be changed.

When the chemical inventory process has been completed, submit the inventory to EH&S by clicking the "Submit Inventory Unit for Review" button on the Chemical Inventory Unit Detail page.

APPENDIX B CHEMICAL SAFETY UPDATES

The EH&S Chemical Safety Updates are periodically revised and copies are sent to laboratories. To obtain a copy, please contact your Department Safety Advisor or visit https://ehs.ucsf.edu/chemical-safety-updates

APPENDIX C

MATERIAL SAFETY DATA SHEETS (SDS)

APPENDIX C1

SAFETY DATA SHEETS (SDS)

A Safety Data Sheet (SDS) is a bulletin prepared by the manufacturers or distributors of all chemicals which summarize the health, safety, and environmental information for that chemical.

Safety Data Sheets must be readily available to users of the chemical. The SDS for each chemical in a laboratory may be collected and stored in a notebook or file cabinet in the laboratory, or can be downloaded from one of the SDS Databases on the EH&S website.
The following is an additional listing of available web sites that offer SDS Databases or links to SDS

Site	Offering
ChemQuik (University of California SDS Management System)	Fully capable search engine
Stanford University Portfolio	Chemical Safety Database
Iowa State University	Database of Material Safety Data Sheets
Arkansas State University	Database of Material Safety Data Sheets
Howard Hughes Medical Institute	Laboratory Chemical Safety Summaries
US Environmental Protection Agency	Envirofacts Warehouse Chemical References Index
Macquarie University	Searchable Gopher Index: Database of Material Safety Data Sheets
UC Santa Barbara	Links to Material Safety Data Sheets
University of Akron	Hazardous Chemical Database
The Vermont SIRI	Collection of Material Safety Data Sheets
Oxford University	Database of Material Safety Data Sheets
US Department of Commerce Northwest Fisheries Science Center	Database of Material Safety Data Sheets
Sigma-Aldrich	Database of Material Safety Data Sheets

APPENDIX C2

GUIDELINES FOR READING AND UNDERSTANDING A SAFETY DATA SHEET (SDS)

A Safety Data Sheet (SDS) is a document which must be provided by manufacturers for each chemical. SDSs are valuable guides that provide important information about chemicals. In general, a SDS will provide the following information:

- Manufacturer
- What the Chemical Is
- Physical and Hazardous Properties
- Safety Precautions
- Emergency Response
- Disposal

A. GUIDELINES FOR READING AND UNDERSTANDING AN SDS

SDSs may not contain all of the information discussed in this guideline and the information may vary depending upon the degree of hazard. However, this example will illustrate the type of information that may be given on a SDS.

If the SDS is blank or has only a trade name and N/A's (Not Applicable), it will not be very helpful. Most SDSs have some of the information filled in. By cross-checking the information in various sections, you can determine what you need to know about the hazards of the material.

We will use E. I. DuPont de Nemours & Co. Inc's Sodium Hypochlorite SDS to illustrate what an SDS should look like. Please keep in mind that different companies have different formats, but the relevant information should be listed.

For definitions of terms, see Appendix G, Glossary of Terms.

APPENDIX C3

SAMPLE MATERIAL SAFETY DATA SHEET (SDS): SODIUM HYPOCHLORITE

MATERIAL SAFETY DATA SHEET

.1. DuPont de Nemours & Co., Inc.
JuPont- NEN Research Products
549 Albany Street
Boston MA 02118

Product and Safety Information: (617)482-9595
Medical Emergency : (800)441-3637
Emergency Transportation: Chemtrec: (800)424-9300
If in D.C.: (202)483-7616

MATERIAL IDENTIFICATION

SODIUM HYPOCHLORITE

SDS NUMBER	:SDS 2738, DMP02298
CORPORATE NUMBER	DU000101
Revision Date	14-Jun-91
Date Printed	31-Dec-92
MANUFACTURER/DISTRIBUTOR	FISHER; KLEEN BRITE LABS; CLOROX CO. DIAL; KODAK; ASHLAND; BAKER
PHONE NUMBERS	
TRANSPORT EMERGENCY	CHEMTREC: 1-800-424-9300
MEDICAL EMERGENCY	1-800-441-3637
CHEMICAL FAMILY	OXIDIZING AGENT
DU PONT REGISTRY NUMBER:	DP162-20-3
TSCA INVENTORY STATUS	Reported/Included
NPCA-HMIS RATINGS	Health: 3 Flammability: 0 Reactivity: 1 Personal Protection rating to be supplied by user depending on use conditions.

COMPONENTS

Material	CAS Number	
SODIUM HYPOCHLORITE	7681-52-9	2-15
WATER	7732-18-5	85-97
{ACIDIFICATION LIBERATES GASEOUS CHLORINE)		
MAY CONTAIN:		
*CHLORINE	7782-50-5	
SURFACTANTS		
PERFUME		

* Regulated as a Toxic Chemical under Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

Household Bleach - Typically 3 - 7% Sodium Hypochlorite.
Industrial Bleach - Typically 7 - 15% Sodium Hypochlorite.

PHYSICAL DATA

Boiling Point	-100 to -110 deg C (-212 to -230 deg F) at 760 mm Hg. Decomposes
Vapor Pressure	Variable
Vapor Density	-1 (Air = 1.0) For 5% solutions
Melting Point	--26 to -O deg C (--15 to -32 deg F) For 12.5 to 5% solutions (PHYSICAL DATA - Continued)
% **Volatiles**	Var. - Water vapor + product of decomposition
Evaporation Rate	-1 (Ether = 1.0)
Water Solubility	100 WT %
pH	-12-13.5 at 20 C for >7% pH decreases with concentration
Odor	Pungent-like Chlorine
Form	Liquid
Color	Clear light green, yellow
Specific Gravity	1.021 at 15 deg C (59 deg F)

HAZARDOUS REACTIVITY

Instability	Stable at normal temperatures and storage conditions. Stability decreases with concentration, heat, light exposure, decrease in pH, and contamination with heavy metals, such as, nickel, cobalt, copper, iron, acids, organics.
Incompatibility	Incompatible with acids, oxidizers, reducing agents, organics, ethers, heavy metals (act as catalysts), ammonia products, vinegar, cyanides, light. Acidification liberates chlorine gas.
Decomposition	Decomposes with heat. Decomposes by reaction with acids. Hazardous gasesjvapors produced are hypochlorous acid, chlorine, hydrochloric acid. Composition depends upon temperature and decrease in pH. Additional decomposition products, which depend on pH, temperature and time, are sodium chloride and chlorate, & oxygen.
Polymerization	Polymerization will not occur.

Anhydrous sodium hypochlorite is highly explosive.

Sodium hypochlorite reacts violently with amines and ammonium salts. Solutions are reactive with many common cleaning products, such as, toilet bowl cleaners, rust removers, vinegar, acids, organics and ammonia products to produce hazardous gases, such as chlorine and other chlorinated species.

Appropriate warning labels should be heeded prior to use as a cleaner alone or with other products.

:'**IRE AND EXPLOSION DATA**

Non-combustible.

FIRE AND EXPLOSION HAZARDS

Strong Oxidizer. Hazardous gasesjvapors produced in fire are chlorine and hydrogen chloride.

(FIRE AND EXPLOSION DATA - Continued)

Decomposes when heated; decomposition products may cause containers to rupture or explode. Vigorous reaction possible with organic material or oxidizing agents, may result in a fire.

EXTINGUISHING MEDIA

Use media appropriate for surrounding material.

SPECIAL FIRE FIGHTING INSTRUCTIONS

Evacuate personnel to a safe area. Keep personnel removed & upwind of fire. Wear self-contained breathing apparatus. Wear full protective equipment. Cool tank/container with water spray. Fight fire from a distance, heat may rupture containers. Runoff from fire control may be a pollution hazard.

HEALTH HAZARD INFORMATION

Sodium hypochlorite is a severe skin, eye and mucous membrane irritant. Exposure to concentrated forms can cause skin burns or ulceration, eye corrosion with corneal or conjunctival ulceration, or death from gross overexposure.

Ingestion is corrosive to the mouth and upper gastrointestinal tract and can cause severe abdominal pain, vomiting, fall in blood pressure, delirium and coma. Perforation of the gastrointestinal tract and its consequences can occur.

Inhalation of concentrated fumes can cause severe lung irritation with coughing and choking followed by pulmonary edema.

ANIMAL DATA

Inhalation 0.25 hour LC50: > 10.5 mgjL in rats
Skin absorption LD50: > 10,000 mgjkg in rabbits
Oral LD50: 8910 mgjkg in rats

The concentrated solution is corrosive to skin, and a 5% solution is a severe eye irritant, but the compound is untested for animal sensitization. Solutions containing more than 5% available chlorine are classified as DOT

corrosive.

INGESTION

Toxicity described in animals from single exposures include muscular weakness, and hypoactivity. Repeated exposure in animals caused an increase in the relative weight of adrenal glands in one study, but no pathological changes were observed in two other studies. Long-term administeration of

(HEALTH HAZARD INFORMATION - Continued)

the compound in drinking water of rats caused depression of the immune system.

SKIN CONTACT

No adverse changes were observed in an eight week dermal study of a 1% solution in guinea pigs.

Tests in animals demonstrate no carcinogenic activity by the either the oral or dermal routes. Tests in bacterial and mammalian cell cultures demonstrate mutagenic activity.

HUMAN HEALTH EFFECTS

Skin contact with dilute solutions may include skin irritation with rash.

Eye contact with dilute solutions may include eye irritation with tearing, or blurring of vision.

Inhalation may include irritation of the upper respiratory passages, with coughing.

Ingestion may include irritation and corrosion of mucosal surfaces with vomiting and abdominal pain.

Exposures to more concentrated forms may lead to skin burns or ulceration; eye corrosion with corneal or conjunctival ulceration; inhalation of concentrated fumes can cause severe lung irritation with coughing and choking followed by pulmonary edema; or fatality from gross overexposure. Significant skin permeation, and systemic toxicity, after contact appears unlikely. The compound has been infrequently associated with skin sensitization in humans.

CARCINOGENICITY

None of the components in this material is listed by IARC, NTP, OSHA, or ACGIH as a carcinogen.

APPLICABLE EXPOSURE LIMITS

SODIUM HYPOCHLORITE

AEL • (DuPont): None Established

TLV	(ACGIH)	None Established
PEL	(OSHA)	None Established
WEEL	(AIHA)	2 mgjm3 - 15 Min. TWA

(HEALTH HAZARD INFORMATION - Continued)

CHLORINE

AEL *	(DuPont):	0.5 ppm- 8 Hr. TWA
TLV	(ACGIH)	0.5 ppm, 1.5 mgjm3 - 8 Hr TWA STEL 1 ppm, 2.9 mgjm3
PEL	(OSHA)	0.5 ppm, 1.5 mgjm3 - 8 Hr TWA STEL 1 ppm, 3 mgjm3

* AEL is Du Pont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

SAFETY PRECAUTIONS

Avoid breathing vapors or mist. Do not get in eyes, on skin, or on clothing. Wash thoroughly after handling. Wash clothing after use.

FIRST AID

-NHALATION

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash contaminated clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, do not induce vomiting. Give large quantities of water. Call a physician immediately. Never give anything by mouth to an unconscious person.

PROTECTION INFORMATION

GENERALLY APPLICABLE CONTROL MEASURES AND PRECAUTIONS

Keep container in a cool place. Keep container tightly closed. Do NOT expose to direct sunlight.

Use ventilation that is adequate to keep employee exposure to airborne concentrations below exposure limits.

(PROTECTION INFORMATION - Continued)

PERSONAL PROTECTIVE EQUIPMENT

EYE/FACE PROTECTION

Wear safety glasses. Wear coverall chemical splash goggles and face shield when the possibility exists for eye and face contact due to splashing or spraying of material.

RESPIRATORS

A NIOSH/MSHA approved air purifying respirator with a acid gas cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air purifying respirators is limited. Use a positive pressure air supplied respirator if there is any potential for an uncontrolled release, exposure levels are not known, or any other circumstances where air purifying respirators may not provide adequate protection.

PROTECTIVE CLOTHING

Wear impervious clothing to prevent ANY contact with this product, such as gloves, apron, boots or whole bodysuit made from Neoprene, as appropriate.

DISPOSAL INFORMATION

AQUATIC TOXICITY

The compound is moderately toxic. 96 hour LC50, fathead minnows: 5.9 mgjL.

SPILL, LEAK, OR RELEASE

NOTE: Review FIRE AND EXPLOSION HAZARDS and SAFETY PRECAUTIONS before proceeding with clean up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean up.
Evacuate personnel, thoroughly ventilate area, use self-contained breathing apparatus. Dissipate vapor with water spray. Dike spill. Prevent liquid from entering sewers, waterways or low areas. Superfund reportable discharge = 100 lbs.

Dilute with water to minimize oxidizing effect on spilled surface. Use fog nozzle on spillage. Flush area with mild soda ash solution, bisulfate solution, or ferrous salt solution. Keep on the alkaline side. Main end product is salt water (NaCl).
Do not use combustible absorbent (such as sawdust, etc.).

WASTE DISPOSAL

Treatment, storage, transportation and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations. Do

not burn. Do not flush to surface water or sanitary sewer system.

SHIPPING INFORMATION

Proper Shipping Name	HYPOCHLORITE SOLUTION (NOT CONTAINING MORE/OR LESS THAN 7% A VAILABLE CHLORINE BY WEIGHT)
Hazard Class	ORM-B FOR LESS THAN 7%
UN/NA No.	UN1791 - >7% (NA1791 < 7%)
DOT Labels(s)	UN1791 >7% - CORROSIVE
Reportable Quantity	100 lbs.

Shipping Containers

If material is shipped in quantities greater than 100 lbs. per container, the Proper shipping name is RQ SODIUM HYPOCHLORITE.

STORAGE CONDITIONS

Store in well ventilated area. Store in cool place. Store in dark place. Keep container tightly closed.

Store in a dry place away from incompatibles.

If closed containers become heated, they should be ventilated to release decomposition products (mainly oxygen under normal decomposition).

TITLE III HAZARD CLASSIFICATIONS

Acute	Yes
Chronic	Yes
Fire	No
Reactivity	Yes
Pressure	No

ADDITIONAL INFORMATION AND REFERENCES

Technical data, except health information, based on Labbco Inc., SDS, The Chloramone Corporation SDS, Ashland Chemical Inc. SDS dated 11/17/89, Fisher Scientific SDS dated 4/13/90, Kleen Brite Labs SDS dated 8/1/90. Clorox Company SDS dated 8/89, The Dial Corporation SDS dated 7/17/87, Eastman Kodak SDS dated 11/21/89, Wonder Chemical Company SDS dated 9/10/90, J. T. Baker SDS dated 5/22/86.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for SDS

Du Pont
Corporate SDS Office - HR
Barley Mill Plaza P14-2150
Wilmington, DE 19880-0014
302-992-6704

# Indicates updated section.

End of SDS

APPENDIX D

UCSF REGULATED CARCINOGEN PROGRAM LABORATORY

CHEMICAL SAFETY INSPECTION CHECKLIST UCSF LAB

STANDARD OPERATING PROCEDURES (SOP)

APPENDIX D1

DESCRIPTION OF THE UNIVERSITY OF CALIFORNIA, SAN FRANCISCO (UCSF) REGULATED CARCINOGEN PROGRAM

Cal/OSHA, through the Division of Occupational Health and Safety, administers the Occupational Carcinogen Registry and Control described in the California Code of Regulations (CCR) Title 8, Sections 5200-5220.

The regulation requires that any business in California using certain chemicals recognized by the State of California to be carcinogenic must register their use, and adhere to certain inventory tracking and medical monitoring instructions.

Title 8 CCR, Section 5203 requires UCSF to report the use of carcinogen if:

1. The regulation for the specific carcinogen requires UCSF to establish a regulated area for the use/storage of that specific carcinogen; or

2. The specific carcinogen does not have a regulated area requirement for any use of a concentration greater than or equal to 0.1% by weight or volume and use results in exposure or potential exposure to employees in excess of the permissible exposure limit.

To properly assess if a carcinogen requires reporting to Cal/OSHA, any laboratory use, operation, handling, process, storage, disposal, or transportation of any of the below listed Cal/OSHA regulated carcinogens must be reported to the Office of Environment, Health and Safety. EH&S will make an assessment if the use of the carcinogen meets the reporting requirement listed above. If the use of the Cal/OSHA regulated carcinogen meets the reporting requirement, EH&S will report the use to Cal/OSHA.

Cal/OSHA Regulated Carcinogen	Chemical Abstracts Service (CAS) Registry No.	Title 8 CCR Section No.
Methylenedianiline (MDA)	101779	1535 & 5200
1,3-Butadiene (BD)	106990	5201
Methylene Chloride	79092	5202
Cadmium		1532 & 5207
Asbestos		1529 & 5208
Non Asbestiform Tremolite, Anthophyllite, & Actinolite		5208.1
2-Acetylaminofluorene	53963	5209
4-Aminodiphenyl	92671	5209
Benzidine (and its salts)	92875	5209
3-3'-Dichlorobenzidine (and its salts)	91941	5209
4-Dimethylaminoazobenzene	60117	5209
alpha-Napthylamine	134327	5209
beta-Napthylamine	91598	5209
4-Nitrobiphenyl	92933	5209
N-Nitrosodimethylamine	62759	5209
beta-Propiolactone	57578	5209
bis-Chloromethyl Ether	542881	5209
Methyl Chloromethyl Ether	107302	5209
Ethyleneimine	151564	5209
Vinyl Chloride	75014	5210
Coke Oven Emissions		5211
1,2 Dibromo-3-Chloropropane (DBCP)	96128	5212
Acrylonitrile	107131	5213

Inorganic Arsenic		5214
4,4'-Methylenebis(2-Chloroaniline) [MBOCA]	101144	5215
Formaldehyde	50000	5217
Benzene	71432	5218
Ethylene Dibromide (EDB)	106934	5219
Ethylene Oxide (EtO)	75218	5220

This registration requires the user to provide the following information for each chemical defined by the state as carcinogenic:

- Describe briefly how the carcinogen or carcinogen-containing-product(s) are processed, handled, used, or transported.
- Give the name and address of each location where a carcinogen is present.
- Give the in-plant location(s) at each address where carcinogen(s) are used or handled.
- Identifying information for each carcinogen present or in use, including trade names or synonyms if known.
- The number of employees authorized in areas where carcinogens are present or used during any operations, including maintenance.
- The total number of employees including office personnel employed at this site.
- The manner in which the carcinogen is present.
- The name and address of the union bargaining representatives, if any, of employees who may be exposed to the carcinogen.
- Nature of business, (SIC Code).
- Quantities used and frequency of employee exposure.

At UCSF, the Regulated Carcinogen Program is administered by EH&S. Refer to the Chemical Carcinogen Program

EH&S periodically queries each user at UCSF regarding their use of regulated carcinogens and updates Cal/OSHA, as required.

In addition to the general information and inventory accounting, the program includes a medical monitoring process. Medical monitoring is implemented when personnel exceed or may exceed certain pre-determined exposure levels of any listed carcinogen. At UCSF, it is rare that exposures exceed these levels. If such exposures are suspected, contact EH&S at 476-1300 for appropriate personal air monitoring and medical monitoring, if needed.

APPENDIX D2

LABORATORY CHEMICAL SAFETY INSPECTION CHECKLIST

The Routine Laboratory Chemical Safety Inspection Checklist is used by the Department Safety Advisors (DSAs) when performing inspections of areas where chemicals are used or stored. The inspections are scheduled on a yearly basis; it is prudent laboratory managers and other chemical users perform a self-audit at least quarterly, using this checklist.

Compliance	**Chemical Compliance**
Chemical Safety Compliance	During our recent inspection, your laboratory was in compliance with all chemical safety pertinent requirements. We would like to congratulate you and your staff for maintaining a good standard of chemical safety.
Labeling	**Labeling**
Chemical Cabinet	Flammable/ corrosive cabinet was not properly labeled. Please label cabinets with applicable Hazard information.
Cylinders hazards	Compressed gas cylinder was not properly labeled with hazard sign. Please label cylinders with applicable hazard information.
Cylinders full/ empty	Compressed gas cylinder did not have full/ empty tag. Please label all cylinders with appropriate tag.
Containers	Chemical containers are not properly labeled. Please label containers with full name of chemical, not formulas, and applicable hazards.
Universal Waste	Universal waste tag was either missing or was incomplete. Please ensure waste is tagged with a properly completed EH&S waste tag.
Labeling other	
Personnel Training	**Personnel Training**
SDS	(User names) was/ were unfamiliar with how to access SDS information online. Please review with all lab employees. Access to SDS information online can be found on the EH&S website
Hazardous waste Management Training	(User names) are responsible for hazardous waste in the lab and have not taken the online Lab Safety for Researcher class. Please have user take this online class immediately at UC Learning Center.
Training Other	
Personnel Exposure Control	**Personnel Exposure Control**
Volatile Chemicals	Volatile/ hazardous chemicals were being used on a workbench. Please ensure all volatile chemicals are used inside a chemical fume hood.
Cryogenics	Cryogenics are used with inadequate ventilation. Cryogenics must be used in well ventilated areas. Please either improve the ventilation or move the use location.
Carcinogens	(Chemical name) is a Cal/OSHA regulated carcinogen. Use of regulated carcinogens requires special precautions. Please refer to UCSF Chemical Carcinogen Program for list of listed and regulated carcinogens. You must comply with all regulations or find a substitute.
Personnel Exposure Control Other	

Equipment	Equipment
Anesthesia Machine	Vaporizer/ anesthesia machine was not certified or has not been certified in the last year. All Vaporizer/ anesthesia machines must be checked and serviced annually by an outside vendor.
Anesthesia Machine	Weight of carbon filter canister on vaporizer/ anesthesia machine was not documented. Weight of canister must be written on the canister itself prior to each use.
Anesthesia Machine	Weight of carbon filter canister on vaporizer/ anesthesia machine is equal to or exceeds 50 grams. Canister must be changed.
Equipment Other	
Use Area	**Use Area**
Ignition sources	Flammable chemicals are stored and or handled in close proximity of ignition sources. Please keep flammable chemicals away from areas that pose a spark hazard.
Incompatible Chemicals	Incompatible chemicals are stored together. Please refer to the Chemical Hygiene Plan, Incompatible Material Handout, or ask your DSA about chemical incompatibility.
Expired Chemicals	Expired chemicals were found in laboratory. Please contact EH&S to arrange for disposal of expired chemicals.
Expired ethers/ peroxide formers	Expired (ethers/peroxide formers) were found in laboratory. Please contact EH&S to arrange for disposal.
Chemicals under sink	Chemicals are stored under a sink. Please move the chemicals to the appropriate cabinet. Flammable chemicals must be stored in an approved flammable cabinet and corrosive chemicals, excluding household bleach, must be stored in an approved corrosive cabinet.
Improper storage in cabinet	Chemicals are stacked and stored in the cabinet improperly. Please ensure proper storage of chemicals when not in use.
Store outside safety cabinet	Chemicals are stored outside of a flammable/ corrosive cabinet. Please store chemicals in flammable/ corrosive cabinet when not in use.
Containers	Chemical containers are degraded due to age or use. Please replace and dispose of old container immediately.
Hazardous Spill	A chemical spill was found. Please ensure all spills are properly cleaned up immediately.
Secondary Containment	Proper secondary containment was missing for (chemicals/ waste).Please store required chemicals and chemical waste in the proper, compatible secondary containment that will hold at least 110% of the volume of the chemicals being contained.
Cardboard in cabinet	Cardboard was found in a flammable cabinet. Please remove all chemical bottles from cardboard boxes prior to storing them in the flammable cabinet.
Use Areas Other	
Inventory Control	**Inventory**
Old, expired, unused chemicals	Please assess the inventory and reduce unwanted, old, expired, or degraded chemicals. Opened chemical bottles can be disposed of by calling the Hazardous Materials department. Unopened, unused chemicals can be recycled through the Chemical Exchange Program.
Inventory Other	

Waste	Waste
Universal waste past one year	Universal waste is collected passed the one year limit. Please arrange for its disposal within one week.
Universal waste storage	Universal waste was not contained properly. Please provide an appropriate collection container.
Anesthesia Machine	Carbon filter canister on vaporizer/ anesthesia machine was disposed of improperly. Carbon filter canister must be tagged and disposed of as chemical waste.
Waste Other	

APPENDIX D3

UCSF Lab Standard Operating Procedures (SOP)

What is SOP? A Standard Operating Procedure (SOP) is an established laboratory procedure describing a method or methods to be followed routinely for chemical-specific reagents that belong to the Particularly Hazardous Chemicals (PHC) list. The SOP provides researchers information on how to conduct laboratory experiment safely, facilitating consistency in the quality and integrity of the end result.

Where Can I Find SOPs? See Laboratory Safety SOP Development Resources for SOP templates of common chemicals and chemical-groups.

Instructions: Tailor the chemical-specific Standard Operating Procedures (SOPs) to match your laboratory chemical-specific experiments. Please refer to the chemical manufacturer's Safety Data Sheet (SDS) to add important information to the SOPs. Instructions on filling out the SOP's are as follows:

- All sections on the SOP template must be completed.
- All SOPs must address health and safety issues including but not limited to use of personal protective equipment (PPE) and safety equipment/devices.
- All SOPs must be accessible to lab members.
- All SOPs must be reviewed, approved and signed by the PI.
- All lab users must be trained on applicable SOPs. Training must be documented.
- All SOPs and training documentation must be uploaded to the specific Chemical Use Authorization.

DO NOT cut and paste contents or certain sections from other SOPs without careful review because the SOP should be specific to your laboratory protocol.

Note: The Laboratory Safety SOP Development Resources does not cover all chemicals in UCSF's inventory.

How to write a chemical-specific research SOP:

1. Provide quantities that will be used in a safe and consistent manner. If necessary, provide two procedures to cover a wider range of quantities.

2. Outline the conditions under which the procedure applies.

3. Provide a general overview and a purpose of the experimental process.

4. Include a chemical-specific procedure describing in detail the experiment. Provide details on engineering controls and hazards associated with the process. This could be an experimental procedure from your lab notebook.

5. If quantities or conditions significantly deviate from the SOP obtain approval from the PI, and update the SOP.

UCSF Lab Standard Operating Procedure

Chemical Process, Name or Hazard Class:

Enter Text

Please fill out the form completely. Insure all users have access to this SOP. Refer to instructions for assistance.

Department:	Enter text.
Date SOP was written:	Enter date.
This lab specific SOP has been reviewed and approved by:	
Principal Investigator Name:	Enter text.
Principal Investigator Signature	
Lab Manager/Supervisor:	Enter text.

Type of SOP: ☐ Process ☒ Hazardous Chemical ☐ Hazardous Class

Purpose Enter text

Physical & Chemical Properties/Definition of Chemical Group

CAS#: Enter text

Class: Enter text

Molecular Formula: Enter text

Form (physical state): Enter text

Color: Enter text

Boiling point: Enter text

Potential Hazards/Toxicity Enter text

Engineering Controls Enter text

Personal Protective Equipment (PPE) Enter text

Respirator Protection Enter text

Hand Protection Enter text

Eye Protection
ANSI approved safety glasses or goggles.

Skin and Body Protection Enter text

Hygiene Measures
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

First Aid Procedures
If inhaled
Move person into fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Consult a physician.

In case of skin contact
Flush with plenty of water for at least 15 minutes while removing contaminated clothing. Take victim immediately to hospital.

In case of eye contact
Flush eyes with plenty of water for at least 15 minutes lifting upper and lower eyelids and removing contact lenses. Consult a physician. Continue rinsing eyes during transport to the hospital.

If swallowed
Never give anything by mouth to an unconscious person. Get medical aid immediately. Do NOT induce vomiting. If conscious and alert, rinse mouth with water.

Special Handling and Storage Requirements
Handling: Enter text

Spill and Accident Procedure
Chemical Spill Dial 9-911 from campus phone or 415-476-1414 from cell phone or 415-206-8522 (SFGH only)

Spill – Assess the extent of danger. Assist contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).

Small (<1 L) – If you have training, you may assist in the clean-up effort. Use appropriate personal protective equipment and clean-up material for chemical spilled. Double bag spill waste in clear plastic bags, label and take to the next chemical waste pick-up.

Large (>1 L) – **Dial 9-911 from campus phone or 415-476-1414 from cell phone or 415-206-8522 (SFGH only)** for assistance.

Chemical Spill on Body or Clothes – Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. If discomfort persists, proceed to the Emergency Department. If no further discomfort is experienced, have the SDS ready and contact Poison Control Hotline at 1-800-222-1222 for further exposure information.

Notify your direct supervisor and EH&S at 415-476-1300 during work hours, or 9-911 during non-working hours and weekends.

Chemical Splash Into Eyes – Immediately rinse eyeball and inner surface of eyelid with water for 15 minutes by forcibly holding the eye open. If discomfort persists, proceed to the Emergency Department. If no further discomfort is experienced, have the SDS ready and contact Poison Control Hotline at 1-800-222-1222 for further exposure information.

Notify your direct supervisor and EH&S at 415-476-1300 during work hours, or 9-911 during non-working hours and weekends.

Medical Emergency Dial 9-911 (campus phone) or 476-6911 (cell phone)
*Note: All serious injuries must be reported to EH&S at **415-476-1300** within 8 hours.*

Non-Life Threatening Emergency– Go to Occupational Health Programs (OHP) Clinic, 415-885-7580**, 2330 Post Street, Suite 460 Hours of Operation for Appointments: Monday - Friday 7:30 a.m. - 4:00 p.m. (except Holidays).**
*Note: All serious injuries must be reported to EH&S at **415-476-1300** within 8 hours.*

Needle stick/puncture exposure (as applicable to chemical handling procedure) – Wash the affected area with antiseptic soap and warm water for 15 minutes. For mucous membrane exposure, flush the affected area for 15 minutes using an eyewash station. Page the needle stick nurse by dialing **415-353-7842 (STIC).**

Decontamination/Waste Disposal Procedure
Clean contaminated surfaces with soap and water and paper towels. Dispose of the paper towels as hazardous waste.

Safety Data Sheet (SDS) Location
Online SDS can be accessed at http://preview.ehs.ucsf.edu/safety-data-sheet-sds-1

Protocol/Procedure
Quantities covered by this SOP:
_____ (g , ml) to _____ (g, ml)

Temperature range covered by this SOP:
__ °C – __ °C

General Overview and Purpose:
Enter the experimental purpose

Procedure:
Enter experimental procedure. You can copy procedure from your lab notebook or from literature.

NOTE
Any deviation from this SOP requires approval from the Principal Investigator.

APPENDIX E SIGNS

AND LABELS

APPENDIX E1

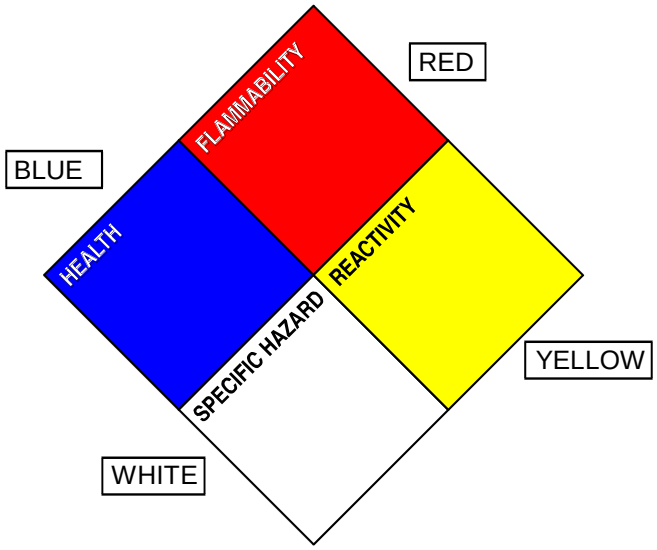
UCSF UNIVERSAL HAZARD SIGN (REPLACE HI SIGN WITH LATEST VERSION)

The Office of Environment, Health and Safety requires all laboratories to post the UCSF Universal Hazard Sign, shown below. The sign addresses the major hazards which can be found in most laboratories. Each sign is specially prepared for the laboratory and tailored to the laboratory's needs. The signs can be obtained by contacting your Department Safety Advisor.

NOTE: remove beaker & replace with NFPA diamond

APPENDIX E2

NATIONAL FIRE PROTECTION ASSOCIATION PLACARD



APPENDIX E3

DEPARTMENT OF TRANSPORTATION SAFETY PLACARDS

(EXAMPLES AFFIXED TO TRANSPORT BOXES / CONTAINERS)

APPENDIX E4

REFRIGERATOR USAGE LABELS

REFRIGERATOR
FOR FOOD ONLY

Lab Safety Supply Inc. Reorder No. 20097

NO FOOD OR DRINK
SHOULD BE STORED IN THIS REFRIGERATOR

Lab Safety Supply Inc. Reorder No. 22263

APPENDIX E5

LABEL FOR REFRIGERATORS AND FREEZERS WHICH ARE NOT "EXPLOSION-SAFE"

APPENDIX E6

TAGS AND LABELS USED BY EH&S FOR CERTIFICATION OF DELUGE SHOWERS, EYE WASH FOUNTAINS, AND FUME HOODS

EYEWASH/SHOWER INSPECTION RECORD

Equipment ID _____

Location _____

Test _____

Date	Initials	Comments

PCT-141 PANDUIT

ENVIRONMENTAL HEALTH AND SAFETY
Hood Evaluation (6-1300)
PHYSICAL PLANT
Hood Servicing (6-2021)

Hood ID: _____

Fan: FH

Manifolded: YES / NO

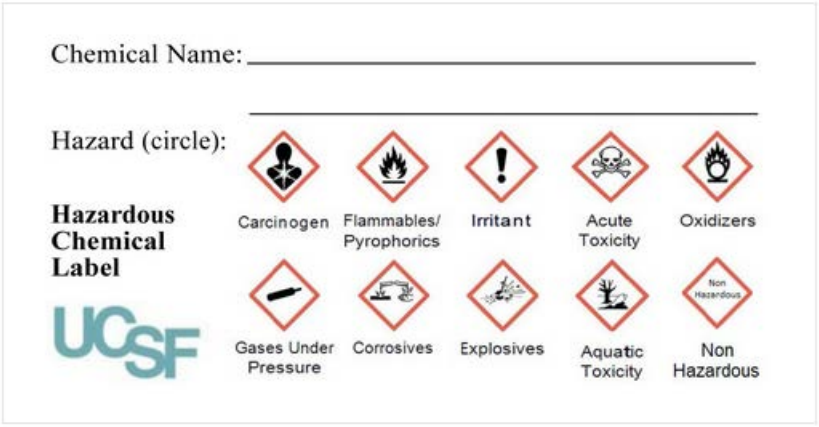
— SURVEY RESULTS —

DATE (M/D/Y)	READING (fpm)	BY	OK	NOT OK	SP"	ALERT	COMMENTS

PLEASE DO NOT REMOVE THIS LABEL 6/88

APPENDIX E7

PORTABLE (SECONDARY) CONTAINER LABEL



APPENDIX E8

INACTIVE LABEL

APPENDIX F

SAFE HANDLING GUIDES

APPENDIX F1

SAFE HANDLING GUIDE FOR CORROSIVE CHEMICALS

A. CORROSIVE

Corrosiveness is a form of acute toxicity unique and hazardous enough to merit separate discussion. Corrosive chemicals include strong acids and bases, as well as oxidizing and dehydrating agents. When they come in contact with skin, eyes, or respiratory tract they react with those tissues and cause tissue injury.

B. LIQUID CORROSIVES

A liquid corrosive will act on the skin either rapidly or slowly depending on concentration and length of contact. These chemicals react directly with the skin - dissolving or abstracting from it some essential components, denaturing the proteins of the skin, or disrupting the skin cells. Mineral acids, organic acids, and bases are among typical liquid corrosives.

When handling liquid corrosives, contact with them must be scrupulously avoided. Wear goggles, rubber or suitable synthetic gloves, and a face shield. A rubber or synthetic apron and rubber boots may also be necessary. Since many liquid corrosives also release irritating vapors, procedures using these materials should be performed in a fume hood.

C. SOLID CORROSIVES

Solid corrosives interact with the skin as the solid is dissolved by surface moisture. Damage occurs from the corrosive action and the heat of solution. Solid chemicals are relatively easy to remove, but because they may not react immediately and may not initially cause pain (as with the caustic alkalis), substantial damage may occur before detection.

Solid corrosives are most commonly dangerous in a finely divided state. Dust control and good exhaust ventilation are essential. Use of goggles, gloves, and other protective clothing is critical. In case of chemical contact, much care must be taken during the emergency shower irrigation to remove all particles of solid matter that might be lodged in the skin or clothes.

D. GASEOUS CORROSIVES

Gaseous corrosives pose the most serious health hazard because of possible damage to the lungs, including spasm, edema, pneumonia, and even death. Different corrosive gases affect different parts of the lung (for example, ammonia affects the upper respiratory tract, while phosgene affects the lung, causing pulmonary edema), but all are to be avoided. It is crucial that corrosive gases not be inhaled. Utilization of a correct fume hood is essential. Skin and eyes must also be protected, as gases interact with all exposed parts of the body.

E. STORAGE

1. Storage areas should be constructed of material that are resistant to the corrosive chemicals used. The interior of the cabinet shall be treated, coated or constructed of materials that are non-reactive with the hazardous materials stored. This treatment shall include the entire interior of the cabinet. The storage cabinets shall be self-closing & self-latching. The bottom of the cabinet shall be liquid tight to a height of two inches.

2. Corrosive chemicals are preferably stored under a fume hood; the storage cabinet should have vertical separations to provide for incompatible storage.

3. Consult the SDS for information on incompatible storage.

4. All corrosive compressed gases shall be stored in a chemical fume hood or ventilated cabinet.

5. Water sensitive corrosives should not be stored under sinks.

F. PROTECTIVE EQUIPMENT

1. It is essential to have a deluge shower and eyewash fountain within 10 seconds of unobstructed travel distance. Flush eye and body for at least 15 minutes.

2. Personal protective equipment must be resistant to the corrosive chemical used.

3. All concentrated corrosive chemicals must be decanted in a fume hood.

4. All corrosive chemical injuries shall be treated and reviewed by a physician. This is particularly important for eye injuries caused by caustic solutions. Tissue damage can occur without symptoms of pain.

5. See specific procedures and familiarize yourself with handling corrosive chemicals.

G. SPILLS

1. Notify EH&S for consultation on large spills.

2. Wear all protective equipment if dealing with spills.

3. Use appropriate neutralizing procedures and check SDS.

H. WASTE

Contact the EH&S Hazardous Materials Removal Program for proper disposal of corrosive chemical waste.

APPENDIX F2

SAFE HANDLING GUIDE FOR PERCHLORIC ACID AND PERCHLORATES

The misuse of perchloric acid has resulted in a tragic number of injuries to both experienced and inexperienced scientists. Before using these chemicals, carefully read this section to be familiar with the properties, precautionary measures, leak/spill and disposal information, and emergency/first aid procedures required for their safe handling and storage. Always review the Material Safety Data Sheet (SDS) provided by the manufacturer. The use of proper safe handling and storage procedures cannot be overemphasized.

When purchasing perchloric acid, order the 60% solution instead of the 70-72% solution (especially if you only need dilute solutions). Never store more than one (1) 450 gram bottle within a laboratory at any time. Note that CAL/OSHA regulations forbid the vaporization of perchloric acid in a chemical fume hood unless it is has a water wash-down capability.

A. GENERAL PROPERTIES OF PERCHLORIC ACID

Perchloric acid is a colorless, fuming, oily liquid. When cold, its properties are that of a strong acid; but when hot, the concentrated acid acts as a strong oxidizing agent. Aqueous perchloric acid can cause violent explosions if misused, or when used in concentrations greater than the normal commercial strength of 72%. Anhydrous perchloric acid is unstable at room temperatures and ultimately decomposes spontaneously with violent explosion. Contact with oxidizers can cause immediate explosion.

B. PERCHLORATES

Each perchlorate or perchlorate system must be separately evaluated as many are extremely sensitive. Organic solutions containing perchlorate salts are capable of violent explosions during evaporation or distillation operations. Small amounts of unstable organic perchlorates are formed which are less volatile than the solute being removed. Near the end of the operation, the temperature rises because of these less volatile components. The higher temperature is enough to detonate the concentrated perchlorate residue. Whenever possible, an excess of water should be present to prevent the accumulation and to slow the temperature rise. Distillation or evaporation of organic-perchlorate mixtures should be halted with enough heel to keep residues diluted. Shielding should be used between the apparatus and laboratory personnel in addition to wearing personal protective equipment.

C. FIRE AND EXPLOSION PROPERTIES

Perchlorate fumes and dusts are irritating, and the acid can cause severe burns to the eyes, nose, and throat. The literature for more than a century reveals descriptions of explosions inlaboratories using perchloric acid. The accidents are usually very severe, with the primary cause being contact of the acid with organic material, or the accidental formation of the anhydrous acid. There is an extreme hazard encountered when strong reducing agents come into contact with concentrated (72%) perchloric acid.

A water spray can be used to extinguish small fires and cool fire-exposed containers. Water is also the best preventative measure against the occurrence of such fires. However if more than a small contained fire is involved, vacate the area and notify the police by calling 476-1414 or 9-911.

D. HANDLING AND STORAGE GUIDES

Perchloric acid should not be purchased, stored, or handled until the potential user is familiar with the hazards and has read the manufacturer's SDS and this section of the Chemical Hygiene Plan.

Do not store perchloric acid near or in contact with combustible materials such as cotton, wood, excelsior, paper, burlap, rags, grease, oil, or organic compounds. Perchloric acid must be stored separately in a deep glass tray with sufficient capacity to hold the entire contents in case of breakage. Storage should be within a fume hood designated solely for perchloric acid use. The bottle and tray should be rinsed daily and after each use. All glass apparatus used should also be rinsed thoroughly. If any discoloration of the liquid is noted, the acid should be discarded by calling the Office of Environment, Health and Safety (EH&S) at 476-1480 and requesting a chemical waste pick-up.

The use of perchloric acid should be limited as much as practicable and the quantity on hand should not exceed one 450g (1 lb.) bottle. Order only 60% solutions; remember that CAL/OSHA regulations forbid the vaporization of perchloric acid in a chemical fume hood unless it has a water wash-down capability. Such hoods are designed to preclude the formation of explosive compounds.

Glass hoods (fume eradicator with or without a reflux head or with a dropping funnel) can sometimes be used to effectively control fumes which are generated by perchloric acid digestion methods. These glass hoods, which are intended as <u>temporary</u> control measures for short term procedures only, are commercially available from laboratory supply companies. You must obtain permission from EH&S prior to the purchase of such hoods.

The glass surface tends to discourage the buildup of perchlorates. However, the equipment should be thoroughly rinsed and cleaned routinely after use. Change the scrubbing solution (sodium hydroxide) after each use, since saturation of the solvent may occur and cause a carryover of toxic materials into the sewage system (this is to be avoided).

E. MAINTENANCE OR SUSPECTED CONTAMINATION

If a fume hood is suspected of having perchloric acid contamination, call EH&S at 476-1300 and request a survey of the suspected hood. The hood should also be surveyed for the presence of perchlorates prior to maintenance work. EH&S may check suspected surfaces with a solution of diphenylamine sulfate (1 gram diphenylamine in 100 ml of 1 to 1 H_2SO_4). The liquid turns black upon contact with a perchlorate. The solution also reacts with nitrates by turning blue. Spills should also be reported to EH&S for verification that a clean-up has been properly completed and that no perchlorate hazard exists.

F. PERSONAL PROTECTIVE EQUIPMENT

Protective clothing consisting of rubber gloves, chemical safety goggles and/or face shield, and rubber apron should be worn when working with perchloric acid. Contaminated clothing is flammable and must be removed and washed thoroughly with water. <u>Do not dry with heat.</u>

G. PROTECTIVE PROCEDURES

1. Order 60% perchloric acid solutions or less.

2. Wear personal protective clothing and eye wear.

3. Transfer acid over a sink or deep glass tray to catch spills and afford a ready means of disposal.

4. When conducting perchloric acid procedures involving wet combustion, first treat the sample with nitric acid to destroy easily oxidizable matter.

5. Procedures involving heating of the perchloric acid must be conducted in an EH&S-approved perchloric acid hood.

6. Do not store any organic materials in the perchloric acid hood.

7. Do not allow perchloric acid to come in contact with strong dehydrating agents (e.g. fuming sulfuric acid, anhydrous phosphorus pentoxide).

8. Standard analytical procedures from authoritative analytical texts should be followed when working with perchloric acid.

9. Perchloric Acid (Greater than 60%): The following additional practices are required.

a. Only experienced lab workers who are familiar with the literature should handle concentrated perchloric acid.

b. A second person should be informed of the intended use of the acid and be in the same room with the research worker (buddy system).

H. MATERIALS

The hazards of breakage due to thermal or mechanical shock are sufficient to warrant quartz apparatus; especially, if it is necessary to chill from boiling. Glass, Teflon™, and Duriron™ can be used with perchloric acid. "O" rings and seals made of one of the fluorocarbons such as "Viton™" are acceptable. For heat transfer or lubrication "Fluorolube™" has been used. Fume hoods should be constructed of stone, PVC, or transite.

I. STIRRERS

Pneumatically driven stirrers, as opposed to the electric motor type, should be used to minimize the fire hazard.

J. HEATING SOURCE

Hot plates (electric), electrically or steam heated sand baths, or a steam bath are recommended for heating perchloric acid. Direct flame heating or an oil bath should never be used.

K. SPILLS

Perchloric acid spilled on the lab bench or floor presents a definite hazard. Do not mop or soak up the acid spill with dry combustibles. First, neutralize the spill with soda ash and flood with large amount of water. Then, soak up with rags or paper towels. Limit the flooded area by using inert sand around the spill. Keep contaminated rags and paper towels wet to prevent combustion upon drying. Discard into a plastic bag, seal, and place in a flammable-waste disposal can, not in the ordinary trash.

L. FIRST AID

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water or milk if available.

APPENDIX G

GLOSSARY OF TERMS

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.
Acute Effect	An adverse effect on a human or animal body with severe symptoms developing rapidly and coming quickly to a crisis.
Acute Toxicity	The adverse (acute) effects resulting from a single dose of or exposure to a substance. Ordinarily used to denote effects in experimental animals.
ACGIH	American Conference of Government Industrial Hygienists: ACGIH develops and publishes recommended occupational exposure limits (see TLV) for hundreds of chemicals substances and physical agents.
ANSI	American National Standards Institute.
API	American Petroleum Institute.
Appearance and Odor	May help you identify the substance you are working with. Do not rely on odor to indicate whether there is a substance in air. Some substances can reach hazardous levels without a noticeable odor.
Asphyxiant	A vapor or gas which can cause unconsciousness or death by suffocation (lack of oxygen). Asphyxiation is one of the principal potential hazards of working in confined spaces.
ASTM	American Society for Testing and Materials.
Autoignition Temperature	The temperature at which a substance will ignite without the presence of an ignition source.
Boiling Point	Boiling point is the temperature at standard conditions (1 atmosphere or 760 mm mercury) in degrees Fahrenheit or Centigrade at which the liquid boils (or becomes gas). Ranges are given for mixtures.
BOM or **BuMines**	Bureau of Mines of the U.S. Department of Interior. Why is this necessary?
C or **Ceiling**	The maximum allowable human exposure limit for an airborne substance; not to be exceeded even momentarily. Also see "PEL" and "TLV".
CAA	Clean Air Act; federal law enacted to regulate/reduce air pollution. Administered by EPA.
Carcinogen	A substance or agent capable of causing or producing cancer in mammals.
C.A.S.	Chemical Abstracts Service; "C.A.S. Numbers" identify specific chemicals.
CCR	California Code of Regulations
CHEMTREC	Chemical Transportation Emergency Center; a national center established by the Chemical Manufacturers Association (CMA) in Washington, D.C. in

1970, to relay pertinent emergency information concerning specific chemicals on request. CHEMTREC has a 24-hour toll free telephone number (800-424-9300) intended primarily for use by those who respond to chemical transportation emergencies.

Chronic Effects — An adverse effect on a human or animal body with symptoms which develop slowly over a long period of time or which recur frequently.

Chronic Toxicity — Adverse (chronic) effects resulting from repeated doses of or exposures to a substance over a relatively prolonged period of time ordinarily used to denote effects in experimental animals.

Corrosive — As defined by DOT, a corrosive material is a liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact, or - in the case of leakage from its packaging - a liquid that has a severe corrosion rate on steel.

CPSC — Consumer Products Safety Commission; federal agency with responsibility for regulating hazardous materials when they appear in consumer goods. For CPSC purposes, hazards are defined in the Hazardous Substances Act and the Poison Prevention Packaging Act of 1970.

Dermal Toxicity — Adverse effects resulting from exposure to a substance via the skin. Ordinarily used to denote effects in experimental animals.

DHHS — U.S. Department of Health and Human Services (includes NIOSH).

DOT — U.S. Department of Transportation: regulates transportation of chemicals and other substances, to aid in the protection of the public as well as fire, law enforcement and other emergency response personnel, particularly when transportation incidents occur involving hazardous substances. Detailed DOT classification lists specify appropriate warnings - such as Oxidizing Agent or Flammable Liquids - which must be used for various substances.

Evaporation Rate — The ratio of the rate of vaporization of a given material relative to the rate of vaporization of n-butyl acetate (n-BuAc), which is assigned a value of one (1.0). Vaporization rates of other solvents or materials are then classified as:

1. FAST evaporating if greater than 3.0
   Examples: Methyl Ethyl Ketone (MEK) = 3.8,
   Acetone = 5.6, Hexane = 8.3

2. MEDIUM evaporating if 0.8 to 3.0
   Examples: 95% Ethyl Alcohol = 1.4,
   VM&P Naphtha = 1.4, methyl isobutyl ketone = 1.6

3. SLOW evaporating if less than 0.8
   Examples: Xylene = 0.6, n-butyl alcohol = 0.4,
   Water - 0.3, Mineral Spirits = 0.1

Extinguishing Media — What kind of fire extinguisher to use. If the substance is not flammable and/or is completely inert, the SDS should say so. Otherwise this line on the SDS must be filled out.

FDA The U.S. Food and Drug Administration

FIFRA Federal Insecticide, Fungicide and Rodenticide Act; regulations administered by EPA.

Flammable A Chemical that falls into one of the following categories:

1. Aerosol flammable:

   An aerosol that, when tested by the method described in Consumer Product Safety Commission regulation, 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. Flammable Gas

   Flammable gas is any material which is a gas at 68^0 F or less at 14.7 psia of pressure which:

   a. Is ignitable at 14.7 psi when in a mixture of 13 percent or less by volume with air, OR,

   b. Has a flammable range at 14.7 psi with air of at least 12 percent, regardless of the lower limit.

3. Liquid flammable

   Any liquid having a flash point below 100 degree F (37.8 degree C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

4. Solid Flammable

   A solid that is liable to cause a 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 the Consumer Product Safety Commission regulations, 16 CFR 1500.44 it ignites and burns with self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flammable Liquids LEL (lower explosive limit) and UEL (upper explosive limit) are the lower and upper limits of vapor and air concentration, given as a percent, which can cause an explosion. The flash point and flammable limits are the most important when related to the boiling point, vapor pressure, % volatile by volume and evaporation rate. If any one of these items is listed, all of the items should be listed in order to provide enough information about the hazards of the material.

Flash Point The minimum temperature at which a liquid will give off enough flammable vapor, mixed with air, to ignite. There are several flash point tests methods, and flash points may vary for the same material depending on the

method used, so the test method is indicated when the flash point is given (150° PMCC 200° TCC, etc.).

General Exhaust

A system for exhausting air containing contaminants from a general work area. Also see "local exhaust."

Hazardous Material

In a broad sense, a hazardous material is any substance or mixture of substances having properties capable of producing adverse effects of the health or safety of a human being. In 1971 the Occupational Safety and Health Administration (OSHA) adopted the following definition:

"The term hazardous material means a material which has one or more of the following characteristics:

1. a flash point below 140°F, closed cup, or is subject to spontaneous heating;
2. a TLV below 500 ppm for gases and vapors below;
3. a single dose oral LD_{50} below 500 mg/kg;
4. is subject to polymerization with the release of a large amount of energy;
5. is a strong oxidizing or reducing agent;
6. causes first degree burns to skin in short time exposure, or is systemically toxic by skin contact; or
7. in the course of normal operations, may produce dusts, gases, fumes, vapors, mists, or smokes which have one or more of the above characteristics."

Irritating

An irritating material, as defined by DOT, is a liquid or solid substance which upon contact with fire or when exposed to air gives off dangerous or intensely irritating fumes (not including poisonous materials: see Poison, Class A and Poison, Class B)

LC_{50}

LETHAL CONCENTRATION 50%; the concentration of a material in air which on the basis of laboratory tests is expected to kill 50% of a group of test animals when administered as a single exposure (usually 1 or 4 hours). The LC_{50} is expressed as parts of material per million parts of air, by volume (ppm) for gases and vapors, or as micrograms of material per liter of air (ug/l) or milligrams of material per cubic meter of air (mg/m^3) for dusts and mists, as well as for gases and vapors.

LD_{50}

Lethal Dose 50%; a single dose of a material which, on the basis of laboratory tests, is expected to kill 50% of a group of test animals. The material may be administered orally or applied to the skin.

LEL or **LFL**

Lower explosive limit or lower flammable limit of a vapor or gas; the lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source is present. At concentrations lower than the LEL, the mixture is too "lean" to burn. Also see "UEL".

Local Exhaust A system for capturing and exhausting contaminants from the air at the point where the contaminants are produced (welding, grinding, sanding, other processes or operations). Also see "general exhaust."

Melting Point The temperature at which a solid substance changes to a liquid state. For mixtures, the melting range may be given.

Mppcf Million particles per cubic foot; a unit for measuring particles of a substance suspended in air. Exposure limits for mineral dusts (Silica, graphite, Portland cement, nuisance dusts and others), formerly expressed as mppcf, are now more commonly quoted in mg/m^3.

Mutagen A substance or agent capable of altering the genetic material in a living cell.

NFPA National Fire Protection Association. NFPA 704M is the code for showing hazards of materials using the familiar diamond-shaped label or placard with appropriate symbols. Hazards are classified on a scale of 0 to 4 as defined below.

FIRE HAZARD (Red)

0 - Will not burn
1 - Will ignite if preheated
2 - Will ignite if moderately heated
3 - Burns readily at ambient conditions
4 - Extremely flammable

Health Hazard (Blue)

0 - Ordinary combustible hazards in a fire
1 - Slightly hazardous
2 - Hazardous
3 - Extreme danger
4 - Deadly

Reactivity (Yellow)

0 - Stable and not reactive with water
1 - Unstable if heated
2 - Violent chemical change
3 - Shock and heat may detonate
4 - May detonate

Specific Hazard (White)

OXY	Oxidizer
Acid	Acid
ALK	Alkali
Cor	Corrosive
Use No Water	
Radiation Hazard	

NIOSH	National Institute for Occupational Safety and Health of the Public Health Service. U.S. Department of Health and Human Services (DHHS); federal agency which - among other activities - tests and certifies respiratory protective devices and air sampling detector tubes, recommends occupational exposures limits for various substance and assists OSHA and MSHA in occupational safety and health investigations and research.
NOx	Oxides of nitrogen.
OSHA	Occupational Safety and Health Administration of the U.S. Department of Labor.
Oxidizer	DOT defines an oxidizer or oxidizing material as a substance that yields oxygen readily to stimulate the combustion (oxidation) of organic matter.
PEL	Permissible exposure limit; an exposure limit established by OSHA regulatory authority. May be a time weight average (TWA) limit or a maximum concentration exposure limit.
% Volatile	Percent volatile by volume; the percentage of a liquid or solid (by volume) that will evaporate at an ambient temperature of 70°F (unless some other temperature is stated). Examples: butane, gasoline and paint thinner (mineral spirits) are 100% volatile; their individual evaporation rates vary, but over a period of time, each will evaporate completely.
PMCC	Pensky-Martens Closed Cup; a flash point test method.
Poison, Class A	A DOT term for extremely dangerous poisons, that is, poisonous gases or liquids of such nature that a very small amount of the gases, or vapor of the liquid, mixed with air is dangerous to life. Some examples: phosgene, cyanogen hydrocyanic acid, nitrogen peroxide.
Poison, Class B	A DOT term for liquid, solid, paste, or semisolid substances - other than Class A poisons or irritating materials - which are known (or presumed on the basis of animal tests) to be so toxic to man as to afford a hazard to health during transportation.
Pyrophoric	A chemical that will ignite spontaneously in air at a temperature of 130°F (54.4°C) or below.
RCRA	Resource Conservation and Recovery Act; federal environmental legislation administered by EPA, aimed at controlling the generation, treating, storage, transportation and disposal of hazardous wastes.
Sensitizer	A substance, which on first exposure, causes little or no reaction in human or animal subjects but which, on repeated exposures may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization in the industrial setting, although respiratory sensitization to a few chemicals is also known to occur.
SETA	Setaflash Closed Tester; a flash point test method.
"SKIN"	A notation sometimes used with PEL or TLV exposure data; indicates the stated substance may be absorbed by the skin, mucous membranes and eyes - either airborne or by direct contact. Appropriate protective measures must be used to prevent skin absorption.

Solubility In Water

Terms used to express solubility are:

Negligible	Less than 0.1 percent
Slight	0.1 to 1.0 percent
Moderate	1 to 10 percent
Appreciable	More than 10 percent
Complete	Soluble in all proportions

SOx

Oxides of sulfur; undesirable air pollutants. SOx emissions are regulated by EPA under the Clean Air Act.

Special Fire Fighting Procedures and Unusual Fire and Explosion Hazard

Would need to be described for any combustible material. Water should not be used to attempt to extinguish fires involving some concentrated corrosives, calcium carbide or reactive metals, for example. Check other sections to see if the material is a catalyst, and if it is reactive with water or polymerization in water or air.

Specific Gravity

Specific gravity refers to the ratio of the weight of a volume of liquid to the weight of an equal volume of water at a specified temperature. If a substance has a specific gravity greater than one, it will sink in water; if it has a specific gravity less than one, it will float in water.

Stability

Cross reference with other sections:

- A mixture may be unstable if the ingredients include catalysts and vehicles, peroxides, explosives, and other unstable or highly reactive substances.
- Are there unusual fire and explosive hazards?
- If there are any very specific instructions in this section regarding precautions in handling and storage, it may indicate that the material is unstable.

STEL

Short Term Exposure Limit; ACGIH terminology.
See "TLV-STEL".

TCC

Tag (Tagliabue) Closed Cup; a flash point test method.

Teratogen

A substance or agent that can cause fetal malformations when a pregnant female is exposed to it.

TLV

Threshold Limit Value; a term used by ACGIH to express the airborne concentration of a material to which nearly all persons can be exposed day after day, without adverse effects. ACGIH expresses TLV's in three ways:

1. TLV-TWA: the allowable Time Weighted Average concentration for a normal 8-hour workday or 40-hour work week.
2. TLV-STEL: the Short-Term Exposure Limit, or maximum concentration for a continuous 15-minute exposure period (maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided that the daily TLV-TWA is not exceeded).

3. TLV-C: the Ceiling exposure limit - the concentration that should not be exceeded even instantaneously.

TOC — TAG Open Cup; a flash point test method.

Toxicity — The sum of adverse effects resulting from exposure to material, generally by the mouth, skin or respiratory tract.

TSCA — Toxic Substances Control Act; federal environmental legislation administered by EPA for regulating the manufacture, handling, and use of materials classified as "toxic substances".

TWA — Time Weighted Average exposure; the airborne concentration of a material to which a person is exposed, averaged over the total exposure time - generally the total workday (8 to 12 hours). Also see "TLV".

UEL or **UFL** — Upper explosive limit or upper flammable limit of a vapor or gas; the highest concentration (highest percentage of the substance in air) that will produce a flash or fire when an ignition source (heat, arc or flame) is present. At higher concentrations, the mixture is too "rich" to burn. Also see "LEL".

Vapor Density — Vapor Density is the relative density or weight of a vapor or gas compared with an equal volume of air. If the vapor density of a substance is less than one, it will tend to rise in air; if the vapor density is greater than one, it will fall in air. Substances with high vapor densities pose a particular problem because they will collect in the bottom of tanks.

Vapor Pressure — The pressure that is exerted by the vapor from a liquid and which varies with temperature. A high vapor pressure indicates that a liquid will evaporate easily. Materials with high vapor pressures can be especially hazardous if you are working with them in an enclosed area or in an area with poor air circulation. Vapor pressures are measured in torr or in millimeters of mercury (mm Hg) at a certain temperature. Xylene with a vapor pressure of 10 mm Hg at 27-32°C and toluene with a vapor pressure of 36 mm Hg at 30°C are two solvents, for instance, the use of which can lead to hazardous concentrations in the air. However, even materials with lower vapor pressures may pose an inhalation hazard because the method of handling (for example, spraying versus brushing) also affects the concentration in air.