CALIFORNIA STATE UNIVERSITY DOMINGUEZ HILLS

CHEMICAL HYGIENE PLAN

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INTRODUCTION

Purpose

The California Labor Code and OSHA's Laboratory Safety Standard requires CSUDH to have a written Chemical Hygiene Plan (CHP).

Requirements

The general requirements of the Chemical Hygiene Plan include:

- Providing employees with training and direction regarding chemical and physical hazards
- Providing the proper safety equipment
- Identifying those persons, organizations, faculty, or staff who are responsible for implementing the Chemical Hygiene Plan
- Assuring access to medical consultation and examinations
- Maintaining records of employee exposures.

Scope

This generic Chemical Hygiene Plan (CHP) has been prepared to meet the basic administrative and safety requirements of OSHA's Laboratory Safety Standard.

The CHP applies to laboratory personnel handling hazardous chemicals.

The CHP's use must be supplemented by specific training, work, and emergency procedures that are applicable to the particular circumstances and practices of each individual's laboratory work.

ORGANIZATION AND SUPPORT

Chemical Hygiene Officer

A staff member of RM/EHOS is designated as the Chemical Hygiene Officer, who insures that the plan is implemented and reviewed periodically, and that the safety requirements of the Laboratory Safety Standard are met.

In addition, each academic division appoints at least one qualified person to provide technical guidance to the Chemical Hygiene Officer on matters relating to safety considerations and procedures for the use of hazardous materials. These division representatives may also assist the Chemical Hygiene Officer in the investigation of accidents involving exposure to hazardous materials.

Environmental Health and Occupational Safety

CSUDH maintains and staffs a RM/EHOS office that supports faculty and researchers in carrying out their safety responsibilities.

The staff has expertise in the fields of industrial hygiene, fire, chemical and occupational safety. The Safety Office provides special safety equipment, emergency response services, and manages the hazardous waste disposal program.

The Safety Office offers Hazard Communication (HAZCOM) safety training on an annual basis for the campus.

The Safety Office also serves as a resource for workplace and procedure evaluations.

A written copy of CSUDH's Chemical Hygiene Plan is available in each group of laboratories where hazardous materials are used.

EMPLOYEE INFORMATION AND TRAINING

General Training

Each division provides general laboratory-safety training and RM/EHOS provides annual hazard communication training.

Specific Training

It is the responsibility of the professors, or a person designated by them, to provide employees under their direction with information and training on the following:

- The hazards of chemicals and toxic materials that they will be using in the laboratory
- Potential hazards, safe work practices, engineering safeguards, and other personal protective measures available
- How to use and care for personal protective equipment, and the emergency procedures to follow in the event of spills or accidental exposure to toxic or dangerous materials
- The availability and location of Material Safety Data Sheets (MSDS) and other reference material
- New laboratory procedures and associated safety practices. Employees should understand these practices before starting the procedure.

STANDARD OPERATING PROCEDURES

General Rules

1. Avoid working alone when working with hazardous materials.

2. Wear appropriate laboratory apparel (lab coats) and eye protection at all times. (See Appendix C, Personal Protective Equipment Guidelines.)

3. When working with flammable chemicals, be certain that there are no sources of ignition near enough to cause a fire or explosion in the event of a vapor release or liquid spill.

4. Use the appropriate shielding for protection whenever an explosion or implosion might occur.

5. When using chemicals, all employees should know and constantly be aware of:

   - The specific hazards of each chemical, as determined from the MSDS and other appropriate references.

   - The potential for any chemical to be hazardous and when in use to be treated as a hazardous material.

   - Appropriate safeguards for using each chemical, including personal protective equipment.

   - The location and proper use of emergency equipment, such as eyewashes and showers.

- How and where to properly store each chemical when it is not in use.
- Proper personal hygiene practices.
- The proper methods of transporting chemicals within the facility, as described in Appendix F, Transporting Chemicals.
- Appropriate procedures for emergencies, including evacuation routes.
- Spill clean-up procedures and proper waste disposal.

Hazardous Waste

The RM/EHOS office is responsible for picking up hazardous waste in the labs. Arrangements for pick-ups can be made by contacting the Safety Office.

General hazardous waste guidelines are described in Appendix A, Hazardous Waste Guidelines.

Emergencies

Refer to the Institute's Emergency Response Guide posted in each laboratory.

ENGINEERING CONTROLS, PERSONAL PROTECTIVE EQUIPMENT, AND HYGIENE PRACTICES

Personal Hygiene

1. Promptly rinse with water whenever a chemical has contacted the skin.

2. Avoid inhalation of chemicals; do not sniff to test chemicals.

3. Do not use mouth suction to pipette anything; use suction bulbs or automatic pipettors.

4. Wash well with soap and water before leaving the laboratory.

5. Do not drink, eat, smoke, or apply cosmetics in the laboratory.

6. Do not bring food, beverages, tobacco, or cosmetics into chemical storage or use areas.

Protective Clothing and Equipment

Personal protective equipment (PPE) is special gear used to protect the wearer from the specific hazards of a hazardous substance. It is a last-resort protection system, to be used when substitution or engineering controls are not feasible.

Personal Protective Equipment is available in the laboratories.

See Appendix C, Personal Protective Equipment Guidelines.

ENGINEERING CONTROLS, PERSONAL PROTECTIVE EQUIPMENT, AND HYGIENE PRACTICES cont.

Housekeeping	1. Do not block access to emergency equipment, showers, eyewashes, and exits, even with temporary equipment such as chemical carts. 1. Label appropriately all chemical containers with the identity of the contents and the chemical hazards. 2. Keep all work areas, especially laboratory benches, clean and clear of clutter. 4. Place chemicals in proper storage areas or cabinets at the completion of their use. They must not be stored in aisles, stairwells, or hallways, or on desks, laboratory benches, or floors. 5. Promptly clean up all spills; properly dispose of the spilled chemical and clean-up materials. 6. Use absorbent paper on working surfaces to avoid the spreading of spilled chemicals. 7. When transporting chemicals from one laboratory or area to another, place the chemical in a secondary container to avoid spillage. (See Appendix F, Transporting Chemicals.)

ENGINERING CONTROLS, PERSONAL PROTECTIVE EQUIPMENT, AND HYGIENE PRACTICES cont.

Chemical Spills and Incidents	1. Use the CSUDH Emergency Response Guide posted in each laboratory for assistance. 2. Know your primary and alternate evacuation routes, as well as the location of the nearest safety shower and eyewash station.
Emergency Eyewash Fountains and Safety Showers	1. Know the location of emergency eyewashes and safety showers and be able to reach them. 2. Do not restrict or block access to emergency eyewashes and safety showers in any way. 3. Physical Plant will check eyewash and safety shower function periodically and promptly repair any facility that does not meet the Cal/OSHA requirements.
Respirators	1. All practical engineering and procedural controls should be employed to reduce any airborne chemical to its lowest possible concentration. At a minimum, vapor and particulate concentrations should be below the OSHA Permissible Exposure Limit (PEL), the Threshold Limit Value (TLV), or any similar limit. 2. In exceptional cases, where engineering and procedural controls cannot adequately protect the employee, respiratory protection should be used. Respiratory protection may only be used in accordance with the CSUDH Respiratory Protection Program. 3. RM/EHOS provides guidance in selection of respirators, and assists in proper respirator fit and maintenance.

CONTROL EQUIPMENT AND DESIGNATED AREAS

Control Measures

1. Chemical safety is achieved by continual awareness of chemical hazards, by keeping the chemical under control, and by using precautions, including engineering safeguards such as fume hoods.

2. Professors and laboratory supervisors should be alert to the failure of engineering controls and other safeguards. All engineering safeguards and controls must be properly maintained, inspected regularly, and never overloaded beyond their design limits.

Ventilation

1. General laboratory ventilation should not be less than 10 air changes per hour (calculated). This flow is not necessarily sufficient to prevent accumulation of chemical vapors. Work with toxic chemicals should always be done in a fume hood.

2. Fume hoods should provide a face velocity of at least 100 linear feet per minute of airflow.

1. Laboratory employees should understand Appendix D, Fume Hood Guidelines.

CONTROL EQUIPMENT AND DESIGNATED AREAS cont.

Designated Areas

A designated area is a space within a lab to be used for work with select carcinogens, reproductive toxins, and other materials with a high degree of acute toxicity. (See Appendix G.)

A designated area can be a hood, glove box, portion of a laboratory, or an entire laboratory room where specific chemicals are used.

Designated areas shall be posted . Only properly trained lab workers are allowed to handle regulated chemicals in regulated areas.

Within the designated area, remember to follow these guidelines:

- Use the smallest amount of the material that is consistent with the requirements of the work to be done.
- Remove chemicals from storage only as needed and return them to storage as soon as practical.
- Decontaminate the designated area when work is completed.
- Store all Cal/OSHA-regulated chemicals in locked and enclosed spaces. (See Appendix H.)
- Wear long-sleeved, disposable clothing and gloves known to resist permeation.
- Do not wear jewelry. Decontamination of jewelry may be difficult or impossible.

SPECIAL OR NON-ROUTINE PROCEDURES

Non-Routine Procedures	Follow the procedures described in this section when performing laboratory work with any carcinogen, reproductive toxin, or substance that has a high degree of acute toxicity, or a chemical whose toxic properties are unknown. (See Appendix G.) The material safety data sheet (MSDS) for many of the chemicals used in the laboratory will recommend safety precautions, control measures, and safety apparel that apply when working with toxic chemicals. See Appendix B, Planning an Experiment.

GENERAL GUIDELINES FOR WORKING WITH HAZARDOUS MATERIALS

Procedures for Flammable Chemicals

In general, the flammability of a chemical is determined by its flash point, the lowest temperature at which an ignition source can cause the chemical to ignite momentarily.

1. Chemicals with a flash point below 200^{o} F (93.3^{o} C) are considered "fire-hazard chemicals."

2. Fire-hazard chemicals should be stored in a flammable solvent storage area or in NFPA or FM rated storage cabinets designed for flammable materials.

1. Fire-hazard chemicals should be used only in vented hoods and away from sources of ignition.

Flammable Liquid Storage

1. Store flammable liquids in excess of 10 gallons in approved flammable liquid storage cabinets.

2. Storage of flammable liquids outside of a cabinet should be

   - in an approved flammable liquid container,

   -OR

   - in its original DOT-approved container with secondary containment.

Procedures for Reactive Chemicals

1. Reactive chemicals are those that are:

   - described as such in the Material Safety Data Sheet,
   - ranked by the NFPA as 3 or 4 for reactivity, the yellow diamond on the NFPA placard.
   - identified by the DOT as an oxidizer, an organic peroxide, or an explosive,
   - known or found to be reactive with other substances.

1. Handle reactive chemicals with the proper safety precautions as described in the chemical's Material Safety Data Sheet.

3. Segregate reactive chemicals from incompatible chemicals. (See Appendix I)

Procedures for Corrosive Chemicals Contact-Hazard Chemicals

Corrosive, allergenic, and sensitizer information is and given in MSDSs and on chemical container labels. Also, guidelines on how to handle corrosive chemicals can be found in the OSHA and DOT standards.

1. A corrosive chemical is one that :

   - fits this OSHA definition: A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.
   - has a pH greater than 12 or less than 2.5.
   - is known or found to be corrosive to living tissue.

1. A contact-hazard chemical is an allergen or sensitizer that :

- is so identified or described in the MSDS or on the label.
- is so identified or described in medical- or industrial-hygiene literature.
- is known or found to be an allergen or sensitizer.

3. Handle corrosive chemicals and contact-hazard chemicals with all proper safety precautions, including wearing both safety goggles and face shield, gloves tested for absence of pinholes and known to be resistant to permeation or penetration, and a laboratory apron or laboratory coat. (See Appendix C.)

New Procedures, Equipment, and Particularly Hazardous Materials.	Evaluate any new or hazardous procedure with the laboratory supervisor and Chemical Hygiene Officer. In addition, utilize the Minor Capital Project Approval process for review of equipment needs and placement. RM/EHOS is also available for consultation. (See Appendix B, Planning an Experiment.)

MEDICAL SURVEILLANCE PROGRAM

Medical Care

Employees are entitled to medical care and close observation for on-the-job injuries, which include exposure or suspected exposure to toxic and hazardous substances.

1. Medical Care is obtained in the following ways:

    - In case of severe injury, dial 911 from campus office phones or 3333 from campus courtesy/lab phones to obtain paramedic transportation to an emergency care facility.

    - For minor injuries, including exposure or suspected exposure to toxic substances during normal working hours, the employee will be referred to Centrepointe Medical Group for further treatment.

2. Results of Medical Consultation and Examinations

    - Through the workers' compensation program, CSUDH employees are assured of medical consultation and examinations by licensed physicians in the event of exposure or suspected exposure to hazardous chemicals or materials. Insofar as is possible, CSUDH and the employee will furnish the treating physician with information concerning the nature of the exposure.

The Chemical Hygiene Officer will conduct required investigations relating to injuries and exposures to hazardous materials. When necessary, the services of the appropriate division advisory committee member will be used as a resource to assist in the investigation.

RECORD KEEPING AND REPORTS

RM/EHOS maintains permanent records of the results of:

- environmental monitoring done to determine the presence and concentration of hazardous substances in laboratories and other campus facilities
- fume-hood performance in laboratories
- results of incident investigations and recommendations for actions to minimize the risk of recurrence
- other records required by regulatory agencies (e.g., OSHA, EPA, California Department of Health Services)

Appendix A

HAZARDOUS WASTE GUIDELINES

1. **Fume hoods and drains are not to be used as waste disposal devices.**

2. Prepare chemical wastes for disposal according to specific waste-reduction procedures that the principal investigator has provided.

3. Do not purchase more of a chemical than you expect to use in the foreseeable future. The cost of disposal often exceeds the purchase price of the chemical.

4. Hazardous waste containers must be completely labeled and dated when the first drop of hazardous waste goes in.

5. Use only authorized Hazardous Waste Identification Tags for container labeling. Other forms of hazardous-waste identification are not acceptable.

6. Waste containers must be kept closed except when adding hazardous waste.

7. The Safety Office must receive all hazardous waste containers within 9 months from the date of initial accumulation.

1. Dispose of your waste at the completion of a project. Do not abandon the waste, so that someone else must deal with it.

2. Arrangements for chemical analysis of unknowns can be made through RM/EHOS. Costs associated with improper handling of waste are charged back to the laboratory.

3. Materials that are donated from off-campus donors must be approved for receipt and used as part of an experiment or lesson.

Appendix B

Planning an Experiment

Important factors in planning and evaluating an experiment include

1. Evaluating the properties of the chemicals to be used
   - Physical properties
   - Reactivity
   - Flammability
   - Radioactivity
   - Toxicity
   - Biological and health effects
   - Chemical products of the experiment

2. Selection of engineering controls
   - Fume hoods
   - Shielding
   - Glove boxes
   - Vacuum lines
   - Any special equipment unique to the experiment.
   - Placement of such equipment and any special hazards the equipment presents.

3. Selection of personal protective equipment based on the chemical properties evaluation
   - Safety glasses
   - Lab coats
   - Aprons
   - Face protection
   - Shielding
   - Gloves of appropriate type

4. Performing administrative controls
   - Review the experiment with the laboratory supervisor or professor
   - Inform the group of any special hazards

Appendix B cont.

5. Selection of the experiment site
   - Earthquake
   - Electrical
   - Plumbing
   - Scale of the experiment
   - Occupancy of the laboratory
   - Anything that is unique to the experiment
   - Utilize Minor Capital Project Approval process for site review

6. Contingency planning with the lab supervisor and the research group
   - Earthquake
   - Power failure
   - Water leaks
   - Instrument failure
   - Engineering controls failure
   - Spills
   - Evacuation
   - An occurrence of a scenario that affects the experiment

Appendix C
PERSONAL PROTECTIVE EQUIPMENT GUIDELINES

2. Always wear safety glasses when working with chemicals. This also applies to any work involving possible physical damage to the eyes (e.g., lasers and other equipment that emit radiation at wavelengths from the ultraviolet through the near infrared).

3. Always wear goggles when the potential of a splash from hazardous materials exists; goggles can be worn over prescription glasses.

4. Use face shields when working with large volumes of hazardous materials.

5. When the possibility of chemical contamination exists, wear protective clothing (a lab coat) that resists physical and chemical hazards of minor chemical splashes and spills. Wear plastic or rubber aprons when using corrosive liquids.

6. Loose clothing (such as ties or overlarge lab coats), skimpy clothing (such as shorts), torn clothing, or unrestrained hair pose a hazard in the laboratory.

1 When working with corrosive, allergenic, sensitizing, or toxic chemicals, wear gloves made of material known to be resistant to permeation by the chemical. Refer to Appendix J. for a listing of glove types and resistivity.

7. Do not wear sandals, open-toed shoes, or perforated shoes in the laboratory.

5. Use a fume hood whenever exposure by inhalation is likely to exceed the threshold limits described in the MSDS.

6. Consult with your supervisor when there are any changes or new procedures.

10. Inspect all protective equipment before using. Do not use defective personal protective equipment.

Appendix D

FUME HOOD GUIDELINES

The protection afforded by a fume hood is only as good as the work practices of the hood user. The following are general guidelines to be followed when working in the hood.

1. Know the toxic properties of the chemicals with which you work. Be able to identify signs and symptoms of overexposure.

2. Mark a line with tape six inches behind the sash and keep all chemicals and equipment behind that line during experiments. This will keep vapors from escaping the hood when air currents from people walking past the hood interfere with air flow at the face of the hood.

3. Keep the sash completely lowered anytime there is no “hands-on” part of the experiment in progress or whenever the hood is on and unattended.

1. Never use a hood unless there is an indication that it is functioning properly. The fume hood has a green light indicating standard operation and adequate performance. A red light with a caution flow alarm indicates the valve is not functioning properly. The fume hood should not be used due to inadequate flow. Notify Physical Plant for fume hood repair.

5. In an emergency such as a large spill inside the hood push the red button on the fume hood and close the sash. Leave the room and notify the instructional support technicians. If the spill occurs outside the fume hood push the red button and open the sash all the way. Leave the room immediately and also notify the technicians.

7. The hood is not a substitute for personal protective equipment. Wear a lab coat, gloves, and safety glasses as appropriate.

8. Visually inspect the baffles (openings at the top and rear of the hood) to be sure the slots are open and unobstructed.

9. Do not block baffles. If large equipment is in the hood, put it on blocks to raise it approximately two inches so that air may pass beneath it.

10. Do not use an active hood as a storage cabinet. Keep only the materials necessary for the experiment inside the hood. If chemicals need to be stored in the hood for a period of time, install shelves on the side of the hood, away from the baffles. Refer to Appendix I. for storage compatibilities.

11. Keep the sash clean and clear.

Appendix D cont.

12. Clean all chemical residue in the hood after each use.

13. All electrical devices should be connected outside the hood to avoid sparks that may ignite a flammable or explosive chemical.

13. DO NOT USE A FUME HOOD AS A WASTE DISPOSAL DEVICE. Use traps and condensers whenever possible to collect vapors and fumes. Never use a hood to evaporate solvents. Instead, collect the solvent and dispose of it as hazardous waste.

14. DO NOT USE A FUME HOOD FOR ANY FUNCTION FOR WHICH IT IS NOT INTENDED. Certain chemicals or reactions require specially constructed hoods. Examples are perchloric acid or high-pressure reactions. If there are any questions about the capabilities of a particular hood, contact the Safety Office.

Use OSHA regulated chemicals and known carcinogens in hoods specifically indicated for such use. Refer to Appendix G. for a listing of these agents.

Appendix E
WORKING WITH CRYOGENICS

Cryogenic fluids are characterized by having a boiling point of less than -73 degrees C (-100 degree F). The boiling points of carbon dioxide and nitrogen are -78.5 degrees C and -195.8 degrees C, respectively. Another physical property of cryogenic fluids is the high-volume-expansion ratio in the liquid-to-gas phase. This ratio is 553 to 1 for carbon dioxide and 696 to 1 for nitrogen.

Using cryogenic fluids improperly may produce physical and personal hazards that are not always obvious. The primary hazard to people is skin or eye contact with splashing liquid as it warms and expands. Injuries similar to a burn will result. Safety goggles or a face shield should be worn. Clean, insulated gloves that can be easily removed are recommended. Arm and leg protection is also recommended.

All cryogenic fluids are capable of causing asphyxiation without warning by displacing oxygen-containing air. Areas where they are used or stored should be adequately ventilated.

Cryogenic fluids are capable of condensing oxygen from the air, causing oxygen enrichment resulting in increased flammability. Condensed oxygen can also react violently in the presence of organic materials and cause an explosion.

Liquefied gases are generally stored at atmospheric pressure in an insulated container, which keeps them near their boiling point, with some gas present. The large expansion in volume that takes place when the liquid becomes a gas means that pressure can build up in an unvented or unrelieved container and in transfer lines and piping. System design and maintenance must take this expansion ratio into account. Only containers designed for cryogenic fluids should be used.

The selection of materials to be used with cryogenics is important because of the changes in physical properties of materials at very low temperatures. Some materials become extremely brittle. Chemical interactions between the cryogenic liquid and its container or equipment must also be evaluated.

Appendix E cont.

The Dewar flask is the most common container used for storage and transfer of cryogenic fluids. When using the Dewar, follow these procedures.

- Cover the Dewar with a cap that allows escape of built-up pressure and keeps air and moisture out.
- Transfer cryogenic liquids from large Dewar vessels with special transfer tubes designed for the particular application.
- Tipping or tilting to pour the liquid may damage large Dewars.
- Do not use heat guns or similar equipment to warm transfer tubing quickly for disconnection.
- Handle containers carefully to protect the vacuum insulation system of Dewars.
- Place large Dewars on dollies that move freely so there is no possibility of personal injury or damage to the supported Dewars.
- Dewars should not be stored or used in confined areas or labs smaller than 120 square feet.

Due to extremely cold temperatures of cryogenic liquids and “boil-off” gases, use the following personal protective equipment (PPE):

- When cryogenics are present, safety glasses with side shields
- When cryogenics are poured or transferred,
    - safety glasses and a full face shield
    - loose-fitting thermal gloves
    - long-sleeved clothing (lab coat)
    - long pants
    - closed-toe shoes

Anyone using cryogenic material must receive instruction in using cryogenic materials safely from their lab supervisor or safety officer.

If there is a cryogenic spill, immediately leave the area. If you believe the cryogen has caused significant oxygen depletion, do not re-enter the area unless the oxygen content of the atmosphere is at least 19.5% and there is no flammable or toxic mixture present.

Appendix F
TRANSPORTING CHEMICALS

Transporting chemicals from the stockroom can sometimes be difficult. Juggling several bottles—along with a box of gloves, a beaker, and a roll of duct tape—is not safe. To make the job easier and safer, the chemistry and biology stockrooms have chemical carriers. They are large rubber buckets that will protect the person carrying the chemical. They provide an easy method of transport between the stockroom and the laboratory.

If several items are needed, use a cart. Side rails on the cart and/or the use of the original shipping containers for the chemical bottles reduce the chances of an accidental chemical spill.

APPENDIX G

SELECT CARCINOGENS, REPRODUCTIVE TOXINS, AND
COMPOUNDS WITH A HIGH DEGREE OF ACUTE TOXICITY

Carcinogens

Carcinogens are chemical or physical agents that cause cancer. Generally, they are chronically toxic substances.

*Select carcinogens are classified as “Particularly Hazardous Substances” and must be handled in a designated area.

Classes of Carcinogenic Compounds (*Select)

Alkylating agents

α-halo ethers:
*bis(chloromethyl) ether
*methyl chloromethyl ether

Sulfonates

*1,4-butanediol dimethanesulfonate
diethyl sulfate
dimethyl sulfate
ethyl methanesulfonate
methyl methanesulfonate
methyl trifluoromethanesulfonate
1,3-propanesulfone

Epoxides

*ethylene oxide
diepoxybutane
epichlorohydrin
propylene oxide
styrene oxide

Aziridines

*ethylenimine
2-methylaziridine

Diazo, azo, and azoxy compounds

4-dimethylaminoazobenzene

Organohalogen compounds

*1,2-dibromo-3-chloropropane
*mustard gas
bis(2-chloroethyl)sulfide
*vinyl chloride
carbon tetrachloride
chloroform
3-chloro-2methylpropene
1,2-dibromethane
1,4-dichlorobenzene
1,2-dichloroethane
2,2-dichloroethane
1,3-dichloropropene
hexachlorobenzene
methyl iodide
tetrachloroethylene
trichloroethylene
2,4,6-trichlorophenol

N-nitroso compounds

*N-nitrosodimethylamine
N-nitroso-N-alklureas

APPENDIX G cont.

Electrophilic alkenes and alkynes
*acrylonitrile
acrolein
ethyl acrylate

Acylating agents
β-propiolactone
β-butyrolactone
dimethylcarbamoyl chloride

Hydrazines
Hydrazine(and hydrazine salts)
1,2-diethylhydrazine
1,1-dimethylhydrazine
1,2-dimethylhydrazine

Misc. inorganic compounds
*arsenic and certain arsenic-compounds
*chromium and certain chromium-compounds
chromium dioxide
beryllium and certain beryllium-compounds
lead and certain lead-compounds
nickel and certain nickel-compounds

Misc. organic compounds
*formaldehyde (gas)
acetaldehyde
1,4-dioxane
ethyl carbamate (urethane)
hexamethylphosphoramide (HMPA)
2-nitropropane
styrene
thioacetamide

Aromatic amines:
*4-aminobiphenyl
*benzidine(p,p-diaminobiphenyl)
*Δ-naphthylamine
*ϑ-naphthylamine
aniline
o-anisidine (2-methoxyaniline)
2,4-diaminotoluene
o-toluidine

Aromatic hydrocarbons
*benzene
benz{a} anthracene,benzo{a

Natural products
adriamycin
selenium sulfites
cisplatin
aflatoxins
bleomycin
safrole
progesterone
reserpine

APPENDIX G cont.

Reproductive Toxins
Reproductive toxins include substances which cause chromosomal damage (mutagens) and substances with lethal or tetratogenic (malformation) effects on fetuses. Many reproductive toxins are chronic toxins that cause damage after repeated or long-duration exposures with effects that become evident only after long latency periods.

The following table lists some materials that are highly suspected to be reproductive toxins.

Partial List of Reproductive Toxins

Acrylic acid
Aniline
Benzene
Cadmium
Carbon sulfide
N,N dimethylacetamide
Dimethylformamide (DMF)
Dimetylsulfoxide (DMSO)
Diphenylamine
Estradiol
Formaldehyde
Formamide
Hexachlorobenzene
Iodoacetic acid
Lead compounds
Mercury compounds
Nitrobenzene
Nitrous oxide
Phenol
Polychlorinated biphenyls
Polybrominated biphenyls
Toluene
Vinyl chloride
Xylene

The above list is not complete. It is the responsibility of the researcher to identify each compound involved in his/her work.

APPENDIX G cont.

Acute Toxins
Acute toxicity is the ability of a chemical to cause a harmful effect after a single exposure. Acutely toxic agents can cause local toxic effects, systemic toxic effects, or both. This class of toxicants includes corrosive chemicals, irritants, and allergens (sensitizers).

Partial List of Compounds with a High Degree of Acute Toxicity

Acrylic acid
Acrylonitrile
Allylalcohol
Allylamine
Arrolein
Bromine
Chlorine
Cyanide salts
Diazomethane
Diborane (gas)
1,2-dibromethane
Dimethyl sulfate
Ethylene oxide
Hydrazine
Hydrogen cyanide
Hydrogen fluoride
Hydrogen sulfide
Methyl fluorosulfonate
Methyl iodide
Nickel carbonyl
Nitrogen dioxide
Osmium tetroxide
Ozone
Phosgene
Sodium azide

The above list is not complete. It is the responsibility of the researcher to identify each compound involved in his/her work.

Appendix H
CAL/OSHA-REGULATED CARCINOGENS

Title 8, California Code of Regulations' Carcinogen Standard, requires submitting a report of use of regulated carcinogens to the Chief of the Division of Occupational Safety and Health. The following are the carcinogens currently regulated.

2-Acetylaminofluorene

4-Aminodiphenyl

Benzidine (and its salts)

3,3-Dichlorobenzidine (and its salts)

4-Dimethlyaminoazobenzene

Alpha-Naphthylamine

Beta-Naphthylamine

4-Nitrobiphenyl

N-Nitrosodimethylamine

Beta-Propiolacetone

Bis-Chloromethyl ether

Methyl chloromethyl ether

Ethyleneimine

Methylene Chloride

Methylenedianiline (MDA)

Cadmium

Asbestos

Vinyl Chloride

Coke Oven Emissions

1,2 Dibromo-3-Chloropropane

Acrylonitrile

Inorganic Arsenic

4,4-Methylenebis
(2-Chloroaniline) MBOCA

Formaldehyde

Benzene

Ethylene Dibromide (EDB)

Ethylene Oxide

1,3 Butadiene

Appendix I
SEGREGATION OF INCOMPATIBLE SUBSTANCES

When transporting, storing, using, or disposing of any substance, exercise utmost care to ensure that the substance cannot accidentally come in contact with another with which it is incompatible. Such contact can result in an explosion or the formation of substances that are highly toxic, flammable, or both. The following table is a guide to avoiding accidents involving incompatible substances.

Examples of Incompatible Chemicals

Chemical	**Incompatible with**
Acetic Acid	Chromic acid, nitric acid, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric acid and sulfuric acid mixtures
Alkali and alkaline earth metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, i.e., powdered aluminum or magnesium, carbon dioxide, halogens, calcium, lithium, sodium, potassium.
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, anhydrous HF
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organics or combustibles
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Bromine	See Chlorine
Calcium Oxide	Water
Carbon (activated)	Calcium hyperchlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials

Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Decaborane	Carbon tetrachloride and some other halogenated hydrocarbons
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Everything
Hydrocarbons (such as butane, propane)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, brass, any heavy metals
Nitrates	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, or gases

Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral). Avoid friction, store cold.
Phosphorous (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerine, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compunds of light metals, such as sodium, lithium)
Tellurides	Reducing agents

APPENDIX J
CHEMICAL RESISTANCE CHART

Explanation of Ratings

Breakthrough detection times (BDT) are given in minutes. CPC index ratings are based on the Forsberg system, which relies on both breakthrough times and permeation rates to establish a rating system for chemical protective clothing. The ratings range from 0 to 5, with 0 being the best and 5 being the worst.

Chemical Protective Clothing Performance Index Rating (CPC)

0 Best selection for unlimited exposure. No breakthrough.
1 Next best selection for unlimited exposure.
2 Sometimes satisfactory. Good for limited exposure.
3 Poor choice. Not for heavy exposure.
4 Very poor. For splashes only.
1 Not recommended.

Chemical by Class	Neoprene		Nitrile		Rubber		PVC		Butyl		Viton	
	BDT	CPC	BDT	CPC	BDT	CPC	BDT	CPC	BDT	CPC	BDT	CPC
Aliphatic Solvents												
1. Cyclohexane	21	2	9	0	55	5	13	3	ND	4	NR	0
2. Gasoline/Unleaded	46	3	46	0	NR	5	22	3	NR	5	ND	0
3. Heptane	ND	0	ND	0	24	3	39	4	23	4	ND	0
4. Hexane	173	2	234	0	21	4	29	3	13	5	ND	0
5. Isooctane	ND	0	ND	0	57	3	114	3	56	4	ND	0
6. Kerosene	ND	0	ND	0	NR	5	ND	0	94	4	ND	0
7. Petroleum Ether	99	2	ND	0	5	5	19	4	15	4	ND	0
Acids, Organic												
8. Acetic 84%	ND	0	240	5	ND	0	300	2	ND	0	ND	0
9. Formic 90%	ND	0	75	0	ND	0	ND	0	ND	0	120	0
Acids, Mineral												
10. Battery 47%	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
11. Hydrochloric 37%	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
12. Hydrofluoric 48%	ND	0	60	3	45	3	110	2	ND	0	185	1
13. Muriatic 10%	ND	0	ND	0	ND	0	ND	4	ND	0	ND	0
14. Nitric 70%	ND	0	NR	5	ND	0	240	5	ND	0	ND	0
15. Sulfuric 97%	ND	0	180	3	ND	0	210	5	ND	0	ND	0
Alcohols												
16. Amyl	ND	0	ND	0	ND	0	116	2	ND	0	ND	0
17. Butyl	ND	0	ND	0	ND	0	155	2	ND	0	ND	0
18. Cresols	ND	0	NR	5	371	2	ND	0	ND	0	ND	0
19. Ethyl	ND	0	225	4	ND	0	66	2	ND	0	ND	0
20. Methyl	226	1	28	3	82	2	39	4	ND	0	ND	0
21. Isobutyl	ND	0	ND	0	ND	0	ND	2	ND	0	ND	0

Chemical by Class	Neoprene		Nitrile		Rubber		PVC		Butyl		Viton	
	BDT	CPC	BDT	CPC	BDT	CPC	BDT	CPC	BDT	CPC	BDT	CPC
Aldehydes												
22. Acetaldehyde	21	3	NR	5	55	3	13	5	ND	0	NR	5
23. Benzaldehyde	93	3	NR	5	81	3	NR	5	ND	0	ND	0
24. Formaldehyde	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
25. Furfural	165	2	NR	5	ND	0	85	3	ND	0	298	3
Alkalis												
26.Ammonium Hydr.	ND	0	240	3	120	3	60	4	ND	0	ND	0
27.Potassium Hydrox.	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
28.Sodium Hydroxide	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
Amides												
29.Dimethylacetamide	84	3	NR	5	29	4	51	4	ND	0	NR	5
30.Dimethylformamide	100	3	NR	5	ND	0	NR	5	ND	0	NR	5
31.N-MethylPyrrolidone	ND	0	34	3	ND	0	140	4	ND	0	NR	5
Amines												
32. Aniline	32	3	NR	5	1	4	71	3	ND	0	ND	0
33. Butylamine	NR	5	NR	5	45	3	15	3	45	3	NR	5
34. Diethylamine	23	5	60	5	60	5	107	4	30	3	9	5
Aromatic Solvents												
35. Benzene	15	5	16	4	NR	5	13	5	34	4	ND	0
36. Toluene	25	4	26	4	NR	5	19	4	22	4	ND	0
37. Xylene	37	4	41	4	NR	5	23	3	NR	5	ND	0
Chlorinated Solv.												
38.Carbon Tetrachloride	73	4	ND	0	NR	5	46	4	53	4	ND	0
39. Chloroform	23	4	6	5	NR	5	10	5	21	4	ND	0
40.Methylene Chloride	NR	5	4	5	NR	5	NR	5	20	4	113	3
41. Perchloroethylene	40	4	ND	0	NR	5	NR	5	28	4	ND	0
42. Trichloroethylene	12	5	9	5	NR	5	NR	5	13	5	ND	0
43.1,1,1Trichloroethane	51	4	49	4	NR	5	52	3	72	4	ND	0
Esters												
44. Amyl Acetate	110	3	77	4	NR	5	NR	5	158	3	NR	5
45. Ethyl Acetate	24	4	30	4	72	4	5	5	212	2	NR	5
46.Methyl Methacrylate	27	3	NR	5	77	3	NR	5	63	3	NR	5
Ethers												
47. Cellosolve Acetate	228	3	47	4	107	3	64	4	ND	0	NR	5
48. Ethyl Ether	12	5	33	4	11	5	14	5	19	5	29	5
49. Tetrahydrofuran	13	5	5	5	NR	5	NR	5	24	4	NR	5
Gases												
50. Ammonia, Anhydrous	29	2	336	1	4	4	19	3	ND	0	ND	0
51. 1,3-Butadiene	33	3	ND	0	25	3	24	3	473	2	ND	0
52. Chlorine	ND	0	ND	0	ND	0	360	2	ND	0	ND	0
53. Ethylene Oxide	21	4	17	5	1	5	1	5	189	2	48	4
54. Hydrogen Fluoride	210	2	1	5	142	1	1	5	ND	0	6	3
55. Methyl Chloride	84	1	ND	0	52	2	ND	0	ND	0	ND	0
56. Vinyl Chloride	7	4	ND	0	2	4	19	3	268	1	ND	0
Ketones												
57. Acetone	35	3	3	5	9	5	7	5	ND	0	NR	5
58. Methyl Ethyl Ketone	30	3	NR	5	12	5	NR	5	202	2	NR	5
59. MIBK	41	3	5	5	38	4	NR	5	292	2	NR	5
Nitriles												
60. Acetonitrile	65	3	6	5	16	3	24	4	ND	0	NR	5
61. Acrylonitrile	27	3	NR	5	48	3	14	5	ND	0	55	4

Reference: Forsberg and Keith (1989) Chemical Protective Clothing Performance Index Book. John Wiley and Sons.