

LABORATORY SAFETY MANUAL

**CALIFORNIA DEPARTMENT
OF
TRANSPORTATION**

APRIL 2005

This Laboratory Safety Manual is for the testing laboratories of the California Department of Transportation (Caltrans). It has been developed to provide information for assuring safety and maintaining the health of laboratory employees in Caltrans.

It is the policy of Caltrans to ensure that the hazards of all chemicals, equipment, procedures, and testing methods are identified and information concerning these hazards is transmitted to laboratory employees. This policy is implemented through this Laboratory Safety Manual.

It is impossible to adopt standards and procedures that apply to every situation that might arise on the job, but there is no substitute for good judgment and common sense.

This manual sets forth safety and health standards to serve as a guide in the formation of and adherence to safe work practices. In situations where unusual working conditions may exist, additional protection and/or precautions may be designed or required. This document, and the procedures herein, is intended to have a degree of flexibility to accommodate unforeseen or special circumstances.

These guidelines and procedures do not supersede or replace existing State or Federal legislation or regulations and are subject to change and amendment as future experience dictates.

This Laboratory Safety Manual is part of the Caltrans Injury and Illness Prevention Program, which also includes the Caltrans Safety Manual. The Caltrans Safety Manual is available at: http://admin.dot.ca.gov/hr/HEALTHSAFETY/Safety/safetymanual_toc.shtml.

The standards established by this Manual conform to Caltrans safety policy and must be followed by all laboratory employees.

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LABORATORY SAFETY MANUAL

Part A

INTRODUCTION

PART A: INTRODUCTION

1.0 PURPOSE

The purpose of this Laboratory Safety Manual is to provide guidance to employees, supervisors, and managers with the goal of preventing human injury and environmental damage from hazardous chemicals, equipment, procedures, and testing methods used in the Materials Laboratories of the California Department of Transportation (Caltrans).

2.0 SCOPE

This Laboratory Safety Manual is implemented pursuant to Title 8, Section 5191 of the California Code of Regulations. These guidelines and procedures shall be implemented and enforced at all Materials Laboratories in Caltrans, including field construction labs. The Laboratory Safety Manual shall be readily available to all laboratory employees. Caltrans shall review and evaluate the effectiveness of the Laboratory Safety Manual annually and update it as necessary.

3.0 OBJECTIVES

The objectives of the Laboratory Safety Manual are to:

1. Institute a Laboratory Safety Program as outlined by this Manual.
2. Make the Safety Plan readily available to all employees.
3. Institute a Chemical Hygiene Plan (CHP).
4. Provide employee training in safe work practices and laboratory procedures.
5. Inform employees of risks involved in materials testing.
6. Avoid underestimation of risk.
7. Minimize chemical exposures.
8. Ensure that laboratories meet California Building Standards codes and Cal-OSHA regulations.

4.0 RESPONSIBILITIES

4.1 DIRECTOR

The Director of the California Department of Transportation has the ultimate responsibility for safety within Caltrans laboratories. The Director must ensure the development, implementation, enforcement, improvement and continuing support of safety policies within the Materials Laboratories of Caltrans.

4.2 DEPUTY DIVISION CHIEF OF MATERIALS ENGINEERING AND TESTING SERVICES, DIVISION OF ENGINEERING SERVICES

The Deputy Division Chief of Materials Engineering and Testing Services (METS) has the responsibility to:

- Issue and update this Laboratory Safety Manual.
- Appoint a Caltrans Chemical Hygiene Officer.
- Ensure the implementation, enforcement and continuing support for safety policies in all testing laboratories of Caltrans.
- Ascertain that the operation and maintenance of laboratories is in compliance with California Building Standards codes and Cal-OSHA regulations.

4.3 MANAGERS

The District Directors, Deputy District Directors, appropriate Deputy Division Chiefs, District Materials Engineers, and Construction Office Chiefs are responsible for safety in all testing laboratories in each District. The METS Deputy Division Chief and Office Chiefs are responsible for safety in the laboratories within METS. They must ensure the implementation, enforcement and continuing support for safety policies within their respective areas of responsibility.

4.4 LABORATORY SAFETY OFFICERS / CHEMICAL HYGIENE OFFICERS

Each District Materials Engineer (DME) shall appoint a Laboratory Safety/Chemical Hygiene Officer. The current District Laboratory Safety Officer shall be provided additional training and responsibility, and will also serve as the District Chemical Hygiene Officer in accordance with the duties and responsibilities in Part B, Section 4.3 Chemical Hygiene Officer of the Laboratory Safety Manual. The DME shall designate Laboratory Safety Officer's for their materials testing units. The Laboratory Safety Officer shall:

- Work with laboratory managers, laboratory supervisors and other laboratory employees to implement and enforce safety policies within the District or Division laboratories.
- Review and maintain a file of training records, inspection reports, accident or near accident reports, and necessary employee medical clearances for the assigned laboratories.
- Seek ways to improve safety within the laboratories assigned.
- Serve as a resource for employees and managers with safety concerns.
- Conduct regular inspections of laboratories to identify safety and health problems and assist supervisors and managers in initiating any necessary corrective action.
- Organize and conduct annual safety training classes for laboratory employees.
- Communicate and coordinate activities and safety concerns with the appropriate supervisors and managers, District Safety Officer, Office of Health and Safety Services, and Caltrans Chemical Hygiene Officer.
- Review positioning of new laboratory equipment before installation and use.
- Review and approve laboratory layouts.
- Ensure compliance with Americans with Disabilities Act (ADA) requirements.

4.5 CALTRANS CHEMICAL HYGIENE OFFICER (CHO)

METS or other Headquarters functional units shall provide training to the District Laboratory Safety/Chemical Hygiene Officers. The Deputy Division Chief of METS (or other Headquarters functional unit) shall designate a Statewide Chemical Hygiene Officer (SCHO). The duties of the District CHO are outlined in Section 4.3 of the Chemical Hygiene Plan.

4.6 CALTRANS LABORATORY SAFETY COMMITTEE

The Caltrans Laboratory Safety Committee consists of a representative from the Office of Health and Safety Services (HQ Safety Office), Safety Officer for METS, four DMEs and four District Laboratory Safety/Chemical Hygiene Officers (one representative from the North, Central, and Southern Regional Labs and one additional district), and the Statewide Chemical Hygiene Officer. The Division representatives and DME shall serve a 2-year term. They will select from among them a chairperson to serve a 1-year term.

The Committee is responsible for the development and on-going improvement of Caltrans safety polices for Materials Laboratories, as well as:

- Providing advice and recommendations to the Deputy Division Chief of METS regarding safety concerns for the testing laboratories of Caltrans.
- Providing an annual review/update of this Laboratory Safety Manual.
- Organizing an annual Laboratory Safety Training Course for Laboratory Safety Officers.
- Conducting annual laboratory inspections statewide and issuing inspection reports.
- Reviewing the implementation of safety policies.
- Reviewing employee safety concerns and suggestions.
- Assisting with defining specific “laboratory areas” within Caltrans.
- Seeking ways to improve safety practices within the Materials Laboratories of Caltrans.

4.7 DISTRICT MATERIALS ENGINEERS AND OFFICE CHIEFS

District Materials Engineers, District Construction Office Chiefs, and METS Office Chiefs are responsible for the safety in each of their laboratories. This responsibility may not be delegated. They are responsible for implementation and enforcement of this Laboratory Safety Manual.

District Materials Engineers, District Construction Office Chiefs, and METS Office Chiefs have overall responsibility for implementation and enforcement of safety procedures in their laboratories, including:

- Enforcing the Chemical Hygiene Plan (CHP).
- Ensuring that each employee understands how to complete each assigned task safely.
- Ensuring that all staff knows and follows the chemical hygiene rules, physical testing safety rules, and unit safety plans.
- Providing appropriate training for all employees under their supervision in conjunction with the District Laboratory Safety Officer.
- Documenting that the appropriate training has been provided and forwards training records to the Headquarters Laboratory Safety Officer and Statewide CHO annually.
- Providing regular, formal chemical hygiene, safety, and housekeeping inspections including inspections of emergency equipment. (See CHP Section 8.0)
- Determining the required levels of protective apparel and equipment, and ensure that protective equipment is available and in working order.
- Advising management of safety needs of subordinates.
- Ensuring that appropriate training has been provided.
- Encouraging each employee to develop safe and healthy work habits.
- Holding regularly scheduled safety meetings.

Additional duties pertaining to safe practices when chemicals are involved are outlined in Section 5.0 of the CHP.

4.8 RADIATION SAFETY OFFICER

Each District Materials Engineer shall appoint a Radiation Safety Officer who has primary responsibility for implementation and enforcement of the units radiation license. It is the Radiation Safety Officers responsibility to:

- Ensure that radioactive materials are stored, operated, and maintained in compliance with the California Caltrans of Health Services requirements.
- Ensure that all operators of nuclear gauges are trained in the proper use, transportation, and storage of nuclear gauge devices.
- Ensure that all operators of nuclear gauge devices wear film badges when operating or transporting the nuclear gauges.
- Ensure that all nuclear gauge devices are stored using the three-lock system.
- Ensure that all nuclear gauge devices are protected with a minimum 2-hour firewall.
- Maintain all required records for the ownership and storage of nuclear gauge devices.
- Maintain all required records of the radiation exposure of all operators of nuclear gauge devices.
- Ensure all x-ray equipment is registered and operated according to proper procedures.
- Ensure all personnel who may be exposed to radiation sources are properly trained.

Specific duties and responsibilities of the Radiation Safety Officer are outlined in California Test Method 121. (Refer to Part C, Physical Testing, Section 1.34 Nuclear Gauges.)

4.9 LABORATORY WORKER

The responsibility for safety during the execution of a laboratory operation or test procedure lies with the worker. Each laboratory worker is required to:

- Plan and conduct each operation in accordance with the divisional chemical hygiene plan, safety plans and prudent laboratory practices.
- Develop and use good personal hygiene and safety habits.
- Follow the requirements of the Laboratory Safety Manual, Caltrans Safety Manual, and other applicable rules.
- Notify their supervisor of any conditions viewed as unsafe by the employee.
- Wear all required personal protective equipment/clothing.

5.0 HAZARDS AND EMPLOYEE EXPOSURE

5.1 GENERAL SAFETY PRINCIPLES

The following are the most basic guidelines for employee safety and health in Materials Laboratories of the California Department of Transportation (Caltrans).

Every Employee is Responsible for Safety and Health.

- Every manager and supervisor is responsible for the safety and health of the employees he or she supervises. This responsibility and authority cannot be delegated.
- All employees must take every reasonable precaution to prevent accidents and injury to themselves, other employees, and to the public.
- Employees must become familiar with this manual generally, and specifically with those portions that directly apply.
- Report all unsafe conditions or practices immediately to the appropriate supervisor. If the supervisor does not address the issue to the workers satisfaction, report the condition to the appropriate District Laboratory Safety/Chemical Hygiene Officer, District Safety Officer, appropriate manager, and/or the Laboratory Safety Committee.
- Caltrans employees have the right to work in a drug-free work environment. The use of nonprescription drugs and alcohol is prohibited on state property and during working hours in accordance with Deputy Directive 08-R1.
- Where a license is required to operate a vehicle or piece of equipment, employees shall not be allowed to operate the vehicle or piece of equipment

unless they are licensed. Should a required license be suspended or revoked, it is the responsibility of the employee to notify his or her immediate supervisor immediately.

- Where certification is required to operate equipment (e.g., operation of the nuclear gauges), certification will be in compliance with the regulations of the regulatory governmental agency. Employees who have not been appropriately certified shall not be permitted to operate the equipment.
- Every employee shall receive the proper training required to safely operate any vehicle or equipment or to perform a task, before operating vehicles or equipment or performing the work.
- In accordance with Chapter 12 (Personal Protective Equipment) of the Caltrans Safety Manual, employees are personally responsible to use good judgment and wear personal protective equipment as directed, or whenever they are involved in a work activity where they can reasonably be expected to be exposed to a hazard, or where a hazard may cause injury or illness.
- When employees are issued equipment for the first time or when new devices are introduced, the supervisors will provide training as to how and why the equipment must be used.
- Inspect all equipment before use.
- Supervisors will allow employees to try out new personnel protective equipment and/or new devices prior to actual use. Employees should offer their comments and discuss the equipment before the work begins.
- Attend all required safety meetings (field workers every 10 working days, office workers quarterly).
- Every employee, prior to performing any test, shall review and familiarize themselves with the test's Code of Safe Practices and the Material Safety Data Sheets (MSDS) for the materials used in that test.
- No eating, drinking, smoking, gum chewing or application of cosmetics in chemical storage areas or areas designated as laboratories.
- Wash hands thoroughly after working with chemicals and before eating, drinking, or smoking.

- Do not store food or beverages in chemical storage areas, laboratory refrigerators or with glassware or utensils that are used for laboratory operations.
- Do not use laboratory ovens, microwaves, etc., to prepare or heat food.
- Confine long hair and loose clothing during testing or while around moving equipment or machinery.
- Wear closed shoes at all times in laboratory. No sandals.
- Inspect eyewash and deluge shower monthly and note on tag.
- Change laboratory coats, if used, on a regular basis and immediately when one becomes contaminated.

5.2 LABORATORY SAFETY - CHEMICAL

The safety policies regarding laboratory procedures involving chemicals are outlined in Part B - Chemical Hygiene Plan (CHP) of this manual.

5.3 SAFETY - PHYSICAL TESTING

The safety policies regarding laboratory procedures involving physical testing are outlined in Part C - Physical Testing of this manual.

5.4 SAFETY - FIELD OPERATIONS AND TESTING

The safety policies regarding laboratory procedures for field operations and physical testing in field laboratories are outlined in Part B and Part C of this manual and Chapter 12 of the Caltrans Safety Manual, "Personal Protective Equipment."

5.5 SAFETY - OFFICE

The safety policies regarding office procedures are outlined in Chapter 5 of the Caltrans Safety Manual, "Office Worker Safety."

5.6 SAFETY BULLETIN BOARD

Each laboratory shall have a Safety Bulletin Board installed in a conspicuous place in the lab area. This Bulletin Board shall contain all required Safety and Health Notices and information.

Both Cal/OSHA regulations and the Caltrans Injury and Illness Prevention Program have requirements for posting of information.

(For a comprehensive list of required postings, please contact the Office of Health and Safety Services or the District Safety Officer).

LABORATORY SAFETY MANUAL

Part B

CHEMICAL HYGIENE PLAN

PART B: CHEMICAL HYGIENE PLAN

1.0 PURPOSE

The purpose of this Chemical Hygiene Plan (CHP) is to prevent human injury and environmental damage from hazardous chemicals and to minimize exposure to hazardous chemicals used in the laboratories of the California Department of Transportation (Caltrans).

2.0 SCOPE

Part B, Chemical Hygiene Plan of the Laboratory Safety Manual's organization and content follow the recommendations in 8CCR 5191 Appendix A, *Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)*, that were developed by the National Research Council, as well as those contained in 8CCR 5191 Appendix B, *Non-mandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection*. The following requirements and procedures will be followed at all laboratories of the California Department of Transportation. The CHP shall be readily available to all employees. Caltrans shall review and evaluate the effectiveness of the CHP annually and update it as necessary.

3.0 REFERENCES

- General Industry Safety Orders Title 8, Section 5191 (8CCR 5191) of the California Code of Regulations.
- National Research Council, *Prudent Practices for Handling Hazardous Chemicals in Laboratories*, National Academy Press, Washington, D.C., 1981.
- American Conference of Governmental Industrial Hygienists *Threshold Limit Values and Biological Exposure Indices*, Cincinnati, Ohio, 1992-1993 Edition.
- *Improving Safety in the Chemical Laboratory* by Dr. Jay A. Young, Wiley & Sons, 1987.
- National Institute of Occupational Safety and Health (NIOSH) *Pocket Guide to Chemical Hazards*.
- Caltrans Safety Manual .

4.0 RESPONSIBILITIES

4.1 DIRECTOR

The Director of the California Department of Transportation has the ultimate responsibility for chemical hygiene within Caltrans. The Director must ensure the development, implementation, enforcement and improvement of the CHP within Caltrans. The Director must provide continuing support for chemical hygiene throughout Caltrans.

4.2 MANAGERS

The District Director(s), appropriate Deputy District Director(s), District Materials Engineer, and Construction Office Chiefs are responsible for the chemical hygiene in each District. The Chief of the Division of Engineering Services and the Deputy Division Chief and Office Chief's of Materials Engineering and Testing Services (METS) are ultimately responsible for the chemical hygiene in the laboratories within METS. They must ensure the implementation and enforcement of the CHP and safety plans within their respective areas of responsibility. They must provide continuing support for chemical hygiene in all laboratories of Caltrans.

4.3 CALTRANS CHEMICAL HYGIENE OFFICER (CHO)

The Deputy Division Chief of METS shall designate a State Chemical Hygiene Officer (SCHO) for Caltrans. The SCHO shall:

- Work with the laboratory managers, laboratory supervisors, District Laboratory Safety/Chemical Hygiene Officers, and other laboratory employees to develop and implement the CHP.
- Maintain a file of the annual inspection reports.
- Provide standard forms for tracking the procurement, use and disposal of chemicals in Caltrans laboratories.

- Oversee development and maintenance of a Hazardous Materials Management Plan (HMMP) and accompanying Hazardous Materials Inventory Statement (HMIS) for all laboratories within Caltrans in accordance with California Fire Code, Appendix II-E.
- Assist in development of maximum quantities of hazardous materials to be maintained in all laboratories to ensure that quantities of hazardous materials presenting a physical or health hazard are maintained within exempt quantities, if possible, as listed in Title 24, California Building Code, Chapter 3.
- Oversee the proper storage of hazardous materials in all laboratories.
- Serve as a member of the Laboratory Safety Committee.
- Seek ways to improve the Chemical Hygiene Program.
- Serve as a technical resource for all employees on materials related to the CHP.
- Be a technical resource regarding the requirements concerning chemicals and other regulated substances being used in all laboratories in Caltrans.
- Propose periodic updates and revisions to the CHP.
- Participate as an instructor in the Annual Laboratory Safety Training Course.
- Provide training to District Laboratory Safety/Chemical Hygiene Officers.
- Attend an Annual Laboratory Safety Refresher.

4.4 DISTRICT MATERIALS ENGINEERS AND OFFICE CHIEFS

District Materials Engineers, District Construction Office Chiefs, and METS Office Chiefs are responsible for implementation and enforcement of the CHP in their laboratories, including:

- Ensuring that the staff knows and follows the chemical hygiene rules and unit plans.
- Monitoring procurement, use, and disposal of chemicals used in all laboratories in Caltrans.
- Reviewing and maintaining a file of training records, inspection reports, monitoring reports, chemical related accident or near accident reports,

medical clearance records, and tracking records of implementation of corrective actions for all laboratories in Caltrans.

- Documenting that the appropriate training records has been provided and retained.
- Providing regular, formal chemical hygiene and housekeeping inspections including inspections of emergency equipment.
- Monitoring and enforcing chemical procurement, storage, use, and disposal procedures in the laboratories.
- Being familiar with the training requirements of Chapter 16, Hazardous Materials Communication Program, of the Caltrans Safety Manual, and ensure that all laboratory employees using or exposed to hazardous materials are trained as required.
- Ensuring that laboratory employees who work with or are exposed to materials are provided with the appropriate protective and safety equipment. Refer to Chapter 12 of the Caltrans Safety Manual for the responsibilities of employees and supervisors regarding Personal Protective Equipment (PPE).
- Ensuring that facilities and training are adequate for any chemical used or stored in their laboratory, and ensure that appropriate training has been provided.
- Knowing the current policies and procedures of Caltrans as noted in the Caltrans Safety Manual, Chemical Hygiene Plan, Laboratory Safety Guide, and California Test Methods.
- Encouraging each employee to develop good safety habits.
- Ensuring that Emergency Action Plans are in place and the first aid kit is available. Refer to Chapter 9, First Aid and Emergency Medical Treatment, of the Caltrans Safety Manual regarding providing first aid and/or emergency medical treatment for occupational injuries and illnesses.

4.5 LABORATORY WORKER

The responsibility for safety during the execution of a laboratory operation lies with the worker. Each laboratory worker is required to:

- Plan and conduct each operation in accordance with this CHP, the Laboratory Safety Manual, Caltrans Safety Manual, and prudent laboratory practices.
- Develop and use good personal hygiene and safety habits.
- Notify their supervisor and the District Laboratory Chemical Hygiene Officer of any conditions viewed as unsafe by the employee. If the supervisor does not address the condition to the employee's satisfaction, then the condition shall be brought to the attention of the District Safety Officer, appropriate manager, Statewide Chemical Hygiene Officer, and/or Caltrans Laboratory Safety Committee.
- Stop any procedure or process that is viewed as unsafe.

5.0 SAFE LABORATORY PRACTICES

5.1 GENERAL SAFETY PRINCIPLES

5.1.1 Minimize All Chemical Exposures

All prudent efforts shall be taken to minimize chemical exposures. Engineering controls (ventilation systems, laboratory hoods, remote handling systems, etc.), Administrative controls (limited use of materials, substitution of less hazardous materials, procurement controls, proper handling procedures, appropriate training, etc.), and personal protective equipment (PPE) will be used to minimize employee exposure to all chemicals. Wear gloves, aprons, and face/eye protection when possible to prevent skin contact. Use the least toxic chemical that the task requires. The use of listed carcinogens or other highly toxic chemicals shall be avoided if at all possible. Test methods requiring these chemicals shall be reviewed to determine if a less toxic compound can be used. Solvents such as benzene, acetone, xylene, or trichloroethylene should not be used for routine cleaning purposes. Protective equipment shall be worn in accordance with Chapter 12 of the Caltrans Safety Manual.

Section 5.1 contains General Safety Principals. Wearing of gloves and other personal protective equipment or devices is discussed in Section 5.2.12.

5.1.2 Know the Hazards and Risks of the Chemicals

It is the responsibility of each person to:

- Learn the potential hazards of each chemical they use.
- Avoid underestimating chemical risks.
- Assume that any mixture will be more toxic than its components.
- Assume that all unknown substances are toxic.
- Know and follow proper safety precautions.

5.1.3 Use Adequate Ventilation

The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by using hoods and other ventilation devices to capture the contaminants and remove them from the laboratory. Use of hoods and other ventilation devices is discussed in Section 5.2.15. Discussion of laboratory ventilation guidelines and requirements will be found in Section 10.2 Laboratory Ventilation, Fume Hoods, and Local Ventilation Devices.

5.1.4 Use Personal Protective Equipment

Use appropriate personal protective equipment to prevent eye and skin contact with chemicals.

5.1.5 Observe the Exposure Limits

The permissible exposure limits (PELs) established by Cal-OSHA and the threshold limits values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH) shall not be exceeded.

5.2 STANDARD OPERATING PROCEDURES

Use the following procedures whenever working with chemicals or conducting materials testing:

- Read instruction manuals for equipment and test methods, and all applicable MSDSs before beginning a new procedure, test method or operation. Review manuals and MSDSs regularly if the procedure, test method, or operation is familiar.
- Know the health and physical hazards and symptoms of exposure for chemicals before handling them.
- Have the necessary laboratory equipment, safety equipment, and personal protective equipment in place and in use before starting work.
- Know the location of the nearest emergency eyewashes and showers. Be sure they are accessible and operational.
- Know how to handle spills and emergencies prior to beginning the procedure. Make sure proper decontamination and containment materials are readily available in the work area prior to chemical handling.

5.2.1 Accidents and Spills

Note: The following requirements are meant for general application to all chemical incidents. If they conflict with the applicable MSDS, follow the MSDS for the specific material involved.

- Eye contact: Promptly flush eyes with water for a prolonged period (at least 15 minutes) and seek medical attention.
- Ingestion: Follow the MSDS. Call Poison Control. Seek medical attention.
- Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. Wash the area with soap and water to remove contamination. If symptoms develop or persist after washing, seek medical attention.

- Clean up: Follow the MSDS. Promptly clean up spills wearing appropriate protective apparel and equipment. Dispose of the waste properly.

5.2.2 Avoid “Routine” Exposure

- Develop and encourage safe chemical handling habits.
- Avoid unnecessary exposure to chemicals by any route.
- Do not smell, taste, or allow chemicals to touch your skin.
- Plan work with chemicals to minimize exposure. Whenever possible, conduct laboratory procedures or testing that releases hazardous materials under a laboratory exhaust hood. If this is not possible, use a local exhaust system or other means to control and remove the hazardous contaminants from the lab.
- Vent laboratory apparatus that may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into an exhaust hood or other appropriate exhaust devices.
- Inspect protective equipment before use. If relying on a ventilation system for protection, ensure system is operating properly before starting work.
- Wear all required Personal Protective Equipment (PPE).
- Clean and store PPE properly after use.

5.2.3 Choice of Chemicals

Whenever possible, select the chemicals that will be used based on minimizing exposure. Use chemicals with lower evaporation rates and vapor pressures. Determine if the available ventilation system is adequate to control exposures. See Section 10.2 for ventilation system guidelines and requirements.

5.2.4 Compressed Gases

The following safety procedures will be followed when compressed gases are used in the laboratory:

- Compressed gas cylinders containing toxic gases shall be used only in an operating chemical fume hood. They shall be stored in a location secure from tampering.
- All compressed gas cylinders (regardless of size) shall be chained to the wall or otherwise held in place to prevent tipping or damage to the neck, valve, and regulator.
- All compressed gas cylinders with a water weight capacity over 30 pounds shall be equipped with a means for connecting a valve protection device or with a collar or recess to protect the valve.
- All compressed gas cylinders equipped for a valve protection device will have a valve cap installed when not in use.
- Compressed gas cylinders will be stored in well-protected, well-ventilated, dry locations at least 20 feet from highly combustible materials such as oil or excelsior. Oxygen cylinders shall never be stored near oil or grease or other combustible materials.
- Compressed gas cylinders shall be stored in a location where they will not be tampered with by unauthorized persons.
- Compressed gas cylinders shall not be stored in unventilated locations such as cupboards or lockers. Exception: Fire suppressant gases.
- Unless secured in a special rack or truck, remove regulators and install protective caps, when provided for, before moving cylinders.
- Close cylinder valves when empty, before moving cylinders, and when work is finished.

- Cylinders shall not be dropped or struck or allowed to hit each other violently.
- Cylinder valves not equipped with fixed hand wheels shall have keys or handles on valve spindles or stems while cylinders are in service. If multiple cylinders are connected to a manifold, only one key or handle is required.
- Leaking regulators, cylinder valves, hose, piping systems, apparatus or fittings shall not be used. Do not attempt to repair or fix cylinder valves.
- Cylinders shall not be used as rollers or supports, whether full or empty.
- Cylinders must not be placed where they might form part of an electrical circuit.
- Never use a cylinder's contents for purposes other than those intended by the supplier.
- Never allow acetylene to come in contact with unalloyed copper, except in a blowpipe or torch.
- When flammable lines or other parts of equipment are being purged of air or gas, open lights or other ignition sources will not be allowed near uncapped openings.
- All compressed gas cylinders will be legibly marked with their contents.
- Cylinders shall not be stored on their side, unless approved for that use.

5.2.5 Eating, Drinking, Smoking, etc.

To minimize the potential for eating/drinking hazardous materials, the following procedures will be followed in all Caltrans laboratories:

- No eating, drinking, smoking, gum chewing, or application of cosmetics in areas where chemicals are stored or used.

- Wash hands and face after working with or around chemicals and before eating, drinking, smoking, using the restroom, applying cosmetics, or leaving the facility.
- Do not store, handle, or prepare food or beverages in refrigerators, glassware, utensils, microwaves, ovens, cabinets, sinks, countertops, tables, or other locations which are also used for laboratory operations. Food and drink is permitted only in designated eating, preparation, and food storage locations within the lab.
- Do not enter designated eating, preparation, and food storage areas wearing contaminated clothing or with contaminated laboratory tools or equipment. If in doubt, remove or clean equipment and clothing before bringing it into these areas.

5.2.6 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 designed purpose. Do not use jury-rigged or makeshift devices or equipment.
- Do not use equipment without safety guards and devices in place and operational.
- Always follow manufacturer's instructions.
- Do not operate equipment or machinery unless trained to do so. If unsure, ask supervisor for direction before proceeding.

5.2.7 Decontamination

To minimize the hazard of residual chemicals, always cleanup your work area after completing test procedures or laboratory work. Wipe up any spills or waste

material and dispose of properly. Clean tools and containers that may be contaminated before putting them away. Clean any protective equipment that may have been contaminated and store properly. After protective equipment has been removed, check personal clothing for contamination. Remove or neutralize contamination or contaminated clothing before leaving the laboratory or going home. Always wash face and hands before leaving.

5.2.8 Horseplay

Avoid practical jokes or other behavior that might confuse, startle or distract another worker. Never use laboratory chemicals, materials, or equipment for practical jokes or horseplay.

5.2.9 Mouth Suction

Do not use mouth suction for pipettes or starting a siphon.

5.2.10 Personal Apparel

To minimize the hazards of entanglement or chemical contamination the following personal apparel rules will be followed:

- Confine long hair, necklaces, neckties, and other loose clothing that could get caught in moving equipment or be contaminated with chemicals.
- Remove jewelry, rings, earrings, watches, and other personal items that will interfere with the use of protective equipment or could get caught in equipment.
- Appropriate shoes will be worn at all times in the chemical and material handling and storage areas of the laboratory. Sandals, flip-flops, or open toed shoes are not allowed, especially in the chemistry laboratory. (NOTE: Refer to Chapter 12.22 “Foot Protection” in the Caltrans Safety Manual for additional guidance.)

5.2.11 Personal Housekeeping

- Keep the work area clean and uncluttered.
- Keep chemicals and equipment properly labeled and stored.
- Cleanup the area on completion of an operation or at the end of the day.

5.2.12 Personal Protective Equipment (PPE)

- Assure that appropriate eye protection (ANSI approved safety glasses or goggles.) is worn by all persons, including visitors, where chemicals or hazardous materials are stored or handled. (NOTE: See the Caltrans Safety Manual, Chapter 12 for additional guidance.)
- Wear appropriate gloves when the potential for contact with hazardous materials exists; inspect the gloves before each use, clean them before removal, and replace them periodically. Refer to MSDSs for guidance on appropriate gloves for a specific chemical or material.
- Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls. Inspect the respirator before use. Respiratory usage requires an annual medical exam, fit testing, and training.

Note: Respiratory usage must comply with the Caltrans Respiratory Protection Program, Chapter 15 in the Caltrans Safety Manual.

- Use any other protective and emergency apparel and equipment as appropriate.
- Avoid use of contact lenses in the laboratory unless necessary. If they are used, inform supervisor so special precautions can be taken. Those that wear contact lenses must also wear appropriate eye and face protection devices in a hazardous environment. It

should be recognized that dusty and/or chemical environments may represent an additional hazard to contact lens wearers.

- Change laboratory coats on a regular basis and immediately when one becomes contaminated.

5.2.13 Planning

- Seek information and advice about hazards.
- Plan appropriate protective procedures.
- Plan positioning of equipment before beginning any new operation.
- Seek prior approval for operations that are described in Section 5.5.

5.2.14 Unattended Operations

- Leave lights on.
- Place an appropriate sign on the door.
- Provide for containment of hazardous substances in the event of failure of a utility service (such as cooling water) to an unattended operation.

5.2.15 Use of Hood

- Use a hood for operations that might result in release of hazardous chemical vapors or dust.
- Use a hood or other local ventilation device when working with any appreciably volatile substance.
- As a rule of thumb, use a hood whenever you can see or smell a chemical, but remember that some chemicals, such as isocyanates have a permissible exposure limit below the level which we can smell. Therefore, learn the hazards first.
- Before use, confirm adequate hood performance to an average of 100 linear feet per minute (lfm) with a minimum of 70 lfm at

any point; keep hood closed at all times except when adjustments within the hood are being made; and, keep materials stored in hoods to a minimum and do not allow them to block vents or air flow. Record the type of device used to perform the measurement and when the data was collected.

- Leave the hood “on” if hazardous substances are stored in it or if uncertain whether adequate general laboratory ventilation will be maintained when the hood is off.

5.2.16 Vigilance

Be alert to unsafe conditions and see that they are corrected when detected.

5.2.17 Waste Disposal

Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (CHP) per Part B, Sections 5.4.3 and 14.0 of this Laboratory Safety Manual.

5.2.18 Visitors

All visitors allowed into the work area shall wear appropriate safety equipment.

5.3 ADDITIONAL PRUDENT LABORATORY PRACTICES

Part C of this Laboratory Safety Manual lists additional general laboratory safety precautions that should be followed by all laboratory workers and visitors. This list should be reviewed with new employees prior to starting work in the laboratory.

5.4 PROCEDURE FOR WORKING WITH PARTICULARLY HAZARDOUS MATERIALS

If it becomes necessary for laboratory workers to handle particularly hazardous substances, such as “select carcinogens,” reproductive toxins and substances that have a high degree of acute toxicity, then the following procedures should be implemented.

5.4.1 Personal Hygiene

Prior to procuring a particularly hazardous material from any source, laboratory personnel must prepare a detailed plan. The plan must be approved by the District Materials Engineer or by METS (preferably with review by the State CHO before any work can commence). The plan shall cover:

- Why the material is necessary and what information will be gained from the experiment.
- Setting up the apparatus.
- Conducting the test or experiment.
- Handling the subject material during the test or experiment including required safety equipment and personal protective equipment.
- Decontamination of apparatus and materials after the test.
- Removal and disposal of any particularly hazardous materials from the laboratory after completion of testing.

The plan must be approved by the District Materials Engineers or by METS preferably with review by the State CHO before any work can commence.

5.4.2 Work Areas

Work areas shall be equipped with properly operating fume hoods, glove boxes, or equivalent containment devices.

- Work areas will be cordoned off in an acceptable manner and appropriate warning signs, visible from at least 20 feet; will be posted when particularly hazardous material, or any residue thereof, is in the area.
- Fume hoods, vacuum systems, and other fluid-train systems must be equipped with appropriate traps, scrubbers, or filters to prevent discharge of carcinogens or potential carcinogens into the environment.
- Selection and arrangement of the traps shall be determined by Laboratory personnel.
- Generally vacuum systems and fluid-train systems will be vented into the fume hood.
- Fume hoods are to be inspected once a year or at more frequent intervals as required.
- It is the responsibility of the personnel using the hood to ensure that it is functioning properly before beginning testing. As a minimum the door of the fume hood should be drawn to within 1-inch of closure and proper draft ensured by placing a strip of paper in the opening.
- Nonessential personnel shall not be permitted access to a restricted area unless they comply fully with all requirements for protective equipment.

5.4.3 Waste Disposal

- Waste shall be placed in clearly labeled containers appropriate for such containment.
- Reaction residues, toweling, etc., shall be placed in a separate container clearly labeled and approved for such containment.
- Containers shall be removed from the laboratory and properly disposed of as soon as possible after completion of testing and subsequent cleanup.

- Containers which must be kept in the laboratory overnight, shall be placed in a locked room designated and approved for overnight storage of such materials.
- A sign stating that particularly hazardous materials are being stored in the room must be posted in the area and be clearly visible to personnel approaching the room whenever such materials are contained therein.

5.5 PRIOR APPROVAL

Employees must obtain approval from the laboratory supervisor prior to proceeding with a laboratory task whenever:

- A particularly hazardous chemical will be used (see Section 5.4).
- A new laboratory procedure or test is to be carried out.
- It is likely that toxic concentrations could be exceeded or that other harm is likely.
- There is a change in a procedure or test, even if it is very similar to prior practices. Change in a procedure or test means:
 - a. A 10% or greater increase or decrease in the amount of one or more chemicals used.
 - b. A substitution or deletion of any of the chemicals in a procedures.
 - c. Any changes in other conditions under which the procedure is to be conducted.

5.6 NOTIFICATION

Employees must notify the laboratory supervisor when:

- There is a failure of any of the equipment used in the process, especially safeguards such as fume hoods or clamped apparatus.
- There are unexpected results.
- Members of the laboratory staff become ill, suspect that they or others have been exposed, or otherwise suspect a failure of any safeguards.

6.0 CHEMICAL PROCUREMENT, DISTRIBUTION, AND STORAGE

6.1 PROCUREMENT

6.1.1 Guidelines for Ordering and Receiving Routine Chemicals

- Personnel should check the laboratory inventory prior to initiation of a purchase requisition.
- Order chemicals in small containers to avoid the hazards associated with repackaging.
- Order only the amount that shall be needed.
- All chemicals shall be received at the loading dock and handled with care by employees after reviewing the MSDS.
- No container should be accepted without an adequate identifying label, which includes identity of chemical, appropriate hazard warnings, and manufacturer's name and address.
- Receiving room personnel shall be trained in the physical handling and emergency procedures for hazardous chemicals during unloading, storage, and transport.

6.1.2 Guidelines for Ordering and Receiving "New" Chemicals

When a new chemical is ordered, it is the responsibility of the requester to ensure that:

- The laboratory facilities are adequate to handle the chemical.
- The necessary safety equipment is obtained.
- Those who will handle the material have the proper safety training.
- Receiving room personnel are notified that a new substance is being ordered and advised of any special handling or storage requirements.

- An MSDS is available to anyone who will be involved with the material.

6.1.3 Responsibility for Labeling Chemicals

Upon receipt of a chemical, the originator of the purchase requisition is responsible for assuring that the chemical has an appropriate National Fire Protection Association (NFPA) label which rates health, flammability, and reactivity on a scale of 0 to 4. This label should also identify any special properties, such as carcinogenicity, extreme toxicity, reactivity with water, Proposition 65 listing, etc.

If not listed on the reagent bottle, this data may be obtained from the MSDS and Section 11.3 of this CHP or the Chemical Hygiene Officer.

6.2 DISTRIBUTION

The hazards associated with each material will dictate the specific handling procedure. Generally when transporting chemicals they should be in a secondary container to protect against breakage. Avoid transporting large quantities of hazardous materials in one trip. Transport of a hazardous material shall be done by a licensed contractor.

6.3 STOCKROOMS/STOREROOMS

Laboratories using large quantities of hazardous chemicals should have a separate, ventilated storage area for those materials. It should be near the working area and accessible to authorized personnel only. Care should be taken to assure that incompatible chemicals are not stored together.

One person should be responsible for the safety and inventory of each stockroom. An inventory shall be maintained and updated at least annually.

Stockrooms should not be used as preparation or transfer locations.

Secondary containment is required in satellite storage areas for hazardous waste.

6.4 LABORATORY STORAGE

All containers used to store chemicals regardless of their construction type must be labeled with appropriate NFPA and Proposition 65 labels as described in Section 11.0. Exceptions to this guideline are beakers and glassware used in an immediate laboratory determination. It is advised that all glassware be clearly labeled as to chemical content during any phase of a determination.

Each laboratory should have designated storage areas for all chemicals routinely used. Chemicals stored in this area should be segregated on the basis of chemical compatibility. All flammable solvents should be stored in metal fireproof cabinets well away from potential heat sources. Strong acids and bases should be separated into different cabinets or compartments. Only compatible materials are to be stored together.

After each use, the chemicals should be returned to this area and not stored on bench tops or in fume hoods. The amounts stored in laboratory areas should be kept to a minimum, within exempt quantities, if possible, as listed in the California Building Code, Chapter 3, and inventoried at least annually.

Properly dispose of any chemicals that have deteriorated, are improperly labeled, or are in damaged containers. Unneeded items should be returned to the stockroom only if useful to others.

7.0 ENVIRONMENTAL MONITORING

Personal air sampling shall be performed at least one time in the areas where there is reason to believe the exposure exceeds recognized safe limits. Unless the operations change, no further monitoring is necessary if the results are less than one half the permissible exposure limits listed in CCR Title 8, General Industry Safety Orders Section 5155. The written results of the monitoring shall be available no later than 15 days after they are received.

The Caltrans Office of Safety and Health is responsible for maintaining a statewide contract to perform the monitoring of records. The records shall be maintained by the District Materials Engineers, District Construction Office Chiefs, and METS Office Chiefs.

8.0 LABORATORY INSPECTIONS

8.1 INITIAL INSPECTIONS

The “initial” laboratory designation inspections shall be a team effort conducted by two Laboratory Safety Officers, the Headquarters Chemical Hygiene Officer or the appropriate METS Office Chief.

OBJECTIVES:

- Define designated lab areas.
- Check safety equipment.
- Review the maintenance and enforcement of lab safety procedures.
- Define and suggest procedures for informal and formal quarterly inspections.

8.2 DAILY INSPECTIONS

The laboratory should be visually inspected on a continual basis. Supervisors and workers should be inspecting their laboratories daily.

8.3 MONTHLY INSPECTIONS

Safety equipment, as well as personal protective equipment, shall be inspected monthly and documented. The documentation can take the form of an inspection log. Typical equipment that should be inspected includes eyewashes, safety showers, first aid kits, respirators, fire extinguishers, etc.

8.4 FORMAL QUARTERLY INSPECTIONS

The formal quarterly inspection shall be conducted by the DME Safety Officer and supervisor. The checklist in Appendix A may be used for this inspection. Document any problems and note time frame to make corrections. A written report will be kept on file by the Laboratory Safety Coordinator and shall be required documentation at the formal yearly inspection. A copy of the quarterly report shall be sent to the CHO. The CHO shall forward copies to the Laboratory Safety Committee and the appropriate District/Headquarters Safety Office.

8.5 FORMAL YEARLY INSPECTIONS

Initiated by METS. The formal yearly inspection shall be conducted by representatives of METS (i.e., State Chemical Hygiene Officer) and the DME. The inspection will be unannounced. There will be specific items checked. The Statewide Laboratory Mitigation Plan Checklist shall be used. All deficiencies and time to correct shall be documented. The DME or the METS Office Chief shall sign and be given a copy of the inspection report. The State Chemical Hygiene Officer (SCHO) shall maintain all yearly inspection reports. The SCHO shall send copies of the yearly inspection to the appropriate District/Headquarters Safety Office or consultants hired by METS.

9.0 MEDICAL CONSULTATION AND EXAMINATIONS

All employees who work with hazardous chemicals have the opportunity to receive medical attention, including any follow up examinations that the examining physician deems necessary, under the following circumstances:

- Whenever the employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed.
- When exposure monitoring reveals levels routinely above the action level (or PEL) for an OSHA regulated substance for which there are medical and surveillance requirements.
- Whenever an event takes place in the work area such as a spill, leak or explosion that results in the likelihood of exposure to hazardous chemicals, the affected

employee shall be provided the opportunity for a medical consultation to determine the need for a medical examination.

All medical examinations and consultations shall be performed by or under the supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place. The DME, in consultation with the District Safety Officer and HQ SCHO, shall provide the physician with information about the hazardous chemical to which the employee may have been exposed, the circumstances under which the exposure occurred, and a description of any signs or symptoms of exposure. The DME supervisor in consultation with the District Safety Officer shall obtain the physicians written opinion that should include a description of the medical examination and test results. Recommendation for further follow up, medical conditions that place the employee at increased risk due to exposure to a laboratory chemical, a statement that the employee has been informed by the physician of the results of the consultation that may require further examination or treatment. The report shall not reveal specific findings of diagnosis unrelated to occupational exposure.

Caltrans policy shall also be followed, and the DME supervisor and District Safety Officer shall be notified when an employee is taken to a physician.

In accordance with CCR Title 8, General Industry Safety Orders, Section 3204, such records shall be kept for the duration of employment plus 30 years.

10.0 PERSONAL PROTECTIVE APPAREL AND EQUIPMENT

Each laboratory worker should know the location and proper use of safety and emergency equipment, and personal and protective apparel and equipment.

10.1 LABORATORY FACILITY

Each lab should have:

- Appropriate ventilation (i.e., fume hoods or other local ventilation devices.)

- Appropriate chemical storage facilities.
- Appropriate safety equipment including eyewash fountains (within 10 seconds), drench showers, and fire extinguishers.
- A nearby fire alarm and telephone for emergency use.
- Appropriate personal protective equipment; gloves, safety glasses, aprons, etc.
- Respirators, which will be provided in accordance with Chapter 15 of the Caltrans Respiratory Protection Program, if they are required.
- Other items designated by the laboratory supervisor.

10.2 LABORATORY VENTILATION, FUME HOODS, AND LOCAL VENTILATION DEVICES

A laboratory fume hood should be provided for operations using strong solvents, acids, toxic chemicals, or hazardous materials.

- The use of a fume hood is advisable when working with chemicals.
- Fume hoods shall provide an average of 100 linear feet per minute (lfm) with a minimum of 70 lfm at any point and should be checked on a monthly basis.
- All apparatus inside the hood should be placed at least 6 inches from the front edge.
- Steps should be taken to prevent drafts from entering or crossing an operative hood. Such air currents can disrupt hood flow patterns resulting in a release of the contaminants the hood is attempting to contain.
- Large bulky items inside a hood should be elevated to allow air passage under the object.
- Hoods should be periodically inspected and cleaned to ensure proper operation.
- Fume hoods should not be used as a permanent storage area for chemicals.

- Airflow readings shall be measured annually to assure proper velocity. Records of such tests shall be maintained for at least 5 years.

Other local ventilation devices, such as ventilated storage cabinets, canopy hoods, snorkels, etc., can sometimes be substituted for fume hoods. See the laboratory supervisor for specifics.

The Cal-OSHA laboratory regulations (8 CCR 5191) Appendix A contain ventilation recommendations which need to be followed at Caltrans laboratories and are reprinted here for reference:

4. Ventilation –
 - (a) General laboratory ventilation. This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).
 - (b) Hoods. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201-206 for a discussion of hood design, construction, and evaluation.
 - (c) Other local ventilation devices. Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).
 - (d) Special ventilation areas. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before

release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).

- (e) **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 (12, 193, 204).
- (f) **Performance.** Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).
- (g) **Quality.** General airflow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194, 195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60-100 fpm) (200, 204).
- (h) **Evaluation.** Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

10.3 RESPIRATORS

The reduction of exposure from airborne contaminants should be accomplished wherever possible by engineering control measures such as enclosure or local ventilation. When such measures are impractical, or while they are being instituted, respirators can be used to reduce worker exposure once the worker passes the required physicals. Each laboratory shall follow the Caltrans Respiratory Protection Program shown in Chapter 15 of the Caltrans Safety Manual.

10.4 PROTECTIVE APPAREL

Protective apparel should be available which is compatible with the required degree of protection for the substances being handled. Examples of protective apparel include lab

coats, chemical resistant gloves, heat resistant gloves, safety glasses, goggles, face shields, hearing protection, etc.

11.0 SIGNS, LABELS, AND HAZARD IDENTIFICATION

Signs and labels help communicate important health, safety, and chemical hazard information to employees. Caltrans shall utilize the National Fire Protection Association (NFPA) hazard labeling system.

Whenever chemicals are being used in the workplace, it is the responsibility of every worker to:

- Read labels before handling container and follow their warnings.
- Make sure that every container of a chemical has a label.
- Report missing, dirty, or illegible labels so they can be replaced.
- Put labels on transfer containers for all chemicals.
- Ask the laboratory supervisor about any label information that is not understood.

11.1 SIGNS

Prominent signs of the following types should be posted:

- Emergency telephone numbers.
- Location signs for safety showers, eyewash stations, other safety and first aid equipment, fire extinguishers, exits, and areas where food and beverage consumption and storage are permitted.
- Warnings at areas or equipment where special or unusual hazards exist.
- Warnings that unauthorized personnel are not allowed in the laboratory, and that safety equipment (safety glasses as necessary) are required in the laboratory.

11.2 LABELS

Each original container of chemicals in the workplace is to be labeled, tagged, or marked with information giving the identity of the chemical, the appropriate hazard warnings, and the name and address of the manufacturer. The identity can be any chemical or common name designated

for the individual chemical or mixture, as long as the term used is the same as on the MSDS.

If the manufacturer's label lists the hazard codes on the container, no other label is required. If the chemical is transferred to another container, it is to be relabeled with the correct ID and hazard code.

Use a MSDS and/or other published data to assign the appropriate values (0, 1, 2, 3, 4) for each of the three NFPA hazard categories (Health, Fire, Reactivity). The value 0 corresponds to minimal hazard and 4 to extreme hazard.

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

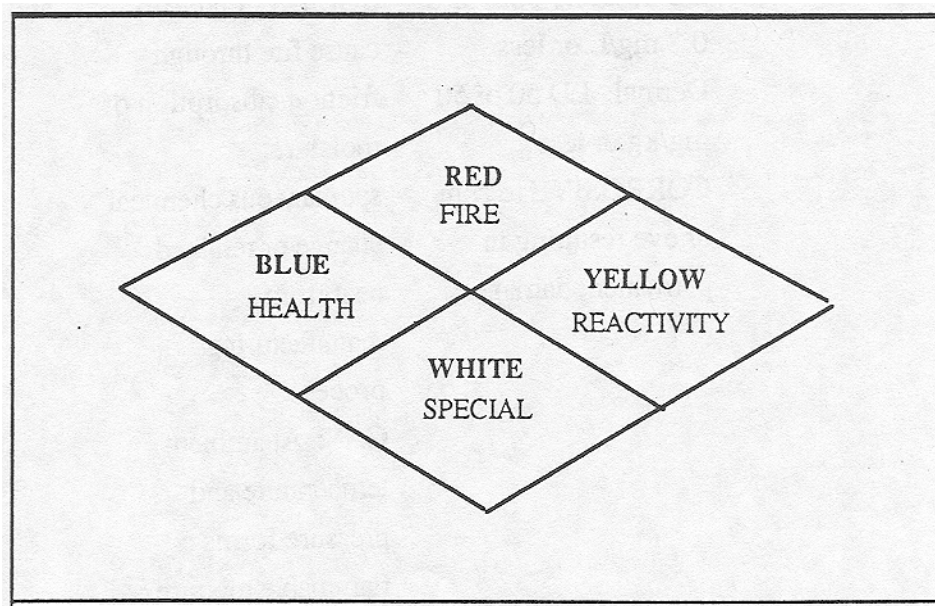
11.3 HAZARD IDENTIFICATION

A chemical shall be considered hazardous if it poses a physical hazard, health hazard, or is listed on the Cal-OSHA Director's List of Hazardous Substances. Employees exposed to hazardous chemicals should refer to Appendix D for a list of some signs and symptoms of overexposure. It is important to realize that the determination of occupational health hazards is complicated by the fact that symptoms occur commonly in non-occupationally exposed populations.

11.3.1 Hazard Codes and Labeling (NFPA)

Using a MSDS and/or other published data, appropriate values (0, 1, 2, 3 or 4) are assigned for each of the other three NFPA hazard categories: Health, Fire, and Reactivity.

Health = BLUE
Fire = RED
Reactivity = YELLOW
Special = WHITE



NFPA Label

0 = Minimal Hazard
 1 = Slight Hazard
 2 = Moderate Hazard
 3 = Serious Hazard
 4 = Extreme Hazard

Special Hazards

C = Chronic Health
 W = Water Reactive
 X = Oxidizer

Note: Proposition 65 chemicals will have the letter C in the white diamond to identify a carcinogen or reproductive hazard.

The following criteria define the numerical value to be assigned in each hazard category of the label.

HAZARD RATING #	HEALTH CRITERIA	FLAMMABILITY CRITERIA	REACTIVITY CRITERIA
3 Serious Hazard	<p>ORAL: LD 50 of 5 to 50 mg/kg.</p> <p>INHALATION: LC 50 of 20 ppm to 200 ppm or LC 50 of between 0.2 mg/L and 2 mg/L</p> <p>DERMAL: LD 50 between 50 mg/kg and 200 mg/kg</p> <p>CORROSIVE: To skin or eye resulting in permanent damage</p>	<p>LIQUIDS: Flash point between 73°F and 100°F or flash point of less than 73°F and a boiling point at or above 100°F.</p> <p>SOLIDS: When ignited, burns vigorously and persistently</p>	<p>READILY Capable of Detonation or explosive reaction but requires a strong initiating source or must be heated under confinement before initiation.</p> <p>EXPLOSIVE: Reacts explosively.</p> <p>STRONG OXIDIZING</p>

HAZARD RATING #	HEALTH CRITERIA	FLAMMABILITY CRITERIA	REACTIVITY CRITERIA
2 Moderate Hazard	<p>ORAL: LD 50 of 50 to 5 mg/kg.</p> <p>INHALATION LC 50 between 200 ppm to 2000 ppm or LC 50 between 2 mg/L and 20 mg/L.</p> <p>DERMAL: LC 50 between 200 between 200 mg/kg and 1000 mg/kg</p> <p>Severely irritating to skin or eyes.</p> <p>MILD SENSITIZER</p>	<p>LIQUIDS: Flash point at or above 100°F and below 200°F</p> <p>SOLIDS: Readily emits flammable vapors.</p>	<p>NORMALLY UNSTABLE and Readily undergoes Violent chemical change but does not detonate.</p> <p>MAY REACT Violently with water or form potentially explosive mixtures with water.</p> <p>MODERATE OXIDIZER</p>

HAZARD RATING #	HEALTH CRITERIA	FLAMMABILITY CRITERIA	REACTIVITY CRITERIA
1 Slight Hazard	ORAL: LD 50 of 500 to 2000 mg/kg. INHALATION: LC 50 between 2000 ppm and 20,000 ppm; LC 50 between 20 mg/L and 200 mg/L. DERMAL: LD 50 between 1000 mg/kg and 2000 mg/kg. Moderately irritating to skin and eyes. WEAK SENSITIZER. NUISANCE PARTICULATES Listed in current Edition of ACGIH TLVs.	LIQUIDS: Flash point at or above 200°F SOLIDS: Must be preheated before ignition occurs.	NORMALLY STABLE Materials that could become unstable at elevated temperatures and pressures. May also react with water but not violently. WEAK OXIDIZER

HAZARD RATING #	HEALTH CRITERIA	FLAMMABILITY CRITERIA	REACTIVITY CRITERIA
0 Minimal Hazard	ORAL: LD 50 of 2001 mg/kg or Greater. INHALATION: LC 50 of greater than 20,000 ppm or 200 mg/L. DERMAL: LD 50 Of 2001 mg/kg or greater. MILD IRRITANT	MATERIALS that will not burn. SOLIDS: Nonflammable under normal conditions	STABLE Normally stable Even under fire exposure conditions. NON WATER REACTIVE NONOXIDIZING

Special Hazards: C = Chronic Health Hazard
W = Water Reactive
X = Oxidizer

12.0 SPILLS, ACCIDENTS, AND EMERGENCIES

12.1 SPILLS

Each laboratory shall implement a spill control procedure. This procedure should include the following:

- Prevention:** Storage, inspection, and training.
- Containment:** Engineering controls, spill kits, and training.
- Clean up:** Equipment and skilled response team.
- Reporting:** Internally and externally when required by state and/or federal regulations (see appropriate Safety Officer).

12.1.1 Large Spills or Hazardous Material Spills

If a spill of more than one gallon or any quantity of hazardous material occurs:

- Notify your supervisor and others nearby.
- Quickly assess the situation – depending on the nature of the spill, an evacuation of the immediate area may be necessary.
- Call 911 – if necessary.
- Close doors to keep others out of contaminated area.

Do not attempt to clean up spill unless it is an innocuous material that can be mopped or broomed up. When a large discharge to a floor drain occurs, the local treatment plant may need to be contacted. If the spill cannot be cleaned up safely with available resources and safety equipment, call a spill contractor or other specialist.

Do not attempt to clean up of even small amounts of toxic volatile solvents such as benzene and trichloroethylene.

- Turn on fume hoods.
- Evacuate the area.
- Allow the local ventilation system to clear the area.

Chemicals that require decontamination – refer to the MSDS of each chemical for the decontamination protocol.

12.1.2 Routine Spills - Gallon or Less Quantities

Wear protective clothing such as gloves, safety glasses and lab coats or aprons. If strong fumes are encountered or if symptoms of exposure are experienced, stop clean up, evacuate the area, notify supervisor and determine appropriate action.

Determine Type of Spill

The most common categories of spills include acids, bases, and aird solvents. Each category of spill has a specific material used in the clean up process. It is necessary to know the type of spill so the proper clean up material is used.

If it is not known what is spilled, check the spill area for any information that will help identify the spill, such as broken glass or overturned containers. These might have a label on them that will identify the spill.

If no such information is available, check the pH of the spill using wide range pH paper. If the pH is less than 5, use an acid spill kit and if it is above 9, use a base spill kit. Water solutions pH 5-9 can be absorbed with a sponge while wearing rubber gloves.

Cleaning the Spill Area

Stop the spill from spreading if possible, but do not step into spill area. Turn ventilation on (fume hoods, etc.). Turn off heating and air conditioning systems to prevent the distribution of fumes.

- **Acid Spills** - Apply the acid neutralizing material to the spill area from the perimeter inward. Make sure to apply enough to cover the spill sufficiently. Foaming will occur, which indicates neutralization is occurring. Note the color of the slurry formed.

Red/Pink	Acidic (Hazardous)
Yellow	Acidic (Hazardous)
Blue/Green	Safe

If any color other than the blue/green appears, add water and more neutralizing material until a blue/green color appears.

Place the slurry and any materials used in the clean up in bags provided in the kit. Label bag and dispose of in the dumpster as non-hazardous solid waste.

- **Basic Spills (Caustic Spills)** - These spills can give off irritating fumes, so the area must be properly ventilated, and a respirator is recommended. Neutralization of bases produces heat so allow time for it to dissipate. Apply the neutralizing solution to the spill from the perimeter inward. The spill material will remain blue in color until neutralization is complete. Mix the neutralizing material until the spill turns an orange/yellow color.

Add the liquid absorbent to the mixture next.

Pick up the saturated liquid absorbent and place in disposal bag along with gloves and any other materials used. Label bag and dispose in the dumpster as non-hazardous solid waste.

- **Solvent Spills** - Extinguish all ignition sources in the area. Solvent spills need to be properly ventilated due to their flammability and ignitability. Do not clean up spills of toxic volatile solvents. See dangerous material spills above.

Solvent spills are cleaned up by applying the absorbent material in the spill kit to the area from the perimeter inward. Make sure enough of the material is added to cover the entire spill. Mix the absorbent material with the spill until the absorbent material regains its appearance as a dry powder.

Transfer the absorbent material to the disposal bag along with all materials used in the clean up. Label bag and contact supervisor for disposal instructions.

12.2 ACCIDENTS

All chemical related accidents or near accidents shall be investigated by the CHO, DME Supervisor, District Materials Safety Officer, and District Safety Officer to determine cause and prevention and to evaluate the effectiveness of the response. Chapter 4 of the Caltrans Safety Manual, Accident Investigation and Analysis, explains the Caltrans, State, and Federal reporting requirements.

12.2.1 Eye Contact

Promptly flush eyes with water for a prolonged period (15 minutes) and seek immediate medical attention.

12.2.2 Ingestion

If a pure chemical is ingested, follow label or MSDS get immediate medical attention.

12.2.3 Skin Contact

Promptly flush affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.

12.3 EMERGENCIES

Each laboratory should have a written Emergency Action Plan. The plan should state the action required by personnel where there is a fire, explosion, medical emergency, or a release of hazardous material into the air, soil, or water supply.

There should be an alarm system to alert people in all parts of the facility in the event of an emergency that may require evacuation.

13.0 TRAINING AND INFORMATION

Each employee is to be trained so that they understand the risks and precautions necessary to SAFELY handle hazardous chemicals. Each employee will be trained in each of the following areas:

13.1 ONE TIME REQUIRED TRAINING - NEW EMPLOYEES OR INITIAL ASSIGNMENT

At the time of an employee's initial assignment to a work area where hazardous chemicals are present, the employee must not work unsupervised until the required training has taken place. Training and information should include:

- Chemical Hygiene Plan.
- Material Safety Data Sheets.
- Permissible Exposure Limits.
- Emergency/Safety Equipment Location and Use.
- Personal Protective Apparel and Equipment.
- Caltrans Hazardous Materials Communication Program.
- Emergency Action Plan.

Follow up discussions should occur on a regular basis until an understanding of laboratory safety is demonstrated. All training must be documented by the supervisor.

13.1.1 Chemical Hygiene Plan (CHP)

Each employee shall be shown the location of the CHP and how to refer to it if the need arises. Much of the chemical use training is included in the CHP; therefore, it is important for the immediate supervisor to carefully review the CHP with each employee.

13.1.2 Material Safety Data Sheets (MSDS)

Each employee should know the location of the MSDS for every chemical they use.

13.1.3 Permissible Exposure Limits (PELs)

Each employee should know the location of the Cal-OSHA established PELs for the materials they use.

13.1.4 Emergency/Safety Equipment Use

Each laboratory worker should know the location and proper use of safety and emergency equipment. Examples include: eye wash, safety shower, spill kits, first aid kits, fire extinguishers, fire blankets, etc.

13.1.5 Personal Protective Apparel and Equipment

Each laboratory worker should know the availability, location and proper use of protective apparel and equipment. Examples include: safety glasses, goggles, face shields, gloves, aprons, respirators, hearing protection, etc.

13.1.6 Hazardous Materials Communication Program

Each employee should know the location of the Caltrans Hazardous Materials Communication Program and understand the hazard labeling information and requirements.

13.1.7 Emergency Action Plan

Each employee should know the location of the Emergency Action Plan. This plan establishes a continuing state of readiness for protection of life and property in the event of medical emergencies, fires, chemical spills, earthquakes, bomb incidents, civil disturbances, and other disasters.

13.2 ANNUAL TRAINING

Annual training should include a review and discussion of all aspects of the topics listed in Section 13.1.

13.3 OPTIONAL TRAINING

13.3.1 Prudent Laboratory Practices

This Chemical Hygiene Plan and Section C of this Laboratory Safety Manual should be used as a training tool.

13.3.2 CPR/First Aid

First Aid and CPR training is periodically available to staff. Ask your supervisor to contact the Office of Safety and Health for scheduling.

13.3.3 Caltrans Owned Video Tapes

The Office of Safety and Health offers several videos and films for viewing e.g., "Care and Use of the Comfo II Chemical Cartridge Respirator."

13.4 TRAINING OF REGULAR VISITORS

Frequent laboratory visitors (secretaries, janitors, etc.) should be trained in general chemical hazards and basic emergency procedures (evacuation, notification, etc.).

All frequent visitors to “laboratory areas” shall have safety apparel available and follow safety precautions (e.g., safety glasses and no food or drink). Laboratory supervisor will enforce.

All visitors who have not received proper laboratory safety training **shall be** escorted at all times by an employee of that laboratory.

Contractors working at the Laboratory should have completed Hazardous Communication Training as part of their contract.

13.5 FACILITY MAINTENANCE FORCES

Scheduled facility maintenance (e.g., electrical, mechanical, plumbing) should occur only after maintenance forces and the laboratory supervisor in charge of the CHP meet to discuss chemical safety precautions. A laboratory staff member should be present during facility maintenance activities and to the extent practicable laboratory operations should be shut down.

13.6 FACILITY CUSTODIAL SERVICES

State Custodians and State Contracted Custodians assigned to the laboratory should have Hazardous Materials Communication Program training. As they are assigned to the building, custodians will be made aware of appropriate safety practices, precautions, and emergency procedures by the laboratory supervisor during a building walk through with their supervisor.

14.0 WASTE DISPOSAL

Efforts will be taken to assure that waste laboratory chemicals or laboratory samples (e.g., traffic paint samples, motor oil, etc.) will not harm people or the environment. No liquid waste, whether hazardous or not, shall be thrown away in the dumpster or poured down the drain. All hazardous waste will be disposed of properly in accordance with state, local, and federal laws.

14.1 GENERAL CONSIDERATIONS

When disposing of chemicals always wear appropriate protective clothing such as gloves, goggles, and lab coats. Small quantities of waste in the laboratory should be maintained for short periods of time and then transferred to a central waste storage area.

Unlabeled, out dated, or unknown containers of chemicals or solutions should undergo special and immediate disposal. Storage, transportation, and disposal of waste chemicals shall be by class to reduce the risk of chemical reaction and aid in disposal.

14.2 METHOD OF DISPOSAL

Off-site transporters shall comply with all federal and state regulations governing the transportation of hazardous waste.

14.2.1 Liquid Chemical Waste

Aqueous

Water samples, latex samples, aqueous extracts and reagents pH 3-11 which do not contain metals (lead, chromium, etc.) can be rinsed down the laboratory sink. Concentrated acids and bases should be diluted or neutralized to pH 3-11 before pouring down the drain. Do not pour acids and bases down the drain at the same time.

Solvents

All solvents must be collected in properly labeled closed containers and disposed of in satellite collecting drums in the waste storage area. Keep chlorinated waste separated from other solvent waste.

Used Hydraulic and Motor Oil

Collect in properly labeled containers and transfer to satellite collection drums for recycling.

14.2.2 Solid Chemical Waste

Spent Abrasive Waste

Wear rubber gloves and a respirator for dust while pouring spent abrasive waste into a 5 gallon, or larger, metal container. Seal with a crimp lid, label with a hazardous waste sticker, and store in the satellite collection area.

LABORATORY SAFETY MANUAL

Part C

PHYSICAL TESTING

PART C: PHYSICAL TESTING

1.0 SAFE LABORATORY PRACTICES

Many laboratory operations and test methods involve procedures, equipment, and/or chemicals that are potentially hazardous. Employees should be thoroughly acquainted with the potential hazards involved in each laboratory operation or test method before proceeding.

Information regarding the safety concerns for each California Test Method is included in the test method text.

1.1 GENERAL SAFETY PRINCIPLES

Use information resources about laboratory safety.

- Read test methods, MSDS, and instruction manuals for equipment and operations before beginning a new procedure or operation.
- Know the health and physical hazards of test methods, equipment, and chemicals involved before proceeding.
- Use personal protective equipment and know the location of all laboratory safety equipment such as eyewashes, showers, fire extinguishers, etc.

The Caltrans Safety Manual cites Caltrans policy and contain specific guidelines on “Code of Safe Work Practices,” Chapter 11; “Personal Protective Equipment,” Chapter 12; “Hearing Protection Program,” Chapter 13; “Confined Spaces,” Chapter 14; and “Respiratory Protection Program,” Chapter 15 which should be reviewed prior to working in a physical testing laboratory.

The following procedures should be used for essentially all work in a physical testing laboratory:

1.1.1 Work Clothing Guidelines

Inappropriate clothing and footwear shall not be worn in the physical testing laboratory. Testers will wear smocks or aprons to protect skin and street clothing from cuts, nicks, and splashing liquids.

No open-toed shoes or sandals shall be worn in the physical testing labs. For conducting concrete beam breaking, steel tipped shoes are required. Long hair, neckties, and other loose clothing should be secured to prevent entanglement in equipment or involvement in sample preparation.

1.1.2 Eye Protection

Eye protection is very important in a testing laboratory. If a test is being conducted that could possibly result in a violent destructive failure, employees in the area of the test and the operator conducting the test must wear safety eyeglasses.

Employees using equipment that may generate flying debris must wear impact resistant safety glasses. If a test is being conducted that could possibly result in the specimen or parts thereof becoming projectiles, employees in the area of the test and the operator conducting the test must wear impact resistant safety glasses.

Protective eyewear for employees who wear prescription eyeglasses must be one of the following:

- Eyeglasses with protective lenses that also provide optical correction.
- Goggles to be worn over glasses
- A face shields to fit over eyeglasses.

Employees who wear contact lenses must wear safety eyeglasses.

1.1.3 Lifting, Pushing and Pulling

A major source of injuries in physical testing laboratories is lifting heavy objects incorrectly and/or without assistance. All employees that have to lift heavy objects should become familiar with proper lifting techniques:

- Plan the move - Know where the object will be placed. Determine how to get the job done. Make sure the route to be used will be free of obstructions. Be sure there is enough space to maneuver. Determine how much help will be needed. The employee should know his limitations regarding lifting weights. Wear the appropriate safety equipment such as back brace, gloves, and/or goggles.
- Get the proper grip - Look over the object and determine how to hold it. Mechanical lifting devices should move things that are not intended to be moved by hand.
- Use the proper motion - Get a good footing. Place feet shoulder width apart with one foot slightly ahead of the other. Bend at the knees and grasp the object to be lifted. Bring the object close to the body. Keep the back straight, but at a comfortable angle. Lift gradually by straightening the knees. Don't jerk, twist or turn suddenly. Use mechanical lifting devices whenever possible.
- Use teamwork when necessary. Share the load equally. Coordinate movements so that everyone starts, turns, and finishes at the same time.

When pushing or pulling, the body's weight and leg muscles should do the work to keep strain off the back. Get a good grip on the object and keep the back as straight as possible. The feet should be braced for maximum leg power and the legs bent to use the body weight to move the object.

1.1.4 Hand Injuries

Employees in the physical testing labs often handle materials that may be caustic, rough, sharp, or very hot. Once the degree of protection needed is established,

then the type of glove can be determined. A simple guide to proper hand protection is as follows:

<u>Hazard</u>	<u>Protection</u>
Mild irritants	Gloves: light duty.
Heat, flame	Gloves: Leather, aluminized fabric, aramic, wool
Heavy material	Gloves: Leather, canvas
Electricity	Gloves: Rubber
Caustics, chemicals	Gloves: Specifically designed to resist exposure (see manufacturers guidelines)
Liquids (non chemical)	Gloves: Moisture resistant, rubber
Sharp objects	Gloves: Cut proof
Solvents	Gloves: Solvent resistant
Contaminated Soils:	Disposable Plastic Gloves Concrete
Gloves: Moisture resistant, rubber,	disposable plastic or Neoprene

1.2 EMPLOYEE FACTORS

Safety is everyone's concern. Be aware of the equipment used and the operations being conducted in the vicinity. Be aware about the presence of other employees or visitors within the vicinity.

1.2.1 Attitude

Employees should maintain a professional attitude in the laboratory. Horseplay of any kind shall not be permitted.

Employees should abide by the safety rules and wear the proper equipment. Decisions concerning the usage of safety gear shall be determined by the laboratory supervisor.

If an employee sees something that appears unsafe, it should be immediately reported. All work in the area or with the piece of equipment shall be suspended until the unsafe condition has been corrected.

Work should be done quietly. Excessive noise can be very distracting. The usage of personal radios shall be determined by the laboratory supervisor.

1.2.2 Eating, Drinking and Smoking

Food and drink are to be stored in designated locations only. Food is not to be prepared using laboratory equipment.

Food should only be consumed in the cafeteria, office space, or other designated areas. No food or drink should be consumed in the laboratory area.

In compliance with Caltrans policy, there will be no smoking in materials laboratories. This policy extends to field laboratories also.

1.3 Nuclear Gauges

Gauges must always be operated by properly trained and certified operators. Daily logs should be kept by the operator pertaining to jobsite, gauge identification, and the work activity. All employees using the equipment should wear film badges to determine the amount of radiation exposure. Strict records are maintained on employee radiation exposure.

The gauges shall only be transported in approved vehicles.

Nuclear gauges will only be stored in approved storage facilities. In storage of nuclear gauges, the “Rule of Three Keys” applies. The gauge will be stored in a locked cabinet in an unused portion of a room or in a separate locked room. The cabinet and room shall both be posted as to the presence of radioactive materials. Gauges cannot be stored in homes, motel rooms or other locations without necessary security. If overnight storage is necessary, the gauge may be stored in an approved vehicle.

There are basically three ways to protect employees from a radioactive source: time, distance, and the use of shielding material.

Time - Employees should, therefore, pay strict attention to the amount of time spent operating a nuclear device. Work should be done as quickly as possible to minimize exposure time.

Distance - Distance from the gauge is very important. The greater the distance, the lower the exposure level. When in operation, all unauthorized personnel should be kept at least 15 feet from radioactive source.

Shielding - There are many materials that can be used for shielding. Most high-density materials are useful for shielding against gamma radiation. Additional shielding is the least preferred means of protection. Nuclear density gauges have self-contained shields which afford excellent protection.

Add testing of nuclear gauges quarterly and each time it's with storage of other material not allowed, such as shovels and other items. (Refer to California Test Method 121 to become a radiation officer.)

2.0 FIELD OPERATIONS AND TESTING

2.1 FIELD LABORATORY TESTING

Field laboratories and the equipment in the field laboratories should be afforded the same safety considerations that the laboratory and equipment located at the District Office have been given. All safety rules, the Chemical Hygiene Plan, and standards apply.

Many laboratory operations and test methods involve procedures, equipment, and/or chemicals that are potentially hazardous. Employees should be thoroughly acquainted with the potential hazards involved in each laboratory operation or test method before proceeding.

Information regarding the safety concerns for each California Test Method is included in the test method text (revised after March 1, 1993).

2.2. PLANT INSPECTION, SAMPLING AND TESTING

Materials employees provide assistance to construction by providing plant inspection and sampling and testing of the materials that are used in concrete or asphalt concrete products.

Plants should have been inspected and certified by a Caltrans inspector prior to their use on a Caltrans project.

When an employee is on-site, the plant operators should be notified of the locations. Caltrans specifies that safe conditions for sampling and inspection must be provided. Employees should not subject themselves to unsafe conditions.

Employees should wear the hard hats, gloves, eye and ear protection, and safety shoes. Loose clothing and long hair should be secured.

A major cause of injuries is lifting. Use proper lifting techniques (Part C, “Physical Testing,” Section 1.1.3 “Lifting, Pushing, and Pulling,” of this manual). In addition, the floors might be slippery with water, dust, or debris. It is important to get a secure footing before taking a sample. Pulling a heavy sample off a moving conveyor belt with insecure footing could result in a fall.

In asphalt concrete plant inspection, an additional hazard exists. Inspectors sample liquid asphalt materials directly from the holding tanks. This material is extremely hot. Heat resistant gloves should be used. In addition, long sleeves and/or forearm protectors should be worn.

2.3. VEHICLE OPERATION

The vehicle operator is responsible for the proper care and maintenance of the vehicle or equipment assigned. No operator shall knowingly operate a vehicle or

piece of equipment that is unsafe.

All vehicles or equipment are to be driven in a defensive manner.

2.3.1 Proper License

Every employee who operates a vehicle or piece of equipment requiring a California driver license must have the appropriate license.

This license must be current and in effect for the vehicle/equipment at the time of operation. An employee who loses that license (expiration, suspension, or revocation) must immediately notify the supervisor and discontinue operation of the vehicle/equipment.

2.3.2 Transportation of Personnel

All employees shall wear seat belts when operating a vehicle.

The number of passengers must not exceed the number that can legally be seated. Employees will not ride in areas other than those specifically intended for passengers.

Tools and equipment carried in the same area with personnel shall be secured. Flammables will not be transported in the passenger area.

2.3.3 Parking

Vehicles should always be properly parked. Always set the emergency brake before leaving the vehicle.

Follow all legal requirements for parking on public streets and highways. If there is a curb, cramp the front wheels against it.

Unless vehicles are being used as protective barriers, park them as far from traffic as possible. Always park vehicles and equipment out of the path of construction equipment. Avoid parking behind or in the operating area of the contractor's equipment.

2.3.4 Flashing Amber Warning Lights

When a vehicle is equipped with an amber light, the following guidelines apply:

Lights on: Entering or leaving a closure.
Moving at slow speed in or near traffic.
When parked within 6 feet of traffic.
When vehicle is used as a barrier in a Traffic Control System.

Lights off: When parked within a closure - day or night operations.
Operating normal traffic.
When parked over 6 feet from traffic.
When usage would create unwarranted traffic congestion.

2.4 HAZARDOUS MATERIALS SPILLS ON THE HIGHWAY

Hazardous spill containment, identification, and cleanup are the responsibility of the Division of Maintenance. However, whenever an employee discovers a spill of an unknown material or substance on a highway or street they should:

1. During regular working hours, call the Maintenance Regional Manager's office, if known, or call the Transportation Management Center (TMC), California Highway Patrol, or other emergency numbers including 9-1-1.
2. Stay clear and "up wind" if possible, and avoid contact with the unidentified material.

3. Provide traffic control, possibly by closing the traffic lane or other traffic controls.
4. Call for assistance.
5. Wait for the experts.

2.5 CORE DRILLING

The core drill operator is responsible for the operation and maintenance of the core drill trailer and vehicle, or vehicle. Core drill operators should read and become familiar with the sections in this manual relative to vehicle operation, hydraulic equipment, and general safety concerns.

Coring operations result in water runoff. Be aware of possible dangers at stop signs, pedestrian crossing, etc. During the winter, this may create icy conditions.

Schedule work when traffic is low if possible. Use maintenance to establish and maintain traffic control. If the protection from traffic is inadequate, discuss alternatives with the maintenance person in charge or terminate operations until the situation can be analyzed and changed.

Be aware of possible buried utilities in the area. If coring on a bridge deck, an engineer should be present to locate cores.

2.6 PROFILOGRAPH TESTING

The Profilograph operator is responsible for the operation and maintenance of the Profilograph. Profilograph testers should read and become familiar with the sections in this manual relative to vehicle operation and general safety concerns.

Profilograph testing is conducted at low speeds. Schedule work when traffic is low if possible. Use contractor or maintenance forces to establish and maintain traffic control. If the protection from traffic is inadequate, discuss alternatives with the person in charge or terminate operations until the situation can be analyzed and changed.

CHEMICAL HYGIENE PLAN

Appendix A

EXAMPLE

Inspection Check List

APPENDIX A -- Inspection Check List

A. EYE WASH OPERATION

1. Run water to remove air.
2. Check for proper flow, adjust if needed.
3. Access to eyewash not obstructed.
4. Eyewash provides water simultaneously to both eyes for at least 15 minutes.
5. Eyewash located 33 - 45 inches above floor.

B. CHECK EMERGENCY LIGHTS

C. COMPRESSED GAS CYLINDERS SECURED

1. Stored and secured properly.

D. CHECK FOR PROPER LABELING OF CHEMICAL CONTAINERS

1. Identity, NFPA hazard label, manufacturer name and address.

E. SAFE STORAGE OF CHEMICALS

1. Oxidizing and reducing agents separated.
2. Heavy bottles, etc. stored below shoulder level.
3. Acid stored in hoods.
4. Flammables, combustibles stored properly.

F. FILL TRAPS ON SELDOM USED DRAINS

G. GENERAL HOUSEKEEPING FOR APPEARANCE AND SAFETY

1. Check working area for tipping, falling hazards.
2. Check for bumping hazards (open drawers, etc.).
3. Check for uncovered containers.

4. Check for electrical hazards, frayed wires, unprotected circuits, etc.
5. Spill kits present.

H. CHECK SAFETY SHOWER OPERATION

1. Appearance of water.
2. Unobstructed access.

I. RECORD HOOD ANEMOMETER READINGS

1. Save records for 5 years.

K. REVIEW ACCIDENT REPORTS

L. PROPER STORAGE OF HAZARDOUS WASTE AND FLAMMABLE LIQUIDS

Annual Safety Inspection Check List

	Yes	No	Notes
1. Designated lab areas are properly marked.			
2. Heavy objects stored below shoulder level.			
3. Worktables or counters are clean and free of debris.			
4. Floor space is clear of hazardous objects.			
5. Safety glasses dispensers are appropriately displayed and stocked.			
6. No food or drink is within designated lab areas.			
7. First aid kits - available & stocked properly.			
8. Proper gloves are available.			
9. Proper facemasks or respirators are available.			
10. Proper storage of respirators and face masks (not face up).			
11. Eye washes are functional.			
12. Safety showers are functional.			

	Yes	No	Notes
13. All chemical containers are labeled and labeling is correct.			
14. All chemicals are stored in proper location.			
15. Flammable liquids are stored in flame proof cabinets.			
16. Reagents labeled flammable where appropriate, i.e. acetone.			
17. Waste properly stored and labeled.			
18. Chemical inventory list is up to date.			
19. MSDSs are posted and up to date.			
20. Review accident reports.			
21. Emergency numbers are displayed in appropriate locations.			
22. Hood anemometer readings.			
23. Training documentation.			
24. Oxidizing and reducing agents are separated.			
25. Cylinders are properly stored and secured.			
26. Proper vehicle to transport cylinders is available.			
27. Spill kits are available.			
28. Proper waste disposal containers are available.			

Notes: _____

CHEMICAL HYGIENE PLAN

Appendix B

Chemical Hazards Classes

APPENDIX B - CHEMICAL HAZARDS CLASSES**1. Flammable**

Definition: A spark will ignite at ambient temperatures; less than 100⁰F

Example: Toluene, Acetone, Methyl ethyl ketone

Handling: Must be kept away from oxidizers. Store away from hazard areas. Fire fighting equipment must be available.

2. Reactive

Definition: Chemicals/mixtures that polymerize, decompose, condense, or are self-reactive due to shock, pressure, or temperature.

Example: Peroxides, Explosives, and Sodium.

Handling: Use respirators when exposure may be high. Use good hygiene practices, local exhaust ventilation, and personal protective equipment (PPE).

3. Explosive

Definition: Produces sudden release of pressure and heat when shocked or under pressure or high temperature.

Example: Picric Acid, Ammonium Nitrate, and Phenyl Ether.

Handling: Keep all explosives from heat and any type of shock. Only nonmetallic materials should be used around explosives. They should not be stored more than 6 feet high.

4. Polymerize

Definition: An internal chemical reaction that forms larger molecules by combining smaller ones, sometimes with an uncontrolled release of energy.

Example: Methacrylate, Styrene, Polysulfone, Polycarbonate, and Isoprene.

Handling: Use protective clothing. If clothing becomes saturated, change immediately. Use under fume hood with the respirator.

5. Biohazard

Definition: Organism, or products of an organism, that presents a hazard to humans.

Example: Bacteria, Viruses, and Molds

Handling: Biohazard warning signs, keep away from all open cuts or sores. Use PPE. Practice good hygiene. Use in a vented area/hood. Keep isolated. People at risk should be immunized against agent, if possible.

6. Radioactive

Definition: Spontaneously emitting alpha or β particles or gamma rays by disintegration of the nuclei of the atoms.

Example: Uranium, Plutonium, and Radioactive Isotopes.

Handling: Area must be labeled with radioactive warnings. Use proper protective shields and equipment.

7. Acute Toxic

Definition: Chemicals with an adverse effect with short term exposure.

Example: Ammonium Nitrate, Hydrogen Chloride, and Acetic Acid.

Handling: Use in a well-ventilated place. Store away from flammables. Use correct PPE.

8. Corrosive

Definition: Causes severe damage to eyes, nose, throat, lungs, skin (wherever contact occurs). May cause blindness if eye contact occurs. May cause severe, permanent lung damage if corrosive gas is breathed into the lung. Will cause scars if it contacts and burns skin.

Example: Caustic Soda, and Hydrofluoric Acid.

Handling: Handle containers carefully. If container is leaking, use protective equipment (eyes, gloves, apron). Use in vented area.

9. Irritant

Definition: Causes eye, nose, throat and/or skin pain or temporary damage. May cause itching, rashes, burns, and other similar conditions, but all of these clear up and do not leave long-term problems or scars.

Example: Nickel Oxide, Nickel Carbonate, and Glycerol.

Handling: Wear correct PPE. Use in a ventilated area. Practice good personal hygiene.

10. Asphyxiant

Definition: Simple asphyxiants cause suffocation by replacing air. Chemical asphyxiants induce chemical changes in the body, causing the body to be unable to use Oxygen.

Example: Methane, Argon, Carbon Monoxide, and Cyanide.

Handling: Use in a well-vented area. Use proper respirator protection, if necessary.

11. Carcinogen

Definition: May cause cancer in some exposed persons; cancer does not show up for ten (10) to thirty (30) years.

Example: Benzene, Sodium Dichromate, and Dichloromethane.

Handling: Protective clothing should be worn at all times; should be used with local ventilation or a respirator. Use PPE.

12. Allergen

Definition: First exposure causes little or no reaction, but further exposure may cause a significant response.

Example: Isocyanates and Formaldehyde

Handling: Wear protective clothing. Use in well-vented area or in fume hood. Practice good hygiene.

13. Reproductive Toxin

Definition: Causes changes in the bodies of men and women that result in low fertility or miscarriage or can directly affect a developing embryo, causing miscarriage or deformity.

Example: Ethylene Oxide and Lead.

Handling: Protective clothing for exposed areas; use in fume hood or wear respirator.

14. Systemic Toxin

Definition: Toxic chemical that affects liver or kidney function or blood manufacture and/or affects the entire body.

Example: Chloroform, Calcium Arsenate, and Carbon Disulfid

Handling: Protective clothing used to protect the skin. Used in fume hood or with local exhaust - if not use respirator.

15. Poison

Definition: Acute systemic toxin - highly toxic.

Example: Sodium Dichromate

Handling: Do not breathe fumes. Use with adequate ventilation and proper PPE.

CHEMICAL HYGIENE PLAN

Appendix C

Common MSDS Terms

APPENDIX C - COMMON MSDS TERMS

ACUTE EFFECT - An adverse effect with severe symptoms occurring very quickly, as a result of a single overexposure to a substance.

ACUTE TOXICITY - The adverse effects resulting from a single overexposure to a substance.

ASPHYXIAN - A vapor or gas that can cause unconsciousness or death by suffocation. Most are associated with a lack of sufficient oxygen to sustain life.

BOILING POINT - The temperature at which a liquid turns to a vapor state. This term is usually associated with the temperature at sea level pressure when a flammable liquid gives off sufficient vapors to promote combustion.

C or CEILING - In terms of exposure concentration, this is the number that should never be exceeded, even for a short period, for a substance.

CARCINOGEN - A substance or agent capable of producing cancer in mammals.

cc - CUBIC CENTIMETER - A volume measurement usually associated with small quantities of a liquid. One quart has 946 cubic centimeters.

CHRONIC EFFECT - An adverse effect with symptoms that develop or recur very slowly, or over long periods of time.

CHRONIC TOXICITY - The adverse effects resulting from prolonged or repeat exposures to a substance, usually used as an indicator of relative toxicity for exposures over great lengths of time.

COMBUSTIBLE - A term used to classify liquids, gases, or solids that will burn readily. This term is often associated with “flash point”, which is a temperature at which a given material will generate sufficient vapors to promote combustion.

CONCENTRATION - A figure used to define relative quantity of a particular material. Such as a mixture of 5 ppm acetone in air.

CORROSIVE - A material with the characteristic of causing irreversible harm to human skin or steel by contact. Many acids are classified as corrosives.

DECOMPOSITION - The breakdown of materials or substances into other substances or parts of compounds. Usually associated with heat or chemical reactions.

DERMAL - Used on or applied to the skin.

DERMAL TOXICITY - The adverse effects resulting from exposure of a material to the skin. Usually associated with lab animal tests.

EVAPORATION RATE - The rate at which a liquid material is known to evaporate, usually associated with flammable materials. The faster a material will evaporate, the sooner it will become concentrated in the air, creating either an explosive/combustible mixture or toxic concentration, or both.

FLASH POINT - The temperature at which a liquid will generate sufficient vapors to promote combustion. Generally, the lower the flash point, the greater the danger of combustion.

FLAMMABLE - Any liquid that has a flash point of 100⁰F or below. Also, any solid that can sustain fire and ignite readily.

GENERAL EXHAUST - A term used to define a system for exhausting or ventilating air from a general work area. Not as site specific as localized exhaust.

g - GRAM - A unit of weight. One ounce equals about 28.4 grams.

HAZARDOUS CHEMICAL - Any chemical which is either a physical or health hazard or both.

IGNITABLE - A term used to define any liquid, gas or solid which has the ability to be “ignited” which means having a flash point of 140⁰F, or less.

INCOMPATIBLE - Materials that could cause dangerous reactions from direct contact with one another.

INGESTION - Taking in of a substance through the mouth.

INHALATION - The breathing in of a substance in the form of a gas, liquid, vapor, dust, mist, or fume.

INHIBITOR - A chemical added to another substance to prevent an unwanted change from occurring.

IRRITANT - A chemical which causes a reversible inflammatory effect on the site of contact, however is not considered a corrosive. Normally, irritants affect the eyes, skin, nose, mouth, and respiratory system.

LC - Lethal Concentration - In lab animal tests, this is the concentration of a substance which is sufficient to kill the tested animal.

LC₅₀ - Lethal Concentration₅₀ - In lab animal tests, this is the concentration of a substance required to kill 50% of the group of animals tested.

LD - Lethal Dose - The concentration of a substance required to kill the lab animal used for the test with a specific material.

LD₅₀ - Lethal Doses - The single dose concentration of a substance required to kill 50% of the lab animals tested.

LEL - Lower Explosive Limit - The lowest concentration, or percentage in air, of a vapor or gas, that will produce a flash fire when an ignition source is introduced.

LOCAL EXHAUST - The system for ventilation or exhausting air from a specific area such as in welding operations. More localized than general exhaust.

MELTING POINT - The temperature at which a solid changes to a liquid.

mg - MILLIGRAM - A unit of measurement of weight. There are 1000 mg in one gram of a substance.

mg/m³ - MILLIGRAMS PER CUBIC METER - A unit of measurement usually associated with concentrations of dusts, gases, or mists in air.

mppcf - MILLION PARTICLES PER CUBIC FOOT - A unit of measure usually used to describe airborne particles of a substance suspended in air.

MUTAGEN - A substance or agent capable of altering the genetic material in a living cell. Normally associated with carcinogens.

NFPA - National Fire Protection Association - An organization that promotes fire protection/prevention and establishes safeguards against loss of property and/or life by fire. The NFPA has established a series of codes identifying hazardous materials by symbol and number for fire fighting purposes. These codes also classify materials in their order of flammability, with 0 being not burnable up to 4 which means will burn spontaneously at room temperature.

OLFACTORY- Relating to the sense of smell.

ORAL - Used in or taken through the mouth into the body.

ORAL TOXICITY - A term used to denote the degree at which a substance will cause adverse health effects when taken through the mouth. Normally associated with lab animal tests.

OXIDIZER - A substance that yields oxygen readily to stimulate the combustion of an organic material.

OXIDIZING AGENT - A chemical or substance that brings on an oxidation reaction, by providing the oxygen to promote oxidation.

PEL - Permissible Exposure Limit - An exposure concentration established by the Occupational Safety and Health Community that indicates the maximum concentration for which no adverse effects will follow.

PPM - Parts Per Million - A unit of measurement for the concentration of a gas or vapor in air. Usually expressed as number of parts per million parts of air.

PPB - Parts Per Billion - As above, only expressed as number of parts per billion parts of air.

REACTIVITY - The term which describes the tendency of a substance to undergo a chemical change with the release of energy, often as heat.

REDUCING AGENT - In an oxidation reaction, this is the material that combines with oxygen.

RESPIRATORY SYSTEM - The breathing system, including the lungs, and air passages, plus their associated nervous and circulatory components.

SENSITIZER - A substance that on first exposure causes little or no reaction, however, with repeated exposure will induce a marked response not necessarily limited to the exposure site. Usually associated with skin sensitization.

SPECIFIC GRAVITY - The weight of a material compared to the weight of an equal volume of water. Usually expresses a material's heaviness. A material with a specific gravity of greater than 1.0 will sink to the bottom of water, whereas a material with a specific gravity of less than 1.0 will float on top of water.

STEL - Short Term Exposure Limit - A maximum allowable concentration of a substance that one can be exposed to for less than 15 minutes and not produce adverse health effects.

TERATOGEN - A substance or agent, usually associated with cancer, that when exposed to a pregnant female will cause malformation of the fetus. Usually associated with lab animal tests.

TLV - Threshold Limit Value - A term used by the Occupational Safety & Health Community to describe the airborne concentration of a material to which nearly all persons can be exposed day in and day out, and not develop adverse health effects.

TOXICITY - The sum of adverse effects of exposure to materials, generally by mouth, skin, or respiratory tract.

TWA - Time Weighted Average - The airborne concentration of a material to which a person can be exposed over an 8-hour workday (an average).

UEL - Upper Explosive Limit - The highest concentration of a gas or vapor in air that will sustain or support combustion, when an ignition source is present.

VAPOR DENSITY - A term used to define the weight of a vapor or gas as compared to the weight of an equal volume of air. Materials lighter than air have a vapor density of less than 1.0, whereas materials heavier than air have a vapor density greater than 1.0.

VAPOR PRESSURE - A number used to describe the pressure that a saturated vapor will exert on top of its own liquid in a closed container. Usually, the higher the vapor pressure, the lower the boiling point, and therefore the more dangerous the material can be, if flammable.

CHEMICAL HYGIENE PLAN

Appendix D

Signs and Symptoms of Overexposure

APPENDIX D - SIGNS AND SYMPTOMS OF OVEREXPOSURE

The following is a list of some of the signs and symptoms of overexposure.

- Abdominal cramps.** Painful stomach area spasms
- Alopecia.** Loss of hair; baldness
- Amenorrhea.** Stoppage of menstruation (period)
- Amnesia.** Loss of memory
- Analgesia.** Loss of sensitivity to pain
- Anesthesia.** Loss of feeling
- Angina pectoris.** Chest pain
- Anorexia.** Loss of appetite
- Anosmia.** Loss of sense of smell
- Anoxia.** Lack of oxygen (O₂) from inspired air
- Anurta.** Lack of urination
- Anxiety.** Troubled feeling.
- Apathy.** Lack of emotion
- Aphasia.** Inability to talk coherently
- Apnea.** Breathing temporarily stopped
- Areflexia.** Loss of reflexes
- Argyria.** Blue-colored tissue from silver
- Arrhythmia.** Irregular heartbeat
- Arthralgia.** Joint pain
- Asbestosis.** Lung disease from inhaling asbestos
- Asphyxia.** Suffocation
- Aspiration.** Drawing material into lungs
- Asthenia.** Loss of strength or energy
- Asthma.** Difficulty breathing
- Ataxia.** Inability to walk straight
- Athetosis.** Slow writhing movements of fingers
- Atrophy.** Reduction in size, or function of body
- Blackened teeth.** Darkening of the tooth surface
- Blindness.** Inability to see
- Blurred vision.** Not in focus

Bradycardia. Slow heart beat

Bronchitis/bronchospasm. Coughing; difficult breathing

Burn. Tissue damage

Cachexia. Wasting away

Cancer. Abnormal tissue growth

Cataracts. Progressive loss of eyesight

Changes in body/breath odor. Abnormal body/breath odor

Cheilitis. Inflammation of the lips

Chemical Pneumonitis. Inflammation of lungs

Chills. Shivering with cold plus fever

Chloracne. Reddish skin rash

Chorea. Jerky uncontrollable movements of limbs

Colic. Abdominal pain, due to intestinal gas

Collapse. Loss of ability to stand

Coma/comatose. Extreme unconsciousness

Confusion. State of bewilderment

Conjunctivitis. Inflamed and reddened eyes

Constipation. Infrequent/difficult bowel movements

Constriction. Binding or contraction

Convulsions. Violent body spasms

Coughing. Forceful expiration of air

Coughing blood. Forceful expiration of blood

Cyanosis. Blue to purple skin color

Dark urine. Discoloration of urine

Dehydration. Excessive loss of body water

Delirium. State of mental confusion

Dental erosion. Loss of tooth surface

Depression, bodily. Decrease in activity

Depression, mental. Feeling of great sadness

Dermatitis. Inflamed, reddened skin

Diaphoresis. Profuse perspiration

Diarrhea. Frequent, loose bowel movement

Dilated. Expanded; opened up

Disequilibrium. Inability to maintain balance

Disordered gait. Change in walking pattern

Dizziness. Feeling faint; light-headed

Drooling. Excess saliva from mouth

Drowsiness. Falling asleep

Dysarthria. Difficulty in speaking clearly

Dysosmia. Impaired sense of smell

Dysphagia. Difficulty in swallowing

Dyspnea. Difficulty in breathing

Dysuria. Painful or difficult urination

Eczema. Inflammatory skin disease with itching and burning

Edema. Fluid Retention; swelling

Emaciation. Extreme low weight; skinniness

Embolism. Obstruction of a blood vessel

Emphysema. Difficulty breathing

Epistaxis. Nosebleed

Erythema. Reddened skin

Euphoria. Exaggerated feeling of well-being

Fasciculation. Muscle twitching under skin

Fainting. Loss of consciousness

Fatigue. Tiredness; sluggishness

Fever. Increased body temperature

Fibrillation. Rapid muscle contraction

Fibrosis. Fibrous tissue formation in lungs

Finger clubbing. Rounded, swollen fingertips

Fluorosis. Darkening of the teeth

Footdrop. Dragging of the foot while walking

Frostbite. Freezing of tissue

Gangrene. Tissue death

Gasping. Difficulty catching breath

Gastroenteritis. Inflammation of the stomach and intestine

Giddiness. Dizziness; silliness

Grigival lead line. Dark line formed on gums

Glossitis. Tongue swelling

Halitosis. Foul-smelling breath

Hallucination. A sensing of unreal things
Headache. Pain in head or neck area
Hematuria. Blood in the urine
Hemiparesis. Paralysis of one side of body
Hemorrhage. Bleeding
Hyperemia. Congestion of blood in a body part
Hyperkinesis. Excess activity or motion
Hyperpigmentation. Excess coloring of skin
Hyperthermia. Elevated body temperature
Hyperventilation. Sudden rapid breathing
Hypocalcemia. Calcium deficiency of the blood
Hypothermia. Lowered body temperature
Hypoxia. Insufficient oxygen (O₂)
Icterus. Tissue discoloration
Impotence. Loss of sexual ability
Incoordination. Inability to accurately move a limb
Inflammation. Swelling; redness; warmth
Inflexibility. Rigidity; inability to move
Insomnia. Inability to obtain normal sleep
Interstitial fibrosis. Scarring of the lungs
Involuntary defecation. Uncontrollable bowel movements
Involuntary urination. Uncontrollable urine passage
Iridocyclitis. Inflammation of the eye's iris and ciliary body
Irritability. Quickly becoming annoyed
Itch. Skin Sensation causing scratching
Jaundice. Yellow discoloration of skin or eyes
Keratoses. Horny growths on skin
Labored. Not easy or natural
Lacrimation. Excessive eye tearing
Lassitude. Sense of weariness
Lesion. Injury to tissue
Lethargy. Sluggish feeling
Lightheadedness. Dizziness
Lipid granuloma. Inflamed lung tissue

Lipid pneumonia. From aspiration of oily materials

Malaise. Uneasiness; discomfort; ill-feeling

Malnutrition. Inadequate diet

Melena. Black tarry vomitus or stools

Menstrual changes. Change in menstrual cycle

Metallic taste. Taste in mouth resembling metal

Miosis. Pupil contraction

Miscarriage. Loss of baby by pregnant women

Myotonia. Temporary muscle rigidity and spasm

Narcosis. Stupor or sleep

Nasal ulceration. Perforation of nasal tissue

Nausea. Feeling of need to vomit

Necrosis. Localized death of tissue

Neoplasm. Abnormal tissue growth

Nephrotoxic. Poisonous to the kidney

Nervousness. State of unrest, uneasiness

Neuritis. Inflammation of the nerves

Nocturia. Excessive urination at nighttime

Numbness. Loss of feeling; prickly feeling

Nystagmus. Rhythmical movement of eyes

Ocular opacity. Loss of eyesight

Ochronosis. Dark spots on skin

Oliguria. Decreased urination

Opisthotonos. Spasms with body arched from head to heels

Oxide pox. Dermatitis from oxide contact

Pallor. Paleness of the skin

Palpitations. Forceful heartbeat

Paralysis. Loss of ability to move limbs

Paresthesias. Abnormal sensation: tingling

Paroxysmal. Sudden recurrence of disease

Perforation. Opening through a tissue

Pharyngitis. Sore throat: hoarse voice

Phlebitis. Swollen, painful vein

Photophobia. Inability to tolerate light

Photosensitization. Allergic reaction to light

Phototoxicity. Irritant reaction to light

Pigmentation. Coloration

Pneumoconiosis. Material particles in the respiratory track

Prostration. Marked loss of strength; exhaustion

Proteinuria. Presence of protein in the urine

Ptosis. Drooping of upper eyelid

Pulmonary edema. Fluid in the lungs

Pyorrhoea. Swollen, bleeding gums

Pyuria. Pus in urine

Red blood cells in stool. Blood in bowel movement

Respiratory distress. Difficulty breathing

Rhino rrrhea. Excessive nasal discharge

Salivation. Discharge of saliva

Scotoma. Blind spot in field of sight

Seizure Convulsion

Sensitization. Allergic reaction

Shock. Depression of all bodily functions

Siderosis. Lung and tissue damage from iron particles

Silicosis. Lung condition from silica dusts

Somnolence. Prolonged sleepiness

Spasm. Convulsive muscular contraction

Stomatitis. Swelling of the mouth lining

Strabismus. Lack of coordinated eye movement, crossed eyes

Stupor. Unconsciousness

Sweating. Excessive moisture on skin

Swelling. Enlargement

Tachycardia. Abnormal rapid heartbeat.

Tachypnea. Increased respiration rate

Tenderness. Painfulness to pressure/contact

Tetany. Intermittent muscle spasms

Tick. Skin twitch

Tinnitus. Ringing in the ears

Tracheobronchitis. Coughing; difficulty breathing

- Tremors.** Shaking; trembling
Tumor. Swelling or growth
Ulceration. Tissue destruction
Urticaria. Skin eruption
Vertiuo. Feeling of whirling motion
Vesiculation. Blisters
Visual disturbance. Abnormal eyesight
Vomiting. Forceful expulsion of stomach fluid
Vomitus. Expelled stomach contents
Wheezing. Noisy breathing
Wrist drop. Inability to extend hand at wrist