Laboratory Safety Manual

California Department of Transportation

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PART A

LABORATORY SAFETY ROLES AND RESPONSIBILITIES AND GENERAL SAFETY DUTIES

A.1.0 PURPOSE

The purpose of this Laboratory Safety Manual is to provide guidance to employees, supervisors, and managers information with the goal of preventing human injury and environmental damage from hazardous chemicals, equipment, procedures, and testing methods used in the Caltrans' materials testing laboratories.

A.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 testing laboratories in Caltrans, including field construction laboratories. 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.

This Laboratory Safety Manual applies to Category I (Sacramento Translab and the Southern Regional Laboratory), Category II (central district labs) and Category III (field construction labs).

For purposes of this document, the following definitions apply:

DLSO – the Designated Laboratory Safety Officer, who is appointed by the lab supervisor.

Lab – the lab at issue: one of the 100+ Category I, II, or III labs in Caltrans.

Lab Supervisor – the person responsible for (1) the safety of the lab; and (2) designating the DLSO. The civil service status of this person depends on the category of the lab:

1. Category I – For Translab the lab supervisors are the Seniors over specific labs. For the Southern Region Lab, this is a Supervising Transportation Engineer in Construction, reporting to the District 8 Deputy Director of Construction.

2. Category II and III – the lab supervisor is a Senior Transportation (or Bridge) Engineer in Construction, Engineering Services, or Design. For Category II labs, this is typically the District Materials Engineer (in Construction, Engineering Services, or Design). For Category III labs, this is typically a Construction Engineer responsible for the area in which the lab is located.

Local Safety Representative – the district, division, office, or other person responsible for safety in the jurisdiction in which the lab is located. For Translab, this is the Division of Engineering Services (DES) Safety Officer. For SRL, this is the Construction Safety Coordinator. For Category II and III labs, it depends on the location of the lab. For example, a lab on district property (district office or maintenance station) is likely under the safety responsibility of the District Safety Officer. However, a Category III lab (i.e., construction field

lab) located on a construction property or leased private property is likely under control of the Construction Safety Coordinator.

A.3.0 OBJECTIVES

The objectives of the Laboratory Safety Manual are to:

- Institute a Laboratory Safety Program as outlined by this document.
- Make this document readily available to all employees.
- Institute a Chemical Hygiene Plan (CHP) in accordance with Cal/OSHA requirements.
- Provide employee training in safe work practices and laboratory procedures.
- Inform employees of risks involved in materials testing.
- Avoid underestimation of risk.
- Minimize chemical exposures.

A.4.0 RESPONSIBILITIES

A.4.1 DIRECTOR

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

A.4.2 EXECUTIVE MANAGEMENT

Management for the DES, the Headquarters Division of Administration, and the Office of Health and Safety, are responsible for assisting in the review and resolution of "corporate level" Laboratory Safety Manual policy issues. This review requires all district-related issues regarding corporate policy be sent to the Chair of the LSM Steering Committee. The LSM Steering Committee, which includes district and headquarters managers, will update executive management on these issues.

A.4.3 MANAGERS, LOCAL SAFETY REPRESENTATIVES, AND SUPERVISORS

The District Directors, Deputy District Directors, appropriate Deputy Division Chiefs, District Materials Engineers, Construction Office Chiefs and all other applicable managers and lab supervisors are responsible for safety and chemical hygiene in all testing laboratories in each of their Districts. In addition, Laboratory Safety Manual responsibilities include the implementation, management, oversight, compliance and enforcement of this Laboratory Safety Manual.

Lab supervisors have overall responsibility for implementation and enforcement of safety procedures in their laboratories, including, but not limited to:

- Knowing current Caltrans policies and procedures as noted in the Caltrans Safety Manual, this Laboratory Safety Manual (and the Chemical Hygiene Plan contained herein), and applicable test methods.
- Laboratory Safety Manual compliance.
- 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.
- Monitoring and enforcing chemical procurement, storage, use, and disposal procedures in their laboratories.
- Ensuring facilities and training are adequate for any chemical used or stored in their laboratory, and ensuring appropriate training has been provided.
- 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 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 Emergency Action Plans are in place and a 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.
- Documenting that the appropriate training has been provided and forwarding training records to the Designated Laboratory Safety Officer (DLSO) and the SCHO annually.
- Providing regular, formal chemical hygiene, safety, and housekeeping inspections including inspections of emergency equipment. (See CHP Section B.6.0).
- Advising management of the safety needs of subordinates.
- 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 Part B, Chemical Hygiene Plan, Section B.3.0 of this Laboratory Safety Manual.

A.4.4 HQ OFFICE OF HEALTH AND SAFETY

The HQ Office of Health and Safety (OHS) is responsible for communicating and distributing safety related CAL-OSHA directives/updates to all Laboratory Safety Manual end-users in a timely and efficient manner. Additionally, the OHS provides support for requests for consultation and interacts with External Agencies, e.g. Cal/OSHA.

A.4.5 STATEWIDE CHEMICAL HYGIENE OFFICER (SCHO) / ASSOCIATE SAFETY ENGINEER

It has been agreed that the services of a private sector consultant will be used on a short-term basis to fill the position of the State Chemical Hygiene Officer until a permanent Associate Safety Engineer can be hired. Once this position is secured, there will be a transition period to allow for the efficient conversion of duties. Responsibilities include, but are not limited to:

- Work with the laboratory managers, lab supervisors, DLSOs, and other laboratory employees to develop and implement the CHP.
- Maintain a file of the annual laboratory safety inspection reports.
- 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.
- Seek ways to improve the Caltrans 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 Caltrans laboratories.
- Propose periodic updates and revisions to the CHP.
- Participate as an instructor in the Annual Laboratory Safety Training Course.
- Attend an Annual Laboratory Safety Refresher.
- Development of a Training Program for DLSOs.
- Training of all DLSOs.
- Development of a Self-Inspection Checklist for DLSOs.
- Coordinate the Statewide Laboratory Safety Committee meetings, tasks, deliverables, etc.
- Coordination with the Headquarters Caltrans Office of Health and Safety.
- Annual Audit of Category I, II and III laboratories (can be 100% or representative sample every year, with each laboratory being SCHO- audited at least once every three years).
- Coordinate the development of job hazard analysis within the laboratories.

A.4.6 DESIGNATED LABORATORY SAFETY OFFICERS (DLSO)

Each lab supervisor shall appoint a Designated Laboratory Safety Officer (DLSO). The DLSO shall be provided additional training and responsibility, and will serve as the DLSO in accordance with the duties and responsibilities listed below.

The DLSO shall:
- Work with laboratory managers, lab 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, local safety representative, HQ Office of Health and Safety Services, and Caltrans State Chemical Hygiene Officer.
- Review positioning of new laboratory equipment before installation and use.
- Inspect eyewash, fire extinguisher, and deluge shower monthly and note on tag.

A.4.7 CALTRANS LABORATORY SAFETY COMMITTEE

Under the direction of the SCHO, the Caltrans Laboratory Safety Committee consists of a representative from the Headquarters Office of Health and Safety Services, Translab Safety Officer, four DMEs and four DLSOs or local safety representatives (one representative from North Region, Central Region, and Southern Regional Laboratory and one additional district or region). The SCHO leads this committee. District, division, and region committee members 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 development and on-going improvement of Caltrans safety polices for materials testing labs, as well as:

- Providing advice and recommendations to the SCHO regarding safety concerns for the Caltrans testing laboratories.
- Providing an annual review/update of this Laboratory Safety Manual.
- Assist SCHO in organizing an annual Laboratory Safety Training Course for DLSOs.
- Assist SCHO in conducting statewide quality assurance laboratory inspections and issuing compliance reports.
- Reviewing the implementation of safety policies.
- Reviewing employee safety concerns and suggestions.
- Seeking ways to improve safety practices within the Caltrans Materials Laboratories.

A.4.8 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:

- Follow the requirements of this Laboratory Safety Manual, the Caltrans Safety Manual, prudent laboratory practices, and other applicable rules.
- Follow oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- Plan and conduct each operation in accordance with the divisional chemical hygiene plan, safety plans and prudent laboratory practices.
- Review and understand the hazards of materials and processes in their laboratory prior to conducting work.
- Develop and use good personal hygiene and safety habits.
- Wear all required personal protective equipment/clothing.
- Keep the work areas safe and uncluttered.
- Utilize appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls.
- Understand the capabilities and limitations of personal protective equipment issued to them.
- Gain prior approval from the lab supervisor for the use of any new chemicals introduced to the laboratory.
- Promptly report accidents to the laboratory supervisor.
- Complete all required health, safety and environmental training.
- Participate in the medical surveillance program, when required.
- Inform the lab supervisor of any work modifications ordered by a physician as a result of medical surveillance, an occupational injury or exposure.

- Stop any procedure or process that is viewed as unsafe and notify the lab supervisor and the DLSO for appropriate remedy action. If the worker feels the remedy action taken was inadequate, then the worker can elevate the issue up the management chain of command or to the SCHO.

A.5.0 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 below

A.5.1 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 shall include:

- Chemical Hygiene Plan.
- 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.

A.5.1.1 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.

A.5.1.2 Safety Data Sheets (SDSs)

Each employee shall know the location of the SDS for every chemical they use.

A.5.1.3 Permissible Exposure Limits (PELs)

As noted in Section B.3.1.5 in this document and 8 CCR 5191(f)(3)(C), the employees shall be informed of the exposure limits of the regulated substances. Each employee should know the location of the Cal-OSHA established PELs for the materials they use.

A.5.1.4 Emergency/Safety Equipment Use

Each laboratory worker shall 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.

A.5.1.5 Personal Protective Apparel and Equipment

Each laboratory worker shall 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.

A.5.1.6 Hazardous Materials Communication Program

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

A.5.1.7 Emergency Action Plan

Each employee should know the location of the Emergency Action Plan for their work location. This plan should be modeled after the template provided and should establish 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.

A.5.2 ANNUAL TRAINING

Annual training should include a review and discussion of all aspects of the topics listed in Section A.5.1.

A.5.3 OPTIONAL TRAINING

A.5.3.1 Prudent Laboratory Practices

The Chemical Hygiene Plan (Part B) and the Physical Testing Methods (Part C) of this document should be used as a training tool.

A.5.3.2 CPR/First Aid

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

A.5.3.3 Caltrans Owned Video Tapes

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

A.5.4 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).

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 shall have been trained in the handling, storage, and use of hazardous materials.

A.5.5 FACILITY MAINTENANCE FORCES

Scheduled facility maintenance (e.g., electrical, mechanical, plumbing) shall occur only after maintenance forces and the lab 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.

A.5.6 FACILITY CUSTODIAL SERVICES

State Custodians and State Contracted Custodians assigned to the laboratory shall 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 lab supervisor during a building walk through with their supervisor.

PART B

CHEMICAL HYGIENE PLAN

B.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).

B.2.0 SCOPE

Part B, Chemical Hygiene Plan of the Laboratory Safety Manual 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.

B.3.0 SAFE LABORATORY PRACTICES

B.3.1 GENERAL SAFETY PRINCIPLES

Section B.3.1 contains General Safety Principles. Wearing of gloves and other personal protective equipment or devices is discussed in Section B.3.2.12.

The following are the most basic guidelines for employee safety and health in Caltrans Materials Laboratories. 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.
- Employees should stop any procedure or process that is viewed as unsafe and notify the lab supervisor and the DLSO for appropriate remedy action. If the worker feels the remedy action taken was inadequate, then the worker may elevate the issue up the worker's chain of command or to the SCHO.
- Where certification is required to operate equipment, 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 proper training required to safely operate any equipment or to perform a task, before operating equipment or performing 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, lab supervisors will provide training as to how and why the equipment must be used.
- An employee should inspect all equipment before use.
- Lab 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.
- An employee should attend all required safety meetings.
- Every employee, prior to performing any test, shall review and familiarize themselves with the test's methods or instructions and the Safety Data Sheets (SDSs) 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.
- Change laboratory coats, if used, on a regular basis and immediately when one becomes contaminated.

B.3.1.1 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 as needed 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.

At any time, a change in a test method to utilize a less toxic chemical can be recommended by the DLSO or lab supervisor to the SCHO. The SCHO can then forward the recommendation on to the Translab for approval.

B.3.1.2 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.

B.3.1.3 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 B.3.2.15.

B.3.1.4 Use Personal Protective Equipment

Use appropriate personal protective equipment in accordance with Chapter 12 of the Caltrans Safety Manual.

B.3.1.5 Observe the Exposure Limits

As noted in 8 CCR 5191(f)(3)(C), the employees shall be informed of the exposure limits of the regulated substances. As per 8 CCR 5191(c), the permissible exposure limits (PELs) established by Cal-OSHA shall not be exceeded. In addition, the threshold limits values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH) should not be exceeded.

B.3.2 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 SDSs before beginning a new procedure, test method or operation. Review manuals and SDSs 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.

B.3.2.1 Accidents and Spills

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

- Eye contact: Follow the SDS instructions and seek medical attention if necessary.
- Ingestion: Follow the SDS instructions. Call Poison Control. Seek medical attention.
- Skin Contact: Follow the SDS instructions and seek medical attention if necessary.
- Clean up: Follow the SDS. Promptly clean up spills wearing appropriate protective apparel and equipment. Dispose of the waste properly.

B.3.2.2 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.
- Work with chemicals in a manner that will 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 laboratory.
- 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.

B.3.2.3 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 B.3.2.15 for ventilation system guidelines and requirements.

B.3.2.4 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.

B.3.2.5 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 laboratories.
- 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.

B.3.2.6 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.
- 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.

B.3.2.7 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.

B.3.2.8 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.

B.3.2.9 Mouth Suction

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

B.3.2.10 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.)

B.3.2.11 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.

B.3.2.12 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 being used or where there is a reasonable risk of exposure. (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 SDSs 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 the lab 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.

B.3.2.13 Planning

- Seek information and advice about hazards.
- Plan appropriate protective procedures.
- Plan positioning of equipment before beginning any new operation.
- Seek prior approval for resuming operations that are described in Section B.3.5.

B.3.2.14 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.

B.3.2.15 Use of Hood

- Use a hood for operations that might result in release of hazardous chemical vapors or dust. Keep in mind that some chemicals do not have a readily detectable odor even at concentrations above their permissible exposure limit.
- Use a hood or other local ventilation device when working with any appreciably volatile substance.
- Before use, consult the hood manufacturer's instructions to confirm adequate hood performance. 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.
- 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.

B.3.2.16 Vigilance

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

B.3.2.17 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 B.3.3.3 and B.9.0 of this document.

B.3.2.18 Visitors

All visitors allowed into the work area shall wear appropriate safety equipment. See Section A.5.4 of this document for visitor training requirements.

B.3.2.19 Safety-Bulletin Boards

Each laboratory shall have a Safety Bulletin Board installed in a conspicuous place in the laboratory area. This Bulletin Board shall contain all required Safety and Health Notices and information (See Chapter 16 of the Caltrans Safety Manual). Both Cal/OSHA regulations and the Caltrans Injury and Illness Prevention Program (IIPP) have requirements for posting of information. (For a comprehensive list of required postings, please contact the Office of Health and Safety Services or the local safety representative).

B.3.3 WORKING WITH PARTICULARLY HAZARDOUS MATERIALS

(Note: This section (B.3.3) normally only applies to the Category I Laboratories)

If it becomes necessary for laboratory workers to handle particularly hazardous substances (as defined in Cal/OSHA 8CCR 5191(e)(3)(H)), such as "select carcinogens," reproductive toxins and substances that have a high degree of acute toxicity, then the following procedures shall be implemented.

B.3.3.1 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 lab supervisor or by the SCHO 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.

B.3.3.2 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 by the manufacturer.
- 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.

B.3.3.3 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.

B.3.4 PRIOR APPROVAL

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

- A new laboratory procedure or test is to be carried out.
- 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:
  - Any changes in conditions under which the procedure is to be conducted.

B.3.5 NOTIFICATION

Employees must notify the lab 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 any results that are different than what is normally expected during a process or procedure.
- Members of the laboratory staff become ill, suspect that they or others have been exposed, or otherwise suspect a failure of any safeguards.

B.4.0 CHEMICAL PROCUREMENT, DISTRIBUTION, AND STORAGE

B.4.1 PROCUREMENT

B.4.1.1 Guidelines for Ordering and Receiving Routine Chemicals

- Personnel shall check the laboratory inventory prior to initiation of a purchase requisition.
- Order only the amount of chemicals needed in small containers to avoid repackaging hazards.
- All chemicals shall be received at the loading dock and handled with care by employees after reviewing the SDS.
- No container shall be accepted without an adequate identifying label in compliance with Cal/OSHA 8 CCR 5194(f), 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.

B.4.1.2 Guidelines for Ordering and Receiving "New" Chemicals

Any new chemical ordered must be done so in compliance with the Caltrans Safety Manual Chapter 16. 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 SDS in compliance with Cal/OSHA 8CCR 5194 (g) is available to anyone who will be involved with the material.

B.4.1.3 Responsibility for Labeling Chemicals

Upon receipt of a chemical, the originator of the purchase requisition is responsible for assuring that the chemical label and SDS are incompliance with Cal/OSHA 8 CCR 5194(f) and 8CCR 5194(g) and 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 shall also identify any special properties, such as carcinogenicity, extreme toxicity, reactivity with water, etc.

B.4.2 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.

B.4.3 STOCKROOMS/STOREROOMS

Laboratories using hazardous chemicals shall have a separate, ventilated storage area for those materials. It should be near the working area and accessible to authorized personnel only. Care shall 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.

B.4.4 LABORATORY STORAGE

All containers used to store chemicals regardless of their construction type must be labeled with appropriate NFPA labels. Exceptions to this guideline are beakers and glassware used in an immediate laboratory determination.

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

After each use, the chemicals shall be returned to this area and not stored on bench tops. 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.

B.5.0 ENVIRONMENTAL MONITORING

In accordance with Cal/OSHA 8 CCR 5191(d), 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 Health and Safety is responsible for maintaining a statewide contract to perform the monitoring. The records shall be maintained by each Category I lab, district, or region.

B.6.0 LABORATORY INSPECTIONS

B.6.1 INITIAL INSPECTIONS

The "initial" laboratory designation inspections shall be a team effort conducted by the DLSO and the SCHO. The objectives of the inspection are:

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

B.6.2 DAILY INSPECTIONS

All Category I, II and III laboratories should be visually inspected on a continual basis. Supervisors and workers should be inspecting their laboratories daily.

B.6.3 MONTHLY INSPECTIONS

Safety equipment, as well as personal protective equipment, shall be inspected monthly and documented at all Category I, II and III laboratories. 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.

B.6.4 FORMAL QUARTERLY INSPECTIONS

The formal quarterly inspection shall be conducted by the DLSO and lab supervisor at all Category I laboratories. Category II and III laboratories are exempt from this requirement. 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 DLSO and shall be required documentation at the formal yearly inspection. A copy of the quarterly report shall be sent to the SCHO. The SCHO shall forward copies to the Laboratory Safety Committee

Chairman and the appropriate District/Headquarters Safety Office.

B.6.5 FORMAL YEARLY INSPECTIONS

Initiated by the SCHO at Category I laboratories, the formal yearly inspection shall be conducted by the SCHO and the respective DLSO for the laboratory to be inspected. The inspection will be unannounced. There will be specific items checked. The Comprehensive Safety Checklist (Appendix A of this document) shall be used. All deficiencies and time to correct shall be documented. The DLSO shall sign and be given a copy of the inspection report by the SCHO. The SCHO shall maintain all yearly inspection reports. The SCHO shall send copies of the yearly inspection to the appropriate District/Headquarters Safety Office.

Category II and III laboratories shall have a self-inspection conducted annually by the lab supervisor or the DLSO using the checklist in Appendix A (can be 100% or representative sample every year, with each laboratory being SCHO-audited at least once every three years). All deficiencies and time to correct shall be documented. The DLSO be given a copy and shall maintain the inspection report in accordance with Caltrans recordkeeping requirements. The inspection checklist shall be made available to the local safety representative and the SCHO upon request.

B.7.0 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 lab supervisor, in consultation with the DLSO, the local safety representative and 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 lab supervisor in consultation with the local safety representative shall obtain the physicians written opinion that should include a description of the medical examination and test results. A report should be developed with recommendations that may include the need for further follow up, medical conditions that place the employee at increased risk due to exposure to a laboratory chemical, and/or 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 lab supervisor, the DLSO and the local safety representative 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.

B.8.0 SPILLS, ACCIDENTS, AND EMERGENCIES

B.8.1 LARGE SPILLS OR HAZARDOUS MATERIALS

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

- Refer to the SDS of each chemical for the decontamination protocol of chemicals that require decontamination.
- Notify your supervisor, DLSO, 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 swept 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 a 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.

B.8.2 ROUTINE SPILLS –GALLON OR LESS

Refer to the SDS of each chemical for the decontamination protocol of chemicals that require decontamination. Wear protective clothing such as gloves, safety glasses and laboratory coats or aprons. If strong odors 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 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 – Follow all instructions provided by the manufacturer of the clean-up kit. A representative example of one manufacturer's instructions is given as follows: 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) - Follow all instructions provided by the manufacturer of the clean-up kit. A representative example of one manufacturer's instructions is given as follows: 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.
- 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 cleanup. Label bag and contact supervisor for disposal instructions.

B.8.3 ACCIDENTS

All chemical related accidents or near accidents shall be investigated by the SCHO, DLSO, and local safety representative 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.

B.8.3.1 Eye Contact

Follow the SDS instructions and seek medical attention if necessary.

B.8.3.2 Ingestion

Follow the SDS instructions and seek medical attention if necessary.

B.8.3.3 Skin Contact

Follow the SDS instructions and seek medical attention if necessary.

B.8.4 EMERGENCIES

Each laboratory shall have a written Emergency Action Plan. The plan shall 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.

B.9.0 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 hazardous waste 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.

B.9.1 GENERAL CONSIDERATIONS

When disposing of chemicals always wear appropriate protective clothing such as gloves, goggles, and laboratory coats. Small quantities of waste in the laboratory may 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 shall referred to the chemical waste disposal contractor for immediate disposal. Storage, transportation, and disposal of waste chemicals shall be by class to reduce the risk of chemical reaction and aid in disposal.

B.9.2 METHOD OF DISPOSAL

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

B.9.2.1 Liquid Chemical Waste

Aqueous

Nonhazardous 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.

B.9.2.2 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.

B.10.0 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.
- 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 and Health Manual

PART C

PHYSICAL TESTING METHODS

C.1.0 LABORATORY PRUDENT PRACTICES

As provided in Cal/OSHA Section 5191 Appendix A, the following recommendations are provided. Prudent Practices is the importance of establishing and nurturing a "culture of safety" - an environment in which safe laboratory practice is standard. Many laboratory operations and test methods involve procedures, equipment, and/or chemicals that are potentially hazardous. Employees shall be thoroughly acquainted with the potential hazards involved in each laboratory operation or test method before proceeding. Information regarding the safety concerns for each test method should be included in the test method text. If not, contact the lab supervisor prior to initiating the test to ensure proper safety measures are in place.

It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals. Skin contact with chemicals should be avoided as a cardinal rule.

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

Observe the Permissible Exposure Limits (PELs) of Cal/OSHA and the Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists should not be exceeded.

Prudent Practices do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, below are recommendations concerning safety hazards which also have implications for chemical hygiene:

C.1.1 GENERAL SAFETY PRINCIPLES

- Read test methods, SDS, 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 shall be reviewed prior to working in a physical testing laboratory. The following procedures shall be used for essentially all work in a physical testing laboratory:

C.1.1.1 Work Clothing Guidelines

Inappropriate clothing and footwear shall not be worn in the physical testing laboratory. Testers

will wear appropriate PPE where necessary 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 laboratories. For conducting concrete beam breaking, steel tipped shoes are required. Long hair, neckties, and other loose clothing shall be secured to prevent entanglement in equipment or involvement in sample preparation.

C.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.

C.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 shall 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. Do not 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.

C.1.1.4 Hand Injuries

Employees in the physical testing laboratories 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.

C.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.

C.1.2.1 Attitude

Employees shall maintain a professional attitude in the laboratory. Horseplay of any kind shall not be permitted. Employees shall abide by the safety rules and wear the proper equipment. Decisions concerning the usage of safety gear shall be determined by the lab supervisor. If an employee sees something that appears unsafe, it shall 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 lab supervisor.

C.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 shall only be consumed in the cafeteria, office space, or other designated areas. No food or drink shall 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.

APPENDIX A - COMPREHESIVE LABORATORY SAFETY CHECKLIST

COMPREHESIVE LABORATORY SAFETY CHECKLIST

SAFETY PROGRAM ADMINISTRATON			
Chemical Hygiene Plan	**Yes**	**No**	**N/A**
• Have all laboratories reviewed the Chemical hygiene plan?			
• Are there any operations that require prior approval before beginning? (ex., Radiation Safety).			
Standard Operating Procedures (SOP's)	**Yes**	**No**	**N/A**
• Are there written SOP's covering the basic laboratory safety and hygiene practices? Check last review date			
• Is there a procedure for identifying particularly hazardous substances used in the laboratory? Do they have a specific written procedure? Check last review date.			
• Training of laboratory personnel documented.			
• Laboratory Supervisor has written training plan for his/her laboratory.			
• Training is current with Chemical Hygiene Plan & Laboratory Safety Manual.			
• Training is complete on Hazardous waste management.			
• Training is complete on general safety management.			
HAZARDOUS MATERIALS	**YES**	**No**	**N/A**
• Laboratory doors are labeled with emergency contact notification names & numbers, hazards present & necessary precautions.			
• Labels are clean and intact on all chemical containers.			
• Contents of stock solution bottles are clearly identified (no laboratory abbreviations).			
• Synthesized, unnamed chemical compounds are labeled by their reactants and possible products or by a useful generic description (not by chemical structure only).			
• Containers with non-hazardous substances (i.e., water) clearly labeled to avoid confusion.			
Chemical Controls	**Yes**	**No**	**N/A**
• Chemicals are not stored on laboratory benches in excessive quantities.			
• Expired or chemicals not used (for more than one year) are disposed of as hazardous waste.			
• Defined area for highly toxic or carcinogens clearly marked.			
• Secondary containment is provided for liquid chemicals if needed.			
• No hazardous materials are stored in, around, under, or above			

sinks.			
• Incompatible chemicals are segregated and stored in compatible hazard classes.			
• All chemical containers are closed, except when actively adding or removing materials from them (i.e., no open funnels left in container).			
• Safety Data Sheets (SDSs) and laboratory chemical inventory are up-to-date and readily available.			
• Chemicals (liquids) are stored below eye level and not directly on the floor.			
Flammable & Combustible Liquids	**Yes**	**No**	**N/A**
• Are quantities of Class 1A liquids are stored in the laboratory?			
• If there are more than 10 gallons of flammable liquids, does the laboratory have the necessary fire protection systems available?			
• How many flammable liquid storage cabinets are in the room and what is the capacity of each?			
• Does the content of the storage cabinet exceed the maximum capacity of the cabinet?			
• Flammable liquids (including flammable liquid waste) stored outside of a storage cabinet does not exceed 10 gallons?			
• No flammable liquid storage cabinet are in the hallway.			
• Flammables are not dispensed from gravity-fed or bottom dispensing containers.			
• Flammables are not stored in combustible containers.			
• Highly flammable liquids are used away from sources of heat and ignition.			
• Flammable storage cabinets vented at bottom and door locked when not being accessed.			
Acutely Hazardous Substances	**Yes**	**No**	**N/A**
• Have all acutely hazardous substances been identified?			
• Is a current inventory available with appropriate SDS information?			
• Are areas or hoods where these substances are in use posted with a designated hazard sign?			
• Have special procedures for these substances been identified?			
• Are special procedures in practice? Verify procedures.			
• Are all users adequately trained? Documentation available.			
• All compressed gas cylinders secured with cap in place, if not in use.			
• All necessary PPE (personal protective equipment) available and used as needed.			

Chemical Waste Storage	**Yes**	**No**	**N/A**
• Have all chemical waste streams been identified as non-hazardous or hazardous and constituents been completely identified?			
• Specific storage containers provided for (check applicable categories: ( ) chemical waste ( ) recyclable solvents ( ) sharps ( ) radioactive waste			
• All hazardous chemical waste is arranged to be picked up Not drain disposed or evaporated.			
• All hazardous chemical waste is secondary contained.			
• Solutions with heavy metals are collected separately and disposed of as hazardous waste.			
• The satellite hazardous waste accumulation storage are is clearly labeled.			
• Training for personnel handling hazardous waste is documented?			
• There is a call for waste pick up when containers are ¾ full.			
• Waste containers sturdy, compatible with the waste, routinely checked for leaks and kept closed when not be filled.			
• Waste is segregated by compatible storage groups.			
• Are there any non-hazardous chemicals that are drain disposed? If so, what are they?			
Labeling	**Yes**	**No**	**N/A**
• All hazardous waste containers have the proper labels with the full chemical name or a list of full name and a percentage of each when waste mixtures are involved.			
• The accumulation area is clean with waste containers clearly marked, secondary contained and safety stored.			
• Synthesized, unnamed chemicals are labeled by their reactants and possible products or a useful generic description and possible hazardous. Do not label with chemical formulas only.			
PERSONAL HEALTH AND SAFETY			
Food and Drink	**Yes**	**No**	**N/A**
• Food and drink is not permitted in laboratories.			
• Food and drink is stored only in refrigerators/freezers dedicated and labeled "for food only."			
Standard Practices	**Yes**	**No**	**N/A**
• Employees wash areas of exposed skin prior to leaving the laboratory.			
• Hands must be washed after removing gloves and before leaving laboratory.			
• Hands must be kept away from face while working in the laboratory area. No cosmetic applications, taking medication,			

touching eyes, nose or mouth.			
HEALTH AND SAFETY EQUIPMENT			
Safety Showers and Eye Washes	**Yes**	**No**	**N/A**
• Approved safety showers and eye washes provided within 10 seconds travel time from the work area for immediate use.			
• All eye washes and showers have unobstructed access.			
• Units inspected monthly by the department and annually by Maintenance for proper functioning.			
• Sign indicating location of safety shower and eye wash unobstructed.			
Personal Protective Equipment	**Yes**	**No**	**N/A**
• Has the correct PPE been? Selected based on a hazard analysis or manufacturer's recommendation?			
• PPE required for laboratory work: ( ) Laboratory Coats, ( ) Safety glasses with side shields/goggles, ( ) Hearing protection, ( ) Face Shield, ( ) Proper foot-wear, ( ) Gloves, ( ) PPE for Radiological work, ( ) Aprons			
• All necessary equipment is available, in good condition, and properly used.			
Laboratory Fume Hoods	**Yes**	**No**	**N/A**
• Storage inside of hood is kept to a minimum.			
• Equipment in use does not interfere with proper functioning of the hood.			
• All work is done at least 6 inches inside hood.			
• Hood has continuous flow monitor.			
• The back ventilation slot is open a minimum of 2 inches.			
• Drains are protected from hazardous materials entering.			
Compressed Gas Cylinders	**Yes**	**No**	**N/A**
• Cylinders stored in well protected, well vented and dry locations away from combustible materials			
• Storage space is secured from damage either by passing or falling objects or subject to tampering by unauthorized persons.			
• Cylinders are secured to a rigid structural component of the building with chains located 2/3 the height of the cylinder			
• Protective caps in place while cylinders are in storage.			
• Proper regulators are being used and closed when cylinders are not in use.			
Air Pollution Control Equipment	**Yes**	**No**	**N/A**
• Are there any sources of air emissions other than chemicals being			

used in the hood?			
• Is there any air pollution control equipment (vapor recovery systems, cyclones, scrubbers, bag houses, electrostatic precipitators) in use?			
• If so, are they maintained and maintenance records kept?			
Housekeeping & Miscellaneous Laboratory Safety	**Yes**	**No**	**N/A**
• Bench tops clean, organized and maintained to eliminate harmful exposures or unsafe conditions.			
• Areas under sinks, window ledges, walls and floors kept orderly, Supplies stored at minimum 6 inches off floor or 18 inches from ceiling.			
• Vacuum lines equipped with traps designed specifically to accumulate/filter the hazardous materials being evacuated.			
• All moving machinery (i.e., vacuum pumps) belts adequately protected by a rigid belt guard or housing.			
• All sharps disposed properly.			
Electrical Safety	**Yes**	**No**	**N/A**
• High voltage equipment (>600V) labeled, grounded and insulated.			
• No equipment has damaged or frayed cords.			
• Extension cords are not used as permanent fixtures.			
• Multiple adaptors used only if they are equipped with circuit breakers.			
• All equipment is grounded via 3-prong plugs.			
• Plug covers are intact and secure.			
• Hot plates and heaters are out of harm's way and monitored.			
• Space heaters are not permitted in laboratory. Office areas may have space heaters if they meet Safety & Environmental Compliance Department requirement.			
Basic Safety	**Yes**	**No**	**N/A**
• Chemical shelves have lips or other type of restraint. Oxidizers are stored on wooden shelves and separated from other chemicals.			
• Cabinets and bookshelves are secured to the wall.			
• Overhead storage is minimized and restrained from falling.			
• Heavy equipment is secured or braced from falling.			
Respiratory Protection	**Yes**	**No**	**N/A**
• Use of respiratory protection conforms to USA guidelines.			
• Respirators are inspected monthly and before any use.			
• All user have been fit tested.			
• Cartridges are changed on designated schedule and are the			

appropriate cartridge for the hazard.			
Emergency Planning & Procedures	**Yes**	**No**	**N/A**
• "In Case of Emergency" or "Emergency Instructions" visibly posted and current.			
• Chemical spill kit/cleanup materials provided (if required by departmental plan).			
• Training in spill clean-up procedures provided and documented (only if spill clean-up materials are provided).			
• First aid materials kept in adequate supply (in a sanitary and usable condition) and made readily available.			
Fire Prevention	**Yes**	**No**	**N/A**
• Appropriate fire extinguisher mounted, unobstructed, available with 75 feet, in working order and inspected within the last year—check tag on extinguisher.			
• Fire extinguisher sign is clearly visible.			
• Fire blankets, labeled and unobstructed, if available.			
• 18-i8nch vertical clearance maintained from sprinkler head (i.e., over shelving).			
• Are all laboratory doors kept closed? Closure devices in place?			
• Storage of combustible material is minimized.			
Exits & Width of Exits	**Yes**	**No**	**N/A**
• Exits and aisles are clear and free of obstructions in case of emergency.			
• Exit signs clearly visible.			
• Width of exit aisles and pathways within laboratory no Less than 44 inches.			

APPENDIX B - CHEMICAL HAZARDS CLASSES

CHEMICAL HAZARDS CLASSES

1. Flammable
Definition: A spark will ignite at ambient temperatures; less than 100oF
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 selfreactive 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 shall be used around explosives. They shall not be stored more than 6 feet high.

4. Polymerizing Agents
Definition: Chemicals that react to 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 13 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 Toxicant
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 Toxicant
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 Toxicant
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 toxicant - highly toxic.
Example: Sodium Dichromate
Handling: Do not breathe fumes. Use with adequate ventilation and proper PPE.

APPENDIX C - COMMON SAFETY DATA SHEET (SDS) TERMS

COMMON SDS 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.

ASPHYXIANT - 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 concentration 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 laboratory 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 100°F 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 avoirdupois 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 140°F, 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 laboratory animal tests, this is the concentration of a substance which is sufficient to kill the tested animal.

LC_{50} - Lethal Concentration$_{50}$ - In laboratory 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 laboratory animal used for the test with a specific material.

LD_{50} - Lethal Doses - The single dose concentration of a substance required to kill 50% of the laboratory 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/m_3 - 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 firefighting purposes. These codes also classify materials in there order of flammability, with 0 being not burnable up to 4 which means will bum 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 laboratory 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 that when exposed to a pregnant female may cause malformation of the fetus. Usually associated with laboratory 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.