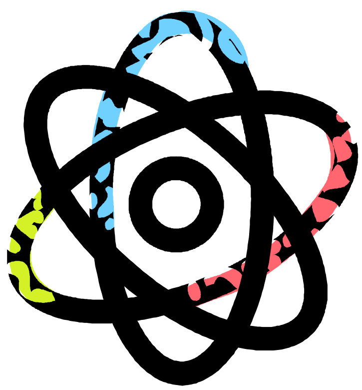
Science Safety Handbook

for California Public Schools
2014 Edition



California Department of Education
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Acknowledgments

Many representatives of various state agencies and educational and research institutions dedicated their time to make this handbook possible. The coordinators and developers of the 1999 edition are gratefully acknowledged.

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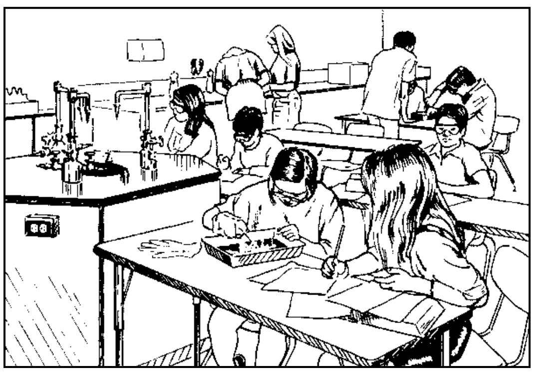
Chapter 1

Introduction

Laboratory activities and demonstrations represent an essential part of effective science teaching. Written materials and pictures can convey an enormous amount of information, but students more fully understand the concepts related to science when they participate in or observe learning activities involving laboratory experiments and demonstrations. In addition, those activities allow students to learn the processes and techniques of science laboratory investigation. Students who go to colleges and universities and take advanced science courses are expected to know laboratory procedures. The *Science Framework for California Public Schools, Kindergarten Through Grade Twelve,* states, "Hands-on activities may compose up to a maximum of 20 to 25 percent of the science instructional time in kindergarten through grade eight.[1]



Although many science activities present potential hazards, reasonable and prudent safety practices greatly reduce the likelihood of accidents. When students adhere strictly to standard safety precautions, they are unlikely to encounter any risks greater than those they might encounter in physical education, vocational education, or home economics classes. Knowing the possible hazards and taking precautions are the basis for creating a safe learning environment. All students studying science benefit from practicing safety procedures and from learning to appreciate scientific methods.

Science teachers should advocate safety and have the information necessary to inform community and school groups and involve them in support of activity-based science classes. School administrators and district administrative staff must be active supporters of hands-on science experiences. Administrators must be kept informed of laboratory activities and concomitant safety precautions and must devote resources to make such experiences possible. Parents, too, must be aware of and approve the laboratory experiences their children will have.

Science teachers are in a unique position to orient school administrators to the attitudes, skills, rational thinking processes, and knowledge resulting from laboratory activities. Many science

1 *Science Framework for California Public Schools, Kindergarten Through Grade Twelve* (Sacramento: California Department of Education, 2004)

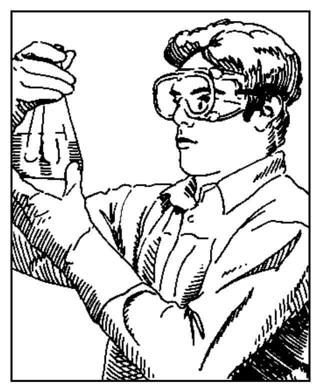
laboratory exercises use readily available materials and may be inexpensive to conduct. This information should be conveyed to administrators to increase their appreciation of the number, variety, and cost-effectiveness of experiments. The main point is that administrators who observe student motivation resulting from laboratory participation will be more likely to increase their support for activities that require more resources. To ensure that support, science teachers need to provide evidence that appropriate safety precautions have been taken.

A. Responsibilities of Students and Parents

Through their own educational background and training, most science teachers have learned to use safe laboratory techniques. Because many students have not had the opportunities at home and in school to observe and practice safety procedures, the science laboratory is a good place to begin learning the fundamentals. Students have a responsibility to themselves and their classmates to learn and observe safety practices in all participatory science activities. In addition, students should adopt positive attitudes about the need for safety in a laboratory setting.

Students' interest in science activities must be channeled constructively so that capricious, careless actions do not occur.

Education Code (EC) Section 51202 names what should be taught in most laboratory classes, including the following practices, skills, or areas of knowledge (see also Appendix A):



- Proper eye-safety practices
- Proper handling of glassware and glass tubing
- Proper setup and handling of electrical equipment
- Safe use of chemicals in the laboratory (correct storage, handling, and disposal)
- Safe, appropriate use of heat sources in the laboratory
- Proper prevention of exposure to bloodborne pathogens from sources such as sharp instruments (lancets, needles), tissues, and body fluids
- First-aid procedures
- Prompt notification to appropriate individuals or agencies of any dangerous or potentially dangerous conditions
- Safe, appropriate, and humane treatment of animals
- Prohibition against the use or presence of any venomous animals, poisonous plants, or plant pests

- Proper fire prevention and control techniques
- Correct methods for cleanup after experiments
- Proper behavior and courtesy for laboratory situations
- Earthquake-safe behavior and evacuation routes

Parents should be aware of the kinds of science laboratory activities that will be conducted and should be encouraged to sign consent forms for their children's participation. The consent forms (see examples included in Appendices B, C, and D) may be used as a way of informing parents of the safety procedures at school and of students' safety training. (Notably, such forms do not necessarily constitute a release of liability; any questions about the legal effect of such forms should be directed to appropriate legal counsel.) Consent forms should be considered affirmations of a partnership with parents, not abdication of control. Parents are welcome in the science laboratory, just as they are in other classes. (Of course, they should wear protective goggles and follow other safety procedures expected of the students.) Parents are encouraged to support the school science program and to reinforce the curricular objectives of the course through family activities, such as museum visits, field trips, and so on. Parents of students participating in science fairs should expect to work with the teacher to ensure that safety procedures are understood and adhered to by all.

B. Reasonable Laboratory Class Size

No current legal mandate prescribes special limits on class size in science laboratories. However, the *California Code of Regulations* (*CCR*), Title 24 – Part 2, the California Building Code, Table 1004.1.2 identifies Occupant Load Factors for different types of building uses. For a science lab classroom in any kindergarten through grade 12 (K-12) educational space, the occupant load factor is 50 square feet per person. Classrooms shall not exceed the number of persons allowed, based on the occupant load factor.

Other design specifications related to science laboratories in the *CCR,* Title 5, Section 14030 (i)(1)(A–J) include the following:

- Laboratories shall be designed in accordance with the planned curriculum.
- Size [of the science laboratory] is at least 1,300 square feet, including storage and teacher preparation area.
    - Science laboratory design is consistent with the requirements for proper hazardous materials management specified in this handbook.

- Accommodations are made for necessary safety equipment and storage of supplies (e.g., fire extinguisher, first-aid kit, master disconnect valve for gas).
- Secured storage areas are provided for volatile, flammable, and corrosive chemicals and cleaning agents.
- Properly designated areas are provided with appropriate ventilation for hazardous materials that emit noxious fumes, including a high-volume purge system in case of the accidental release of toxic substances that may become airborne.
- Exhaust-fume hoods, eye washes, and deluge showers are provided.
- Floor and ceiling ventilation is provided in areas where chemicals are stored.
- Room is provided for movement of students around fixed-learning stations.
- The capability for technology that complements the curriculum is built into the classroom.
- Classrooms are flexibly designed to ensure full student access to laboratory stations and lecture areas.

Because of these requirements, teachers and administrators need to establish reasonable limits on the number of students in a laboratory setting to ensure maximum safety in the science laboratory. Factors to consider include:

1. The space required for each student to perform experiments safely;
2. The safety features in the design of the facilities or space;
3. The level of maturity and safety knowledge that students bring to the science laboratory;
4. The number of students that one teacher can supervise during a potentially dangerous activity;
5. The nature and degree of increased hazard and liability when the class size exceeds 24 students.

It is recommended that schools take a practical approach to safe science instruction in determining the number of students in the laboratory classroom. Factors such as safety, number of stations, and total classroom square footage should be considered.

Laboratory Capacity

Faculty cannot be expected to monitor an overcrowded laboratory when potentially hazardous experiments are being conducted. No one—whether student, teacher, or administrator—wants the increased risk of having too many students in a science laboratory class. But overcrowding still occurs. It is a difficult risk–benefit decision for school administrators to set limits on laboratory class size. However, if a large number of students must be placed in an inadequately designed facility, there are ways to provide supervisory assistance for the teacher. An obvious alternative is to add an advanced high school student, a college student, or a retired science specialist as an aide (monitor) during the potentially hazardous laboratory activity; or other teachers may be willing to help supervise the laboratory. These assistants should be trained in all aspects of laboratory safety and be provided with liability coverage for their work.

Another alternative is to schedule additional laboratory sections to reduce the class size. Express safety concerns, in writing, to the department chairperson and school-site administrator. Under no circumstances should laboratory instruction proceed when the number of participating students exceeds the design capacity of the laboratory.

Students' Safety Experience

In determining laboratory class size, the teacher, department head, and principal should assess the students' backgrounds in relation to safety. Some students come to the science laboratory with safety training; they include students from previous science (laboratory) classes and from many vocational education courses. Obviously, students who have been instructed in safety and first-aid procedures are less at risk than those who lack such training. In addition, some groups of students demonstrate a more mature capacity for greater responsibility and, therefore, allow a greater sense of security in the laboratory. Section A addresses the students' responsibility to learn safety practices; the bibliography and appendices provide additional help in preparing students for safety.

Facilities

No amount of student screening can make up for overcrowded or potentially unsafe laboratory settings. A primary concern is the physical distance between students and between workstations in the laboratory. In many school laboratory stations that are designed for two pairs of students, a fifth student is added in the aisle. This practice crowds the students and blocks traffic lanes, inviting accidents and preventing orderly evacuation and administration of first-aid procedures.

Most laboratories were designed for a set number of students that should not be exceeded. For example, a chemistry classroom with a single vented hood was not designed for 30 or more students to test volatile toxic chemicals. Therefore, prudent planning of the laboratory program is necessary. Similarly, laboratories with single or distant eyewash and first-aid stations cannot accommodate multiple-injury or emergency victims. Alternative actions must be considered.

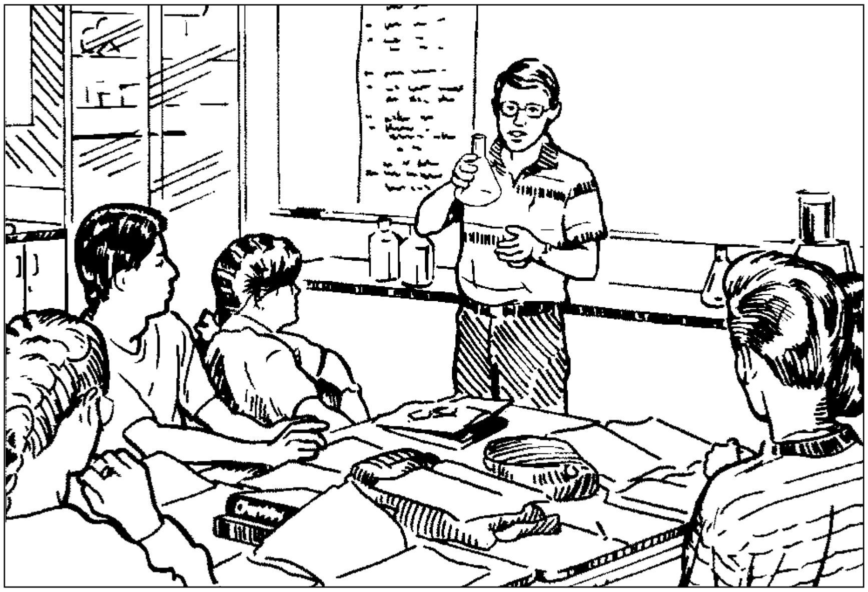
Work with the administrators to identify and alleviate potential hazards due to overcrowding and limitations in facilities. The objective should be to guarantee the safest possible environment for conducting experiments without reducing the number or quality of activity-based science lessons.

C. Reducing Risks of Injury and Liability

Laws and regulations at the national, state, county, city, and school district levels are explicit enough to place direct responsibility for the safety of students in science classrooms on teachers, administrators, school board members, and school district science specialists. This handbook is not intended to provide, and does not provide, legal advice of any kind. No representation is made as to the rules, requirements, or application of current law on liability arising from science classes, school premises, or any other matters. Only general recommendations are provided for reducing the risk of injury in science classes, and with it any attendant risk of liability. Any questions or concerns about the applicable law or liability should be directed to appropriate legal counsel.

In the existing climate of accountability and liability for the safe conduct of educational processes, school districts, schools, and science teachers come under close scrutiny and, in some circumstances, may be liable for injuries that occur in science classrooms and laboratories. Schools and school districts should ensure that science teachers receive adequate training, materials, and facilities to conduct classroom work safely.

It is important to plan preventive steps that will minimize accidents and reduce potential liability. Essentially, such steps include effective safety instruction, careful supervision of all activities, and proper maintenance of laboratory and classroom equipment.



Posting safety guidelines and procedures (see Appendix B, “Sample Safety Regulations for Science Students”) is a recommended practice for science classrooms. However, in and of itself, posting such materials may not be sufficient to ensure students’ safety and eliminate the risk of liability. Continually remind students of both general and specific hazards before the performance of laboratory activities in which any element of danger might exist.

If a textbook or laboratory manual specifies a dangerous procedure that neither the students nor the instructor can reasonably carry out, it is important to insure the procedure is replaced with a safe one. Students should not be allowed unsupervised access to potentially dangerous materials or equipment and should be under continual supervision in all laboratory situations (for the safety of students and equipment). Monitoring or supervising a laboratory setup during passing periods is an essential consideration.

Specific safety instruction and testing are highly recommended as an integral part of every science classroom procedure. This handbook includes suggested safety procedures and a student safety test that may be adapted for use in the teaching of various scientific disciplines (see Chapter 3 and Appendices B, C, D, E, F, G, and J). The checklist in Appendix F will be helpful in assessing the safety features of classrooms/laboratories, preparation areas, and storerooms. And the “Science Laboratory Safety Checklist” in Appendix C is designed to assist department chairpersons and administrative staff in evaluating the effectiveness of facilities and established procedures regarding accident prevention.

D. State and Federal Legislation Affecting Science Instruction

Since 1982, legislative enactments have had a significant impact on safety in science instruction. The following are the topics of those enactments:

1. Hazardous materials education (*EC* Section 49340 et seq.)
2. Removal of chemicals (*EC* Section 49411)
3. Occupational exposure to hazardous chemicals in laboratories; chemical hygiene plan (*CCR,* Title 8, General Industry Safety Orders, Section 5191)
4. Bloodborne pathogens (*CCR,* Title 8, General Industry Safety Orders, Section 5193)
5. Hazard communication; Standardized Safety Data Sheets (*CCR,* Title 8, General Industry Safety Orders, Section 5194)
6. Unified hazardous waste and hazardous materials management regulatory program (*Health and Safety Code* [*HSC*], Division 20, Chapter 6.11, Section 25404 et seq. and *CCR*, Title 27, Division 1, Subdivision 4, Chapter 1, Section 15100 et seq.). Associated laws and regulations can be accessed at ://www.calepa.ca.gov/CUPA/LawsRegs/ (accessed November 17, 2014).
7. Requirements for K–12 schools hazardous waste collection, consolidation, and accumulation facilities (*CCR,* Title 11, Division 4.5, Chapter 45, Article 5, Section 67450.40 et seq. and *CCR,* Title 22, Section 66270.60(d)(7))
8. Requirements for accumulation and treatment of laboratory hazardous waste (*HSC* Section 25200.3.1)
9. Hazardous Waste Source Reduction and Management Review Act of 1989, also commonly known as Senate Bill (SB) 14 (*HSC,* Division 20, Chapter 6.5, Article 11.9 and *CCR,* Title 22, Division 4.5, Chapter 31)
10. As of January 1, 1994, off-site storage, treatment, transportation, and disposal of extremely hazardous waste is subject to the same requirements specified for hazardous waste, and special or additional permits are not required (*HSC* Section 25153)
11. Specific requirements for “milkrun operations” for hazardous waste were repealed on December 31, 2001 (*CCR,* Title 22, Section 66263.42)
12. The State of California periodically adopts an updated version of the California Building Code. All public schools in California come under the jurisdiction of the Department of General Services. The Division of the State Architect has the specific task of enforcing all applicable building codes. Additional information may be obtained at ://www.dgs.ca.gov/dsa/Home. (accessed November 17, 2014).

Significant excerpts from these (and other) laws are cited in Appendix A. Summaries of the recent enactments are provided below:

1. Hazardous materials education (*EC* Section 49340 et seq.)

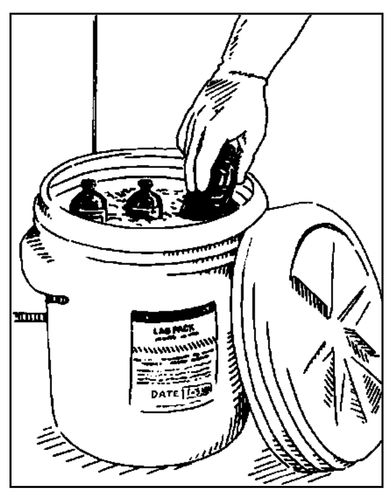
   This legislation recognizes the potentially hazardous nature of materials and procedures used in school science laboratories and the need for educators to increase the awareness of persons dealing with the materials to minimize the dangers. Each school is encouraged to designate a trained member of its professional staff as the building laboratory consultant responsible for reviewing, updating, and carrying out the school's adopted procedures for laboratory safety. School districts are encouraged to hire health and safety staff who can provide consultation and assistance to individual schools on all related issues, including those affecting science instruction.

   The Legislature urges the California Department of Education (CDE) to assume the leadership necessary to provide qualified individuals with the skills and materials to assist schools and teachers in the development of laboratory safety policies and procedures.

   School districts are encouraged to take steps to ensure that hazardous materials are properly used and stored; the governing boards may request consultation services from the California Occupational Safety and Health (Cal/OSHA) Consultation Service.

2. Removal of chemicals (*EC* Section 49411)

   The CDE, in cooperation with the Division of Occupational Safety and Health, shall prepare a list of chemicals used in school programs. The list includes the potential hazards and estimated shelf life of each chemical or chemical compound. The CDE should develop guidelines for school districts regarding the regular removal and disposal of all chemicals whose estimated shelf life has elapsed.

   The county superintendent of schools may implement a system for disposing of chemicals from schools within the county or may permit school districts to arrange for the disposal of the chemicals.

Chemicals identified as hazardous waste should be disposed of according to applicable hazardous waste disposal regulations. For additional information about compliance with these requirements, please contact the local Certified Unified Program Agency (CUPA). The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the California Environmental Protection Agency at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

Note: School districts and county departments of education may request reimbursement for the costs of implementing and maintaining a program for the regular removal and disposal of all chemicals whose shelf life has elapsed, in accordance with the guidelines, *if they certified to the Superintendent of Public Instruction by June 30, 1988, that the district complied with the guidelines.* See Appendix I for more information on reimbursable costs and details for filing claims for reimbursement.

3. Occupational exposure to hazardous chemicals in laboratories; chemical hygiene plan (*CCR,* Title 8, General Industry Safety Orders, Section 5191)

   This legislation requires all employers engaged in the laboratory use of hazardous chemicals to take specific action toward minimizing employee exposure to such chemicals. Employers must develop a chemical hygiene plan that includes:

   - Safe operating procedures
   - Protective equipment
   - Maintenance of proper labeling on hazardous substances
   - Retention of all Standardized Safety Data Sheets (SDS) from vendors and made available to employees
   - Employee information and training
   - Provisions for medical consultations and examinations
   - Designation of a chemical hygiene officer to implement and maintain the plan

   Employee information and training on the hazards of chemicals present in the work area shall be provided at the time of an employee's initial assignment to his or her work area and prior to assignments involving new exposure situations. Refresher information and training shall be provided at intervals determined by the employer.

The chemical hygiene plan shall be readily available to employees, employee representatives, and, on request, the Chief of the Division of Occupational Safety and Health.

4. Bloodborne pathogens (*CCR,* Title 8, General Industry Safety Orders, Section 5193)

   This regulation applies to all employers whose employees are subject to reasonably anticipated exposure of their skin, eyes, or mucous membranes, or through parenteral contact, to blood or other potentially infectious materials as a result of the performance of the employees' duties.

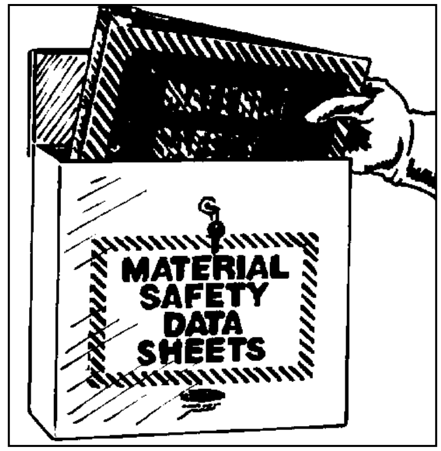
   Employers are required to establish a written exposure control plan (ECP) designed to eliminate or minimize employee exposure. The ECP must contain at least the following elements:

   - Determination of employees who may be exposed to blood-borne pathogens (school nurses, physical education teachers, school security personnel, science teachers, and other staff as appropriate)
   - Methods of compliance (e.g., engineering and work practice controls, personal protective equipment, and housekeeping procedures)
   - Hepatitis B vaccination
   - Postexposure evaluation and follow-up
   - Hazard communication information (labels and signs) and training
   - Recordkeeping

   Because science classes include a variety of hands-on laboratory activities in which the use of glassware and sharp instruments may result in cuts and abrasions, science teachers should be an integral part of, and comply with their school's exposure control plan.

5. Hazard communication; SDS (*CCR,* Title 8, General Industry Safety Orders, Section 5194)

According to Section 5194 of the General Industry Safety Orders, laboratories not engaged in either production of hazardous substances for commercial purposes or provision of quality control analysis for production processes are partially exempt from the requirements of obtaining a SDS from the manufacturer, of complying with the written hazard communication program, and of labeling containers (except as required by other safety orders regulating labels) when all of the following conditions are satisfied: (1) all exposed employees (professional, technical, janitorial, and maintenance) are under the direct supervision and regular observation of an individual who has knowledge of the physical and health hazards and emergency procedures involved; and (2) the supervisor **conveys this knowledge to employees in terms of safe work practices***.* Such exempted laboratories must also ensure that labels of incoming containers of hazardous substances are not removed or defaced and must maintain any SDS that are received with incoming shipments of hazardous substances, and ensure that those SDS are readily available to laboratory employees.



6. Unified hazardous waste and hazardous materials management regulatory program (*HSC*, Division 20, Chapter 6.11, Section 25404 et seq. and *CCR*, Title 27, Division 1, Subdivision 4, Chapter 1, Section 15100 et seq.)

   In 1993, Senate Bill 1082 established a unified hazardous waste and hazardous materials management regulatory program (known as the Unified Program) with the goal of consolidating, coordinating, and making consistent local implementation of the following six environmental programs:

   - Hazardous Waste Generators and Hazardous Waste On-site Treatment Permit Programs (*HSC*, Division 20, Chapter 6.5, Section 25100 et seq. and *CCR*, Division 4.5, Chapter 12, Section 66262.10 et seq. and Chapter 45, Section 67450.1 et seq.). Under the authority of the Department of Toxic Substances Control (DTSC), businesses whose processes generate waste are required to determine whether it meets hazardous waste criteria (*CCR,* Title 22, Division 4.5, Chapter 11). If a waste is hazardous, it is subject to various requirements of generation, storage, labeling, treatment, post-treatment storage, and disposal. Hazardous waste generators are required to obtain authorization before treating their waste on site, or under one of three authorization tiers [*CCR,* Title 22, Division 4.5, Chapter 45, Article 1, Section 67450.1 et seq. and *CCR,* Title 22, Section 66270.60(d)(3) and (4)]. Hazardous waste must be transported using a Uniform Hazardous Waste manifest. Off-site treatment, storage, and disposal of hazardous waste also require authorization.

- Aboveground Storage Tanks (*HSC*, Division 20, Chapter 6.67, Section 25270 et seq.). Under the authority of the State Water Resources Control Board (SWRCB), owners or operators of aboveground petroleum storage tanks are required to file a storage statement, pay fees, and implement measures to prevent spills.

- Underground Storage Tanks (*HSC*, Division 20, Chapter 6.7, Article 2, Section 25280 et seq. and *CCR*, Title 23, Division 3, Chapter 16). Under the authority of the SWRCB, an owner or operator of an underground storage tank must obtain a permit prior to commencing operation of a tank. The permit includes conditions regarding design, construction, installation, monitoring, repairs, upgrades, release response, closure, and notification/reporting.

- Hazardous Material Release Response Plans and Inventories, also known as Business Plans (*HSC*, Division 20, Chapter 6.95, Section 25500 et seq. and *CCR*, Title 19, Division 2, Chapter 4). Under the authority of the Office of Emergency Services (OES), each person who handles more than a specified quantity of hazardous materials must prepare a Business Plan, which includes a chemical inventory, site map, emergency response plan and procedures, and information on hazardous materials training.

- California Accidental Release Prevention Program, formerly known as the Risk Management and Prevention Program (*HSC*, Division 20, Chapter 6.95, Article 2, Section 25500 et seq. and *CCR*, Title 19, Division 2, Chapter 4.5). Under the authority of the OES, businesses that handle more than a threshold quantity of any extremely hazardous substances are required to prepare a Risk Management Plan to analyze the potential for accidents and devise mitigation measures.

- Uniform Fire Code Hazardous Material Management Plans and Inventories (*HSC* Section 13143.9 and *California Fire Code*, Article 80, Section 8001.3). Under the authority of the State Fire Marshal, a permit is required to store, dispense, use, or handle hazardous material in excess of specified quantities. Permit applicants may be required to prepare a Hazardous Materials Management Plan (HMMP) and Hazardous Materials Inventory Statement (HMIS). The HMMP designates storage and use areas for hazardous materials, prescribes the maximum amount of each hazardous material that can be stored or used in each area, specifies locations of emergency valves and conveyance piping, and includes a storage plan. For each hazardous material stored in excess of a threshold quantity, the HMIS lists general chemical names, common/trade names, major constituents for mixtures, manufacturer, United Nations or North American shipping numbers, hazard class or classes, material safety data sheets, aggregate quantity ranges, and carcinogen identification forms.

Under the oversight of the California Environmental Protection Agency (CalEPA), the state agencies responsible for these programs set the standards for their program while local agencies implement the standards. For additional information about compliance with these requirements, please contact the local CUPA. The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the CalEPA at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

7. Requirements for K–12 schools for hazardous waste collection, consolidation, and accumulation facilities (SHWCCAF) (*CCR,* Title 11, Division 4.5, Chapter 45, Article 5, Section 67450.40 et seq. and *CCR,* Title 22, Section 66270.60(d)(7)).

   These regulations establish mechanisms and requirements for off-site collection, consolidation, and accumulation of hazardous wastes generated by the routine operation and maintenance of K–12 schools. Requirements for activities at a contributing school and at the SHWCCAF are provided. Requirements are also provided for specific hazardous wastes generated from school science laboratories, including chemistry, physics, and biology classes managed at a SHWCCAF.

   For additional information about compliance with these requirements, please contact the local CUPA. The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the CalEPA at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014). Requirements are also provided for accumulation and treatment of laboratory hazardous waste (*HSC* Section 25200.3.1).

8. Requirements for accumulation and treatment of laboratory hazardous waste (*HSC* Section 25200.3.1)

   This statute defines **laboratory, laboratory accumulation area, and laboratory hazardous waste***.* It also defines limits and requirements for accumulation and treatment of laboratory hazardous waste generated on site. Up to 55 gallons of laboratory hazardous waste, or one quart of laboratory hazardous waste that is acutely hazardous, may be accumulated on site in a nearby laboratory accumulation area if requirements identified in this statute are met.

   If the treatment of laboratory hazardous waste complies with requirements specified in this statute, a permit or other authorization from the DTSC is not required. For additional information about compliance with these requirements, please contact the local CUPA. The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the CalEPA at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

9. Hazardous Waste Source Reduction and Management Review Act of 1989, also commonly known as Senate Bill (SB) 14 (*HSC*, Division 20, Chapter 6.5, Article 11.9 and *CCR*, Title 22, Division 4.5, Chapter 31).

   SB 14 requires hazardous waste generators to seriously consider source reduction as the preferred method of managing hazardous waste. Source reduction is preferable over recycling and treatment options because it avoids waste generation costs and management liability. It also provides the best protection for public health and the environment.

   Only hazardous waste generators who routinely generated more than 12,000 kilograms of hazardous waste or 12 kilograms of extremely hazardous waste in a reporting year are required to prepare the following three documents required under SB 14:

   - Source Reduction Evaluation Review and Plan. Or prepare the Compliance Checklist if the SB 14 criteria are met for a small business.
   - Hazardous Waste Management Performance Report. Or, if the SB 14 criteria for a small business are met, use the most recent biennial generator report as the Performance Report. Section 66262.41 of the *CCR* specifies the requirements for generators who must prepare the biennial generator report.

- Summary Progress Report.

All three SB 14 documents (or a copy of each) must be kept on the facility site and available for an inspector to review. The Summary Progress Report must be submitted or sent to the DTSC. The Plan and Performance Report need not be sent to the DTSC, unless requested by the DTSC.

Additional information on SB 14 is available at ://www.dtsc.ca.gov/PollutionPrevention/SB14/SB14_intro. (accessed November 17, 2014). Please contact the DTSC, Office of Hazardous Waste, at 1-800-728-6942 or e-mail @dtsc.ca. for additional questions.

Note: Guide to Hazardous Substances Reporting Requirements is a handbook to help organizations comply with this legislation. Available at a cost of $40 per copy, the guide may be ordered by writing to the Hazardous Materials Data Management Program at the following address:

California Environmental Protection Agency
Department of Toxic Substances Control
400 P St., Fourth Floor
Sacramento, CA 95812

Links to additional information regarding hazardous materials can be found at ://www.oehha.ca.gov/public_info/TDhazmat.html# (accessed November 17, 2014).

E. District Emergency Procedures

In addition to the *Science Safety Handbook*, there should be easy access to the following documents:

- The school district's emergency procedures.
- The school's chemical hygiene plan (*CCR,* Title 8, General Industry Safety Orders, Section 5191).
- The school district's injury and illness prevention plan (*CCR,* Title 8, General Industry Safety Orders, Section 3203; see also the Department of Industrial Relations Web site at ://www.dir.ca.gov/dosh/dosh_publications/IIPP.html#) (accessed November 17, 2014).
- The school's evacuation plans, hazardous materials spill procedures, and so forth.

Important local telephone numbers should be readily available in case of an emergency. The numbers may be set on speed dial for classroom, office, or mobile phones. Suggested emergency numbers include the following:

- Standard emergency number (9-1-1)
- Ambulance source
- Animal control
- California Division of Industrial Relations (Safety Concerns)
- Chemical disposal contact
- City/county health department
- District safety officer
- Fire department
- Hospital
- California Poison Control System **(1-800-222-1222)**
- Police/Sheriff
- School health service
- Toxic Substances Control office

Chapter 2

First Aid

Under normal circumstances, the school nurse will direct the activities necessary for treatments of illness, injury, or other health problems of students. However, at times the nurse may not be available for first aid on the school premises because of other responsibilities, including making home calls, transporting students, and engaging in health education duties. At those times, science teachers need to take appropriate action. Each science classroom should be equipped with appropriate first-aid and safety materials (see Appendix K).

A. General Information

Information in this section is adapted from multiple resources. It is not intended to supersede or make invalid any laws or rules established by local educational agencies or the State of California.

If a student becomes ill or is injured, instructors are expected to act in an informed and objective manner, with a minimum of emotional expression. Evaluate the problem, with special attention to the following symptoms:

- Difficulties in breathing—Start artificial respiration if breathing is absent; obtain a trained person to give cardiopulmonary resuscitation (CPR), if needed.
- The presence of bleeding—If necessary, control the bleeding in compliance with the school's bloodborne pathogens exposure control plan.
- The presence of shock—If necessary, initiate treatment. Section G of this chapter provides a discussion of shock resulting from injury.

Once assistance is given, it should be continued until the problem is resolved, or until the Emergency Medical Services personnel assume care for the victim, or until the patient is released to qualified medical help, the parent, or another responsible person. Measures should be taken to reduce any anxiety or fear that the injured student or other students may experience. A written accident report should be given to the school-site administrator when any such incident occurs (see Appendix K).

Do’s in First Aid

1. **Do** be cool, calm, and collected. Most cases are not serious.
2. **Do** obtain staff assistance if necessary.
3. **Do** handle the person as little as possible. Do not move the person until the illness or injury evaluation is complete.
4. **Do** call 9-1-1 if necessary.

On completion of the emergency-handling phase:

5. **Do** check with the victim and with any witnesses about what happened.
6. **Do** make a prompt, complete, and accurate report of the incident to the department chairperson and the administration.
7. **Do** pay attention to injuries that occurred on the way to and from school, as well as, those that occur at school.

Don’ts in First Aid

1. **Don’t** give liquids (or medicines) to an unconscious person.
2. **Don’t** try to arouse an unconscious person.
3. **Don’t** cut the skin, break blisters, and so forth.
4. **Don’t** diagnose.
5. **Don’t** give medical advice.
6. **Don’t** reduce dislocations.
7. **Don’t** transport an injured student in a private car.
8. **Don’t** send a student home before consulting a parent.
9. **Don’t** treat injuries that happened at home.

B. Bites by Snakes, Spiders, Insects, and Mammals

Rattlesnakes are common in California and are the only native venomous snakes in the state. They are common in canyons, mountains, deserts, and new construction areas. Few adolescents or adults die from rattlesnake bites, although such bites inflicted on small children are considered especially serious. Bites by insects seldom result in death, but the ensuing pain and discomfort may be minimized by early intervention. Dogs often come onto the school grounds and bite students; human bites occasionally occur in schools. Such bites often become infected, and victims should be referred to a physician for treatment and continued observation.

Venomous Snake Bites

1. The victim should be kept at absolute rest. Call 9-1-1. Treat for shock, as described in Section G of this chapter.
2. The major effort of the teacher should be to call 9-1-1 and quiet the victim.
3. Poison information centers recommend the following steps:
   a. Keep the victim still. Call 9-1-1.
   b. Place the injured extremity in a lowered position to retard the flow of the toxins to the victim's heart.
   c. Cool the extremity with cold compresses, if possible, until Emergency Medical Services (EMS) personnel arrive, but do not pack the wound in ice.
   d. Do not cut the wound area. A person injured at school can be transported quickly to a hospital where they can receive prompt, expert care by EMS personnel.
   e. Do not use a tourniquet. Tourniquets can shut off the blood supply, resulting in worse damage to the limb and bite wound.

Spider Bites

1. Apply a cold application to the wound site.
2. Refer a student with black-widow spider bites to the nurse and the student's parents for medical attention. Generally, the bites are not considered to be medically urgent unless the school nurse alerts the teacher that the student has had an allergic reaction.

Bee Stings

1. Observe the person for an allergic reaction while carrying out steps two through five described below. Some of the signs to look for would be:

   - Breathing difficulties
   - Dry, hacking cough
   - Swelling and itching about the eyes
   - Sense of constriction in the throat or chest
   - Massive rash

- Sneezing and wheezing
- Sense of uneasiness

These symptoms usually occur within minutes, and victims experiencing such symptoms should be seen by a physician right away. Occasionally, the reactions are delayed.

2. Remove the stinger as soon as possible by scraping it with a fingernail or the blunt edge of a knife or a plastic card. To avoid releasing more venom, do not squeeze the end of the stinger by pulling it out.
3. Wash the area of the sting well with soap and water.
4. Place an ice pack on the sting. Do not put ice directly on the skin. Use an ice bag or wrap ice in a cloth.
5. Seek medical evaluation if the swelling becomes severe. Observe for infection, as bacteria are associated with any bite or sting.

Mammal Bites

There is danger of infection and rabies from the bites of all warm-blooded animals. Students should be advised not to approach strange dogs or other animals, especially a familiar pet that is acting peculiarly. Bats and skunks that are active in daytime must be considered rabid.

First-aid treatment consists of washing and flushing out the wounds thoroughly with strong soap and warm water or detergent solution as quickly as possible. Continue the washing for at least 10 minutes. Call 9-1-1. The value of the washing procedure is greatest when performed during the first hour or two. Refer the student to parents for medical follow-up. Catch the animal, if it is deemed safe to do so, and obtain information on the animal. Then call the local animal control agency.

Tick Bites and Lyme Disease

Lyme disease is an infectious disease caused by a bacterium known as a spirochete. The western blacklegged tick, *Ixodes pacificus*, transmits the bacteria that cause Lyme disease to humans in California, primarily in the northern part of the state. Lyme disease can start as a mild flu-like illness, developing eventually into severe chronic health problems. Lyme disease can be successfully treated with antibiotics, especially in the early stages. The potential for long-term complications increases if the disease progresses untreated. For this reason, any tick bite occurring during school-related activity should be monitored for the development of the following symptoms and the individual should be seen by a physician:

- Red, expanding rash called erythema migrans (EM)
- Fatigue, chills, fever, headache, muscle and joint aches, and swollen lymph nodes

(Source: ://www.cdc.gov/lyme/signs_symptoms/ accessed November 17, 2014)

C. Burns

Because heat sources and corrosive chemicals are used in many laboratory science activities, there is the potential for burns to occur. If someone is burned, the following procedures are appropriate.

Chemical Burns of the Skin (usually from strong acids or alkalies)

This kind of burn needs to be washed with large amounts of water. Use a shower or hose at **low** pressure (a forceful stream of water may further injure the burned skin) for at least 10 minutes. Remove clothing from the affected area while the skin is being flushed. Clothing should be cut off, not pulled off, to avoid spreading the chemical over skin, face, and eyes. The label of some chemical containers may suggest other helpful first-aid measures that may be used for the particular chemical. **Do not attempt to neutralize any chemical**. Never pour vinegar or citrus juice on alkali burns; never pour baking soda on acid burns. Attempts at neutralization may cause further chemical reaction and more damage. Apply a nonocclusive (i.e., loose) dressing and call 9-1-1.

Chemical Burns of the Eye

See Section D, “Eye Injuries.”

Nonchemical Burns of the Skin

The degree or extent of burns and the percentage of skin surface involved usually determine the first-aid measures to be used. In general, adults who have suffered burns over 10 percent of their body surface (or a child with 2–10 percent burns) require hospitalization. Burns on the face suggest possible injury to the respiratory tract and may obstruct breathing as facial swelling increases. **Call 9-1-1, as prompt medical attention is urgent.**

First-degree burns mean minor burns, such as those resulting from overexposure to the sun or from light contact with a hot object. The usual signs are redness or discoloration, together with mild swelling and pain. First aid includes applications of cool water or submersion of the burned area in cool water for no longer than 10 minutes to stop the burn. Follow with a dry dressing, if necessary.

Second-degree burns may result from a very deep sunburn, contact with hot liquids, or flash burns from flammable products. These burns are usually of greater depth than first-degree burns and have a red appearance. Blisters are usually present. First aid for second-degree burns entails (1) immersing the burned part in cool water (**not** in ice water) for a few minutes (water at room temperature or less is appropriate); (2) applying dry, sterile gauze or a clean cloth as a protective bandage; (3) taking precautions against breaking intact blisters or removing tissue; (4) avoiding the use of an antiseptic preparation, ointment, spray, or home remedy; (5) keeping affected arms or legs elevated; and (6) seeking medical evaluation.

Third-degree burns may be caused by a flame, ignited clothing, immersion in hot water, grease scalds, contact with hot objects, or electricity. The temperature and duration of contact are important in determining the extent of tissue destruction. These burns are usually characterized by deep tissue destruction; white, dark brown, mottled, or charred appearance (at first, the burn may resemble a second-degree burn); and complete destruction of all layers of the skin. First-aid procedures for third-degree burns are as follows:

1. Extinguish any smoldering clothing by applying water or by smothering with a fire blanket or any available clothing.
    - **Do not attempt to remove clothing***.* Burnt clothing may be stuck or melted to the affected area.
    - Do not apply ointments, commercial preparations, grease, or other home remedies; those substances may cause further complications and interfere with treatment by the physician.
2. Do not attempt to administer any liquids or medicines orally to unconscious persons.
3. Cover the patient with a blanket.
4. If the hands are involved, keep them above the level of the heart.
5. Keep burned feet or legs elevated. (The victim should not be allowed to walk.)
6. Slightly elevate the head of a victim who has facial burns. Keep the person under continual observation for breathing difficulty. If respiratory problems develop, an open airway must be maintained.
7. Avoid immersing an extensively burned area or applying ice water over it; the cold may intensify the shock reaction. Cool water may be applied to the burned area to relieve pain and stop any further burning. Follow with the application of a dry, clean dressing or sheet.

8. Call 9-1-1 immediately and follow the serious injury or illness routine provided by the school district for emergency procedures.

Use of a Fire Blanket

If a student's clothing catches fire, the student should not run. He or she should stop, drop, and roll on the ground immediately while another student brings the fire blanket. Then the burn victim should wrap himself or herself in the blanket and roll on the ground to smother the flames. While the student is rolling in the blanket, the blanket should be held close to the neck to keep the flames away from the head and hair. Water, if available, may be appropriately used with the fire blanket to extinguish the flames.

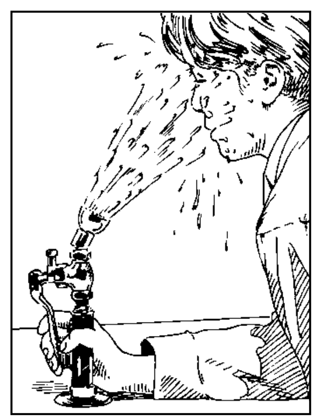
Do **not** use a fire extinguisher on a person; serious chemical reactions or frostbite (with the use of a extinguisher) may result from such use.

D. Eye Injuries

Immediate first-aid treatment for eye injuries may save the eyesight of an injured student. It is important to identify the source of chemical injuries to the eye.

Exposure to Chemicals—Acid Burns

Begin first aid for acid burns of the eye as quickly as possible.



1. Thoroughly wash the face, eyelid, and eye with tap water for at least 15 minutes, using the eyewash or eye/facewash station if possible (see Chapter 5, Section D, "Exposure to Corrosive or Irritating Substances"). If the victim is lying down, turn the head to the side; gently hold the eyelid open and, using the drench hose, apply water from the inner corner of the eye outward. Make sure that the chemical does not wash into the other eye.
2. Cover the eye with a dry, clean protective dressing (do *not* use cotton) and gently bandage in place.
3. Caution the victim against rubbing the eye.
4. Call 9-1-1.

Chemical Burns of the Eye—Alkali Burns

Alkali burns of the eye are progressive injuries. An eye that at first appears to have only slight surface injuries may develop deep inflammation and tissue destruction, and the patient may lose eyesight.

1. Flood the eye thoroughly with water for 15 minutes, using the eyewash or eyewash/facewash station. If the victim is lying down, turn the head to the side. Gently hold the eyelid open and, using the drench hose, apply water from the inner corner of the eye outward. Make sure the chemical does not wash into the other eye.
2. Cover the eye with a dry, clean protective dressing (do **not** use cotton) and gently bandage in place.
3. Caution the victim against rubbing the eye.
4. Call 9-1-1.

Other Chemicals in the Eye

1. Hold eyelids open; wash eyes immediately, using the eyewash or eyewash/facewash station, and continue to wash for at least 15 minutes. Make sure that the chemical does not wash into an unaffected eye.
2. Have someone call the California Poison Control System hotline at 1-800-222-1222 to speak to an expert who can ascertain the need for further medical treatment.
3. Call 9-1-1.

E. Exposure to Poisons

Proper storage and safety precautions, including correct labeling of all containers (see Chapter 7, Section F), are effective in preventing poisoning; instructors should follow those procedures. It is important to identify not only the poison but also the mode of entry. The danger of poisoning is present, and the teacher must be ready to act immediately.

The California Poison Control System has four answering sites or centers run by staff who can assist in evaluating the potential health risks from an exposure and the need for first aid and further medical management. The system can be accessed any time by calling 1-800-222-1222 from anywhere in California. (See Appendix H for a list of poison control centers.)

Be prepared to give staff at the poison control center the following information:

- Name of victim
- Age of victim
- Name of the poison involved
- Amount or degree of exposure
- Time of ingestion or exposure
- Condition of the victim
- Any first aid that has been performed

The poison control center staff will provide detailed instructions about additional steps to be taken.

If at any time the victim loses consciousness or develops difficulty in breathing, dial 9-1-1 to summon emergency medical personnel. CPR, including the use of an automated external defibrillator, should be performed, if needed.

Inhaled Poisons

1. If possible, carry the victim immediately (do not let him or her walk) to fresh air. Open all doors and windows if the victim is too heavy to carry.
2. Loosen clothing.
3. Use appropriate CPR if the victim is not breathing. Do not stop until the patient breathes or help arrives.
4. Have someone else dial 9-1-1 on the telephone for emergency medical assistance.
5. Monitor the victim for shock. (See Section G in this chapter.)

Ingested Poisons

1. Call the poison control center at 1-800-222-1222 (see Appendix H), give the staff the necessary information, and follow the staff's instructions.
2. Do **not** administer syrup of ipecac. Never induce vomiting in a stuporous or unconscious person.
3. Take the victim to a doctor or medical facility for further evaluation and treatment if instructed to do so. The package or container of the ingested poison, with the intact label(s), as well as any vomited material, should also be taken to the doctor. Avoid self-contamination.

4. **Note:** If there is any delay in the above procedures, the patient may be allowed to rinse out his or her mouth with water. A *small* quantity of water (2 to 4 ounces [60 to 120 ml]) may be swallowed to relieve any localized irritation in the throat or esophagus. It is **no longer** considered appropriate to give 8 to 16 ounces (240 to 480 ml) to dilute the poison in the stomach.
5. Notify the parents or guardians and arrange for them to meet the child at the hospital.

Poison (Chemicals) on Skin

1. Remove any clothing that has come into contact with chemicals or poison and place the clothing in a plastic bag labeled with the name of the injured person. Avoid self-contamination.
2. Wash the skin with large quantities of cool, running water.
3. Call the poison control center to determine the need for additional treatment (see Appendix H).

Poison Oak

Poison oak is common in wooded areas throughout California. Before going on outings in areas known to have poison oak, show the students a picture of poison oak so that they know what it looks like and can then avoid it. The skin rash that some people develop when they come in contact with poison-oak sap is called **allergic contact dermatitis**. The first exposure to the sap may sensitize the skin for future allergic reactions. It is not necessary to touch the plant to develop a rash; the sap can be carried by clothes, tools, pets, and even by the smoke from the burning plant. However, not everyone develops allergies from these plants, and sensitivity varies among individuals.

Once the skin is sensitized, a rash develops whenever another contact is made with the sap. Initially, the rash is red and itches. Blistering may occur later. Fluid inside the blisters is not contagious. If the rash spreads, some sap has remained on the skin (or reexposure has occurred). The serum from existing rashes does not spread the rash.

The treatment for exposure to poison oak is as follows:

1. Wash all exposed surfaces with soap and water.
2. Wash all exposed clothes, shoes, belts, bedding, and animals.
3. **Do not** use calamine lotion over the area.
4. Use wet soaks with tepid water for 20 to 30 minutes every two hours.

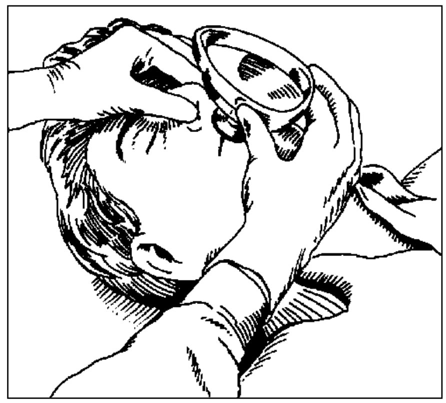
5. Use baking soda paste to reduce the itching.
6. See the family physician for diagnosis and suggested management.

Note: For further information about poisonous plants, see Chapter 5, Section F, “Poisonous Plants.”

F. Cardiopulmonary Resuscitation (CPR)

This procedure must be administered by someone who has been trained according to the standards of the American National Red Cross or the American Heart Association.

Basic life support is an emergency first-aid procedure that consists of the recognition of airway obstruction, respiratory arrest, and cardiac arrest and the proper application of CPR.



The CPR procedure consists of the following steps:

1. Open an airway and maintain the open airway.
2. Provide artificial circulation by means of external heart compression.

Each science teacher should be familiar with the CPR procedure because experience has shown that a stoppage of breathing is seldom isolated from a heart stoppage. Even if normal breathing and heartbeat are not restored, the injured person can be kept alive by this procedure until expert medical assistance is available.

Any condition requiring CPR is a serious medical emergency. During the execution of CPR, another staff member or responsible individual should first call 9-1-1 to recruit emergency assistance, then notify the parent and the nurse, who can also assist in calling 9-1-1. The EMS crew is specially trained for such emergencies, carries hospital emergency-room equipment, and communicates with hospital emergency staff, receiving instructions as well as providing information so that the emergency-room staff are better able to prepare for the patient’s arrival.

The American Red Cross (ARC) guidelines follow the American Heart Association’s (AHA) new CPR guidelines for laypersons, “Guidelines 2010 for Emergency Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.”

Automated External Defibrillators (AEDs)

AEDs are devices that help to restore a normal heart rhythm when the heart is not beating properly. It does this by delivering an electric shock to the heart. These devices are now increasingly being placed in public places such as airports and schools.

A physician’s prescription is required to purchase an AED. A physician is also required to provide medical direction to the school or school district that acquires an AED. If the school has an AED, obtain training in its use, and training in CPR, before an emergency occurs. The majority of AED use in the schools will be on adults at the facility, since the medical conditions likely to require use of an AED on a child are extremely rare.

AED training is offered through the American Heart Association, the American Red Cross, the American Health and Safety Institute, the National Safety Council and other CPR and AED training programs. AED manufacturers also offer training. The AED regulations are available at the EMS Authority’s Web site ://www.emsa.ca. (accessed November 17, 2014). (See *CCR*, Title 22, Division 9, Chapter 1.8, Training Standards and Utilization for Use of the Automated External Defibrillator by Non-Licensed and Certified Personnel for further information).

G. Shock

Shock from injury is also called **traumatic shock**. Body functions are depressed, and death may result even though injuries would not otherwise be fatal. Look for the following symptoms:

1. Pale or bluish skin. In a dark-skinned victim, examine mucous membranes inside the mouth or under the eyelids.
2. Moist or clammy skin.
3. Rapid pulse, often too faint to be felt at the wrist.
4. Increased breathing rate; shallow breathing if there is chest or abdominal pain.
5. Weakness. If the weakness is caused by hemorrhage, the victim may also be restless and anxious. The patient will complain of deep thirst.
6. Retching or vomiting. Note the following:
    - If the patient has vomited, save a sample in a container that can be closed. Do not touch vomit or any other body fluid.
    - Do not give fluids; do not induce vomiting.
    - If an unconscious victim is vomiting, logroll the patient onto his or her side to prevent aspiration. During logrolling, it is important to stabilize the head and trunk by manual

in-line immobilization, especially in patients with trauma or suspected trauma to the head or spinal cord.

7. Fainting or collapse.

   Treatment of shock consists of these measures:

   - Keep the victim lying down.
   - Cover the victim to minimize further loss of body heat.
   - Begin CPR if the victim stops breathing.

H. Universal Precautions

Universal precautions refer to a safety practice that assumes that all body fluids may be contaminated with a communicable disease. Therefore, great care is taken when victims are provided with first aid or CPR, or when body fluids are involved.

For protection from possible bloodborne diseases, such as HIV and hepatitis C, it is important to wear nitrile or latex gloves when providing care and to carefully remove them after providing care. Remember to wash hands thoroughly after providing care to a victim, even if gloves have been used. Use CPR mouth barriers when providing rescue breathing or CPR to a victim.

It is important to dispose of any materials that come into contact with body fluids. This should be done in an appropriate manner in the school setting, as if disposing of hazardous waste. Follow the school's hazardous waste procedures for such disposal.

Chapter 3

General Laboratory Safety Precautions

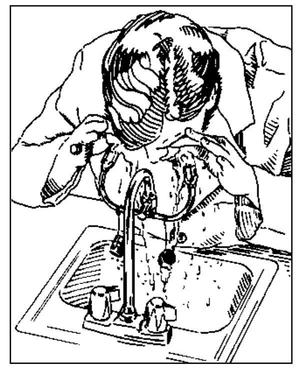
The laboratory science instructional program should be carefully planned and conducted to ensure maximum safety conditions for all personnel. If the instructor has concerns about particular safety conditions related to facilities, equipment, supplies, curriculum, classroom occupant load, and so forth, immediately notify the school-site administrator **in writing** for assistance in relieving the condition.

The following list identifies safety practices and regulations common to all school science laboratories. Additional laboratory and safety practices for specific subject areas and teaching situations are provided in subsequent chapters.

1. Be fully acquainted with the first-aid procedures in Chapter 2.
2. Understand the potential hazards of all the materials, processes, and equipment that will be used in the school laboratory. Table 7.1 in Chapter 7 provides a list of chemicals that are common sources of accidents in schools.
3. Know the risks involved in using chemicals and prepare the chemicals before class begins. Neutralizing solutions should be available for dangerous materials used by students.
4. Report any student injury or accident immediately on the school district's accident report form, available in the main office or health office of each school. (See Appendix K for a sample accident report form.)
5. Safety in the laboratory should be taught and reinforced throughout the year. Make notations in the daily lesson plans for each instructional act regarding safety and maintain a record (log) for each class to document the specific topics of safety instruction and the dates on which they were taught. Thorough instruction on safety procedures, including appropriate disposal of excess or waste chemicals, must precede each laboratory activity. (See Appendix B for sample classroom safety regulations and a sample student science safety agreement; see Appendix E for a sample science laboratory safety test.)

6. The use of approved eye-protective devices is required of all persons performing science activities that involve potential hazards to the eyes. This includes chemical and water-propelled rockets. All persons in dangerous proximity to such laboratory activity (that is, all persons within the laboratory) must also wear approved eye-protective devices. (Read carefully Chapter 5, Section C, “Eye Safety,” and *EC* sections 32030–32033 in Appendix A.)

7. A plumbed-in eyewash station, supported by a face-and-shower “drench hose,” must be available in each laboratory/classroom in which chemical splashes on eyes, skin, or clothing are possible. (*CCR,* Title 8, General Industry Safety Orders, Section 5162; see Appendix A.) Teachers and students should be familiar with the location and function of the eyewash station. Several types of stations are possible, including:



   - A completely plumbed-in or self-contained eyewash or eyewash/facewash station.
   - A faucet-mount eyewash or eyewash/facewash unit that attaches directly to an existing faucet and also allows for normal faucet usage.
   - A face-and-shower-head drench hose, operated by a squeeze handle, that may support plumbed or self-contained units but may not be used in lieu of them (unless specially designed with separate flushing sprays for each eye).

   The showerhead should be on a hose that pulls out of the counter and is installed next to an existing sink, where the face can be held as the eyes are washed. Plumbed eyewash and shower equipment must be activated at least monthly to flush the line and to verify proper operation.

8. Be aware of the code requirements and other information on eye safety discussed in items 6 and 7. Many of the hazardous activities described below are of interest to junior high school and high school teachers of general science courses, and the following additional information on eye protection is particularly important to those teachers:

   a. There is potential for injury to eyes when working with hot liquids or solids or with chemicals that are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or that generate pressure through heat, decomposition, or other means. Splash-proof indirectly ventilated goggles and face shields must be worn.

b. Investigations in geology and earth science frequently involve activities such as hammering, chipping, and grinding rocks, minerals, and metals. When hammering or chipping is being done, the use of eye-protective devices, as well as a cloth cover over the rock or mineral to reduce the hazards from flying particles, is absolutely necessary. When grinding rocks, use a face shield for protection.

c. **Students must not look directly into the sun**, even during complete solar eclipses. The danger of retinal burn comes from the invisible infrared rays, which penetrate light filters and instantaneously damage eyes. The retina is not sensitive to pain; therefore, the victim might not immediately be aware of eye damage. Retinal burns are incurable and destroy the field of fine vision. The victim’s ability to read can be lost forever.

   Note: No homemade eye protection has been approved for use when the sun is being viewed. Therefore, students may not participate in this activity unless images of the sun can be projected or can be viewed through a commercial telescope with an approved objective filter. Do not use the viewfinder of any telescope during an activity that involves viewing the sun unless the viewfinder is designed for that purpose. To avoid eye injury that may result from accidentally tripping the mechanism and engaging the viewfinder, place tape on the bracket supporting the mirror for the finder to hold the bracket in a position to shade the mirror. Supervise closely all activities in which a telescope is used.

   - Layers of photographic film or welders’ masks should not be used to look directly into the sun, even during a complete solar eclipse.
   - The indirect pinhole method should be used to view the eclipse. A projector for observing the eclipse can be made with two pieces of white cardboard. A pinhole or pencil-point hole in the top piece serves to project and focus the image of the eclipse on the second piece. The size of the image can be changed by altering the distance between the two pieces of cardboard.

d. When using infrared and ultraviolet light sources, observers must shield themselves from a direct view of the light source.

9. Reagent and storage bottles containing chemicals should be properly labeled (including date of receipt or preparation) at all times.[2] If the label is lost and the contents are unknown, the substance should be regarded as potentially hazardous and must be chemically categorized by an experienced waste specialist before possible treatment and transport to a proper disposal site.

10. Poisons and dangerous reactants should be made inaccessible to students except during actual usage. Students should be instructed never to taste or place any substance or object in the mouth except as specifically directed by the teacher under controlled conditions.

11. Suction devices or pumps should be used when pipetting. **The mouth should never be used for this purpose.**

12. Chemicals should be stored according to their compatibility group in a **single** safe and practical storage pattern. Adopt and standardize a plan that is agreeable to all staff members and use it **throughout** the school. The storage compatibility categories shown in Chapter 7, Table 7.4, are suggested for use in all California secondary schools. Use of more than one storage compatibility system at one site may be dangerous.

13. Chemicals should be stored in chemically inert containers appropriate for the type and quantity of chemical. The containers must be stored in a location or manner to prevent physical damage to or deterioration of the container. For example, chemical containers should not be stored directly on the floor. This precaution will prevent the contact of chemicals with water from flooding, mopping, or condensation and the puddling of liquid contents of defective or broken containers around adjacent stored chemicals. Large containers should be stored on the lowest shelves to minimize the danger of breakage or spillage when containers are being removed or replaced. (See Appendix A for *CCR,* Title 8, Division 1, Chapter 4, Subchapter 7, Group 16, Article 109, Sections 5163 and 5164.)

14. No explosive chemicals should be kept in the school laboratory. See Chapter 7, Table 7.2, for examples of common explosive chemicals, which **must be disposed of only by trained and qualified officials***.* (Consult Chapter 7, Section E, Step 2, for more information.)

[2]. Minimum precautionary labeling standards for injurious substances used in places of employment in California are established in *CCR,* Title 8, General Industry Safety Orders, Article 112: Labeling of Injurious Substances (Sections 5225–5228). The labeling standards that are of special concern to high school science teachers are included in Chapter 7, Section F.

15. Any known carcinogen must be removed from the science area and disposed of appropriately. (See Chapter 7, Table 7.3, “Extremely Hazardous Chemicals Requiring Prompt Disposal.”)

    Note: Materials containing asbestos pose a health risk only if asbestos fibers become airborne and are inhaled. As a result, products made of asbestos, once used in the manufacture of heating pads, wire gauze centers, beaker tongs, gloves, and various other products, should be replaced by ceramic-fiber or glass-fiber products if they are damaged or the asbestos fibers can become airborne.

16. Food for human consumption should not be stored in refrigerators or cabinets or on shelves used for storing chemicals or biological materials. Food should **not** be eaten in science laboratories or storage areas because of the danger of ingesting toxic or corrosive substances.

17. In an experiment or demonstration involving any flammable liquid (such as alcohol), care must be taken that any flame in the room is at an absolutely safe distance from the volatile liquid. Vapors may flow along a table or countertop for long distances to an unseen ignition source, then blast back. Beware of gas water heaters in or near science classrooms or stockrooms.

18. Teachers and students should be familiar with the operation of all fire extinguishers in the laboratory. The labels on the extinguishers contain directions for use.

19. Teachers should be familiar with the location of all master controls for utilities, especially the master valve in each room for the gas outlets. Mark or color-code all services clearly.

20. The instructional area should be kept free of spills, broken glass, and unnecessary equipment and materials. Good housekeeping is essential.

21. Laboratory waste should be segregated by waste type to facilitate proper disposal. For example, different waste receptacles may be used for paper, glass, metal, plastic, organics, biological, and hazardous (such as waste chemicals). Hazardous wastes should be placed in compatible containers and segregated to prevent interaction of incompatible wastes. Any hazardous waste should be disposed of according to applicable hazardous waste disposal regulations. For additional information about compliance with these requirements, please contact the local Certified Unified Program Agency (CUPA). The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the California Environmental Protection Agency

at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014). (See Chapter 7, Section E, Step 6.)

22. Teachers should avoid unsafe practices by instructing and cautioning students about the correct techniques for the following activities:
    - Using a Bunsen burner and other related flame-producing equipment
    - Heating liquids in test tubes, beakers, and crucibles
    - Handling reagent bottles
    - Using polyethylene squeeze bottles
    - Obtaining and handling dry chemicals
    - Cutting, bending, and fire-polishing glass tubing and rods
    - Using other laboratory materials, as appropriate (for example, pipettes)

23. When an electrical plug is to be removed from its socket, the plug, not the electrical cord, should be pulled.

24. Laboratories should always be locked when not in use.

25. The custodial staff should be alerted to general hazards they may encounter in science areas and to special situations that arise.

26. Teachers should set an example for the students by wearing goggles, aprons, gloves, and appropriate footwear when students are required to do so. Follow all safety regulations and be alert at all times, reminding students of hazards. Students who do not adhere to the rules should not be allowed to participate until the teacher is assured there will be no further infractions. (**Note:** More information on proper protective equipment may be found in the Occupational Safety and Health Administration handbook *Personal Protective Equipment* at ://www.osha.gov/Publications/osha3151.html (accessed November 17, 2014).

27. Periodic use of the "Safety Checklist for Science Instruction, Preparation, and Storage Areas" (see Appendix F) should be made to check classroom and preparation areas. Safety and energy-savings procedures should be carried out at the end of each school year (see Appendix G).

Chapter 4

Safety in the Elementary Science Classroom

Students in California are expected to engage in the process of science as soon as they begin their formal schooling. The *Science Framework for California Public Schools* (California Department of Education, 2004) describes investigative skills for students, beginning with the kindergarten level. The kindergartner may observe the appearance of vegetative structures that develop from seeds planted and maintained in the classroom, or the student may sort common objects according to a physical characteristic. A third-grader may study insect metamorphosis by observing the life cycle of mealworms. A fifth-grader may perform simple chemical reactions to observe differences between reactants and products.

The examples described above clearly indicate that the students and the teacher must do more than read about science. A robust elementary science program that includes hands-on investigations must be accompanied by an intentional and ongoing focus on safety. This “safety consciousness” most appropriately begins with the student’s earliest science experiences and ideally becomes refined and internalized as the student progresses through the grades.

Science teachers should become especially familiar with the following chapters: Chapter 1, “Introduction”; Chapter 2, “First Aid”; Chapter 3, “General Laboratory Safety Precautions”; and Chapter 5, “Additional Safety Practices.” Although some of the recommendations in these chapters relate to activities, equipment, and chemicals that are more likely used in middle and high school science laboratory programs, elementary students and teachers are equally impacted by the need to practice safety as they perform grade-level-appropriate investigations. In addition, be especially vigilant about modeling safe practices before each investigation and monitoring the students throughout the laboratory session. Younger students require repeated emphasis on issues of safety in order to instill in them safe habits that will support their confident participation in science activities.

A. Physical Space and Class Size

A classroom environment that supports the implementation of science activities in a safe manner is established only through the concerted effort of the teacher, students, school administrators, and parents. Of primary concern is the physical space where the science activities will take place. The classroom must adequately accommodate the number of students for whom the space is designed. Overcrowding in the laboratory increases the risk of accidents and exposes the school district, the school administration, and staff to greater liability. According to research cited in a National Science Teachers Association position paper, accidents increase when class enrollments exceed 24 students or when not enough individual work space is provided.[3]

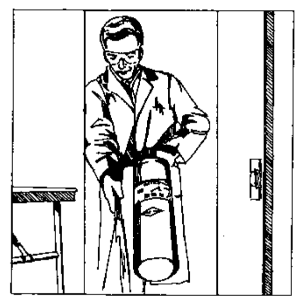
The *CCR* (Title 5, Subchapter 1, Section 14030) calls for school design to provide 1,300 square feet, including teacher-preparation areas as well as apparatus and chemical storage space.

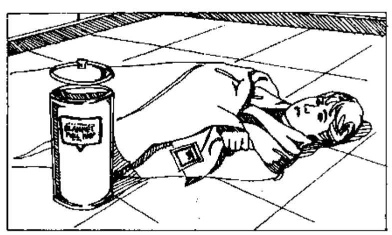
B. Use of Safety Equipment

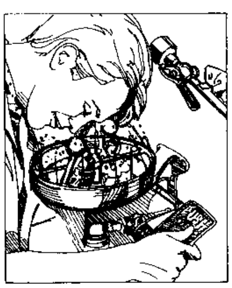
Once it is established that the physical space is appropriate, the next step is to become thoroughly knowledgeable about the location, proper use, and maintenance of safety equipment. Administrators can support teachers in the area of safety by providing safety training from persons or agencies with such expertise.

Know about:

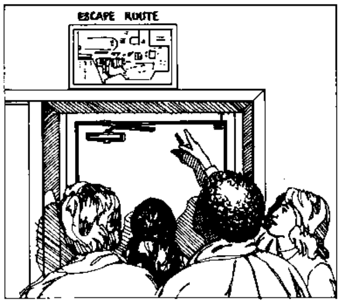
- Adequate room ventilation
- The location and proper use of the cut-offs for the room's gas supply and electricity source
- The location and proper use of fire extinguishers
- Fire blankets
- Eyewash fountains or devices







[3]. From the "National Science Teachers Association Position Statement: Liability of Science Educators for Laboratory Safety," adopted by the NSTA Board of Directors, September 2007.



Clearly label or mark materials, storage space, and evacuation routes.

Teachers and students must be familiar with a posted safety plan, including an evacuation route. Keep a first-aid kit fully supplied and readily accessible at all times. Chemical hygiene plans based on standards from the California Occupational Safety and Health Administration (Cal/OSHA) should be implemented.

C. Making Safety a Habit

Safe practices are essential in any laboratory activity. The safe handling of equipment and materials should be reviewed as the instructor explains and models the procedure for a given activity. Responses that reflect students' understanding of safe practices should be solicited before the instructor proceeds with a lab activity. Effective strategies for fostering a responsible attitude regarding safety include the use of a student agreement to be signed by both student and parents and the display of student-generated posters on various aspects of safety in the science classroom.

In addition to learning the proper way to handle laboratory equipment and materials (both living and nonliving), students must learn how to manage their own personal safety. Instruct students about appropriate dress in a laboratory setting and the proper use of safety items such as goggles, gloves, and aprons.

Personal safety in the laboratory includes behavior. Horseplay is forbidden in the lab setting. Discipline must be maintained to preserve a safe environment and to help impress upon students the potential hazards of many substances and procedures.

D. General Safety Checklists

As cited in Chapter 3, "General Laboratory Safety Precautions," specific safety precautions are discussed, although some may involve laboratory experiences outside the scope of the elementary curriculum. Appendix F is an excellent checklist for assessing the physical setup of the laboratory setting to determine readiness for instruction.

Another source of science safety checklists is the Council of State Science Supervisors (CSSS) Web site, ://www.csss-science.org/safety. (accessed November 17, 2014). The views and recommendations expressed by the CSSS concerning the law and/or legal liability are not necessarily those of the CDE, and the CDE makes no representation as to the validity, accuracy, or applicability of such views and/or recommendations by mention of any CSSS publication herein. Notable safety recommendations for elementary teachers are to:

- Avoid the use of glass where possible, substituting appropriate plasticware instead.
- Avoid the use of mercury thermometers with elementary students.

Must-have items of note are:

- Appropriately sized indirectly ventilated chemical splash goggles
- Nonallergenic gloves
- Protective aprons
- Eyewash units
- Safety spray hoses/shower
- ABC tri-class fire extinguishers (A is for paper, wood, cloth, rubber, or plastic fires; B is for burning liquids, gases, or greases; and C is for burning electrical equipment)
- Fire blanket
- First-aid kit (as local and state policies permit)

Implement a goggle sanitation plan if multiple classes will share goggles.

E. Common Laboratory Operating Procedures

Another need expressed by elementary teachers, according to CSSS, is a description of common laboratory operating procedures. District, local, and state safety regulations should form the foundation for safe laboratory procedures. The CSSS safety document conveniently organizes common laboratory operating procedures into three categories: regulated safety rules, general safety rules, and classroom management.

Regulated safety rules are those district, local, and state statutes and regulations that apply to the operation of a safe laboratory. Science teachers should know and follow these rules as they use and store chemicals or provide for the care of an animal.

General safety rules are those related to the proper use of materials and equipment in the laboratory. Teachers and their students must wear laboratory attire and properly use appropriate equipment that is in good working order.

Classroom management speaks to teacher supervision of students and to an intentional emphasis on adherence to safety. Involve students immediately in becoming responsible for their personal safety through the use of safety agreements and assessments of the students' understanding and application of safety rules.

Parents should also indicate their understanding of laboratory expectations around safety when they sign the safety agreements. Examples of safety agreements and laboratory safety tests at the elementary level are in Appendices B and E, as well as at laboratory safety sites on the Web.

Routinely perform a trial run of a planned laboratory activity to determine potential hazards associated with the activity and then develop a plan to reduce or eliminate them. Then implement the activity according to the plan and monitor the students as they complete the activity in a safe manner. As part of the plan, students should:

- Wear appropriate clothing
- Use appropriate safety equipment (goggles, gloves, and protective aprons if necessary)
- Confine themselves to their assigned lab groups and lab areas (never in the teacher prep area)
- Follow the teacher's instructions

Student hand washing and a post-activity cleanup procedure should be a part of the overall lab plan.

F. Use of Chemicals

The use of chemicals in the elementary laboratory setting deserves some additional discussion. The CSSS recommends that the amount and types of chemicals used for instruction in the elementary science classroom be small in quantity and number. However, there are many instances when elementary students will work with chemicals. Therefore science teachers need to know about the physical properties, toxicity, proper storage, and handling of the chemicals being used.

As a part of the proper use of chemicals in the laboratory, a SDS must be maintained for each chemical used (locally purchased or purchased from a chemical supply house). The SDS is a form designed to support the safe use and handling of chemicals. It contains information about a chemical substance, such as physical data (melting point, boiling point, and so forth), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment , and what to do in case of spillage or leakage.

The SDS normally is included in the shipment of a chemical, but it may also be accessed online free of charge at selected Web sites. The sites are described at ://www.ilpi.com/MSDS/#Internet (accessed November 17, 2014). Although there should be no implication of endorsement or lack of endorsement by the CDE, a useful Web site for teachers is the Flinn Scientific site at ://www.flinnsci.com/msds-search.aspx (accessed November 17, 2014).

Do not use unfamiliar chemicals without reviewing the SDS first. Specimens and chemicals should be labeled and dated upon receipt of the shipment. Containers used by students or by the teacher in the preparation area should be labeled as to the contents.

Purchase and Management of Chemicals

The CSSS Web site offers some general guidelines for the purchase, labeling, storage, and disposal of chemicals of particular interest to elementary teachers. In addition to reviewing the SDS before purchasing a chemical, consider using generic chemicals commonly obtained from home, the grocery store, or the drugstore whenever possible. Below is a list of examples:

- Vinegar (acetic acid)
- Aluminum foil (aluminum metal)
- Vitamin C tablets (ascorbic acid)
- Ammonia (ammonium hydroxide, base)
- Chalk (calcium carbonate)
- Lime (calcium oxide, basic)
- Plaster of Paris (calcium sulfate)
- Rubbing alcohol (isopropyl alcohol)
- Talc (magnesium silicate)
- Baking soda (sodium bicarbonate)
- Table salt (sodium chloride)
- Table sugar (sucrose)
- Epsom salts (magnesium sulfate)
- Starch (corn starch)

Chemicals should be purchased in a quantity sufficient to be used within a defined period, ideally within the school year.

Chapter 7, "Safety in the Chemistry Laboratory," gives a comprehensive treatment of the considerations for managing chemicals in the laboratory. The CSSS adds the following recommendations for elementary teachers:

- When labeling chemicals, give the chemical name or trade name of the product on the label. Include the name of the chemical manufacturer or supplier along with the address and telephone number. Indicate the strength of the chemical, especially if it was prepared on site.
- It is recommended that elementary students not handle any chemical with a National Fire Protection Association (NFPA) rating in any category over 2, out of a 0–4 rating where 0 represents no hazard and 4 represents the highest hazard level. (See Section G in Chapter 7.)
- Chemicals should be stored in a separate, locked area away from the classroom, if possible. A NFPA warning symbol should be placed on the front of the cabinet showing the highest hazard rating in each category of any chemical stored in the cabinet.
- Maintain a complete inventory of every chemical in storage. Keep copies of the inventory and all SDS in the storage area and in the principal's office. The chemical inventory should be reviewed and revised annually.
- Follow accepted guidelines to separate and store chemicals properly.
- Use information contained in the SDS and in local and state mandates to dispose of chemicals properly.

G. Animals in the Classroom

Animals are often used in elementary science instruction. However, the teacher should check school, district, and state policies regarding live organisms in the classroom. Section B in Chapter 5, "Additional Safety Practices," notes that there is a trend away from maintaining live animals in the classroom due to concern for preserving their optimal health. However, if a science teacher wants to keep animals in the classroom, some considerations must be addressed. The list below includes recommendations of the CSSS about animals in the classroom.

- Cages must be of the appropriate size and constructed of the proper material. Cages should be cleaned daily and kept locked in safe, comfortable settings.
- Animals should be handled minimally and gently by handlers wearing non-allergenic gloves and only after proper directions and demonstrations have been given. Students should never be allowed to stick their fingers into animal cages, throw things into the cages, tease the animals, or disturb any animal that is sleeping or eating.
- Students should be discouraged from bringing personal pets to school. Do not allow dead animals in the room, as the exact cause of death may not be known.

- Have a plan for the removal, care, and return of animals during holidays and at the end of the school year.
- Animals used most often in the elementary classroom should be invertebrates. Vertebrate studies should be restricted to observations of normal functions such as growth, feeding, or life cycles.
- For most elementary students, the CSSS does not recommend student-performed dissections. If upper-elementary students do perform dissections, it is recommended that they use preserved, lower-order animals such as worms, insects, or crustaceans.
- Beware of allergic reactions that may result from the study of insects.
- Owl pellets used in the classroom should have been previously sanitized, and a check for student allergies to fur and feathers should be done.

Note: As of August 5, 2009, there is a Cal/OSHA requirement for employers that have employees who may be exposed to zoonotic aerosol transmissible diseases. Such employers should check with local health officers of the California Department of Food and Agriculture (CDFA) for alerts regarding the presence of zoonotic diseases and the steps that should be taken to prevent school staff from contracting the diseases. The details of the requirements are in the *CCR,* Title 8, General Industry Safety Orders, Section 5199.1, Aerosol Transmissible Diseases, Zoonotic.

H. Plants in the Classroom

Compared with animals, plants are somewhat easier to care for, especially over brief periods when school is not in session. However, there are still some precautions teachers need to take when managing plants in the classroom. (See Section F, “Poisonous Plants,” in Chapter 5.) A primary precaution is never to place any part of an unknown plant in the mouth. Teachers should point out toxic or poisonous plants to their students to prevent or reduce the students’ exposure to the plant’s toxins. Rubbing plant sap or juice from a plant’s fruit onto the skin should be avoided, as well as inhaling smoke from a burning plant or burning leaves. Students should not touch mushrooms, as many varieties are poisonous.

Students should be discouraged from picking wildflowers or unknown plants. Table 5.2 in Chapter 5 lists the effects of some poisonous plants.

Elementary laboratory activities with plants often involve studies of seed sprouting (germination). The CSSS recommends that, for experiments, teachers purchase seeds from a grocery store, not seeds marketed for garden or field planting, as those seeds may be coated with chemicals that are poisonous or that are irritating to the skin. Remember the following tips, as recommended by CSSS, when working with plants:

- Wash hands thoroughly or wear non-allergenic gloves when working with plants. Avoid using plants that have thorns.
- Use sterilized potting soil instead of soil removed from the outside, as the latter likely contains mold and other fungi. For outdoor soil studies, students should use proper digging tools.
- Take care if studying aquatic plants from ponds or marshes, as pond or marsh water may contain substances that can cause illness.
- Wash hands thoroughly after the plant activities, and wash all surfaces where the plants were handled.

I. Field Trips at the Elementary Level

All students, and especially elementary-age students, benefit from the observations and hands-on activities that are possible on field trips and other field experiences. The keys to successful field trips are careful planning and supervision. Section E in Chapter 5 gives details about planning and implementing safe field trips as well as precautions that may be especially applicable in California. Additional CSSS recommendations are as follows:

- Have students and parents sign a safety agreement outlining rules and expected behavior.
- Arrange for the use of school-approved vehicles and drivers if transportation is required.
- Carry a mobile phone in case of emergencies.
- For water-related field experiences, ensure that at least one adult is trained in water safety techniques, including cardiopulmonary resuscitation (CPR) and life saving.
- Obtain the most current weather forecast prior to the activity in order to plan for potential hazardous weather conditions and to better inform students of appropriate clothing.
- Group students in pairs or teams under the supervision of an adult chaperone.
- Monitor student activities continually.
- Reinforce the learning objectives for the field experience and keep students focused on the activity's purpose and any assigned tasks.

Chapter 5

Additional Safety Practices

This chapter deals with general safety practices that apply to various areas of science instruction.

A. Fire Prevention and Control

If a serious classroom fire occurs, conduct a fast, orderly evacuation of the room. The fire should be reported immediately, and control measures may be taken if the fire is localized and does not present imminent danger. Both teachers and students should know the location of the nearest fire alarm, fire blanket, and fire extinguisher. Know how to use the fire-control devices.

When an open flame is used in the classroom, the instructor should caution students to stay well away from the flame. Never reach across the flame area. If hair or clothing becomes ignited, douse with water. A fire blanket can be used to smother the flaming area if water is not immediately available in sufficient quantity. (See the end of this section for instructions on use of a fire blanket.) Do not use a fire extinguisher on a person because it can cause serious chemical burns or frostbite (in the case of a extinguisher).

In an electrical fire, pull the plug if that can be done without sustaining a burn (the cord might be hot) or becoming a part of the circuit. **Do not use water**, because water is a conductor of electrical current.

Many substances and types of chemical reactions involved in science programs present potential fire hazards. Anticipate the possible causes of fire and be ready to act swiftly if a fire occurs despite the preventive measures taken.

The most common causes of fire in the science laboratory are (1) failure to understand the nature of the supplies or equipment being used and (2) careless handling of supplies or equipment.

The following extinguishing procedures are recommended for different kinds of fire, as indicated:

1. Class A fires include wood, paper, fabrics, and other common combustibles. Cool the fire with water or use a general-purpose dry-chemical extinguisher (for use with all class A, class B, and class C fires).

2. Class B fires involve gasoline, oil, paint, alcohol, or other volatile flammable liquids. Smother the fire by using carbon dioxide (), dry-chemical, or foam extinguishers. Aim at the base of the flame with the extinguisher and do not hold the nozzle (horn) because of the danger of frostbite. Foam should be floated over the fire. Expel the entire contents of the extinguisher.
3. Class C fires are fires in live electrical devices. Use a nonconductive substance to prevent becoming a part of the electrical circuit. Use a or dry-chemical extinguisher. Shut off the electrical power if it is possible to do so without sustaining a burn.
4. Class D fires occur with combustibles, such as magnesium, titanium, potassium, sodium, zirconium, or other reactive metals. A special extinguishing powder is needed for those fires. Do not use regular dry-chemical extinguishers. Dry sand is effective on small class D fires. Call the fire department and inform personnel that it is a class D fire. Never use water or damp sand.

Multipurpose (2A-10BC) fire extinguishers are mandatory (*CCR,* Title 19, Section 568 et seq.). The State Fire Marshal requires that one extinguisher be provided for every 6,000 square feet (540 sq m) of laboratory space and that one be located not more than 75 feet (22.5 m) from any point in the laboratory on the same story or floor.

The following items are recommended for use in classroom fires:

- General-purpose (ABC) dry-chemical fire extinguisher. (*Exception: Not for use with class D fires.)*
- Carbon dioxide () fire extinguisher. (*Exceptions: Not for use with class A or class D fires.)*
- Fire blanket for fires involving clothing on persons. The victim should stop, drop, and roll immediately on the floor to minimize inhalation of smoke or hot gases. Someone should assist the victim in rolling up in the fire blanket, wrapping the upper portion of the body to prevent flames from reaching the head; make sure that the victim's head is free.

B. Use of Animals in the Classroom

A science teacher (or other adult supervisor) should assume primary responsibility for the environmental conditions under which any activity involving live animals is conducted. If no one on the school faculty has training in the proper care of laboratory animals, the services of an appropriately trained consultant should be sought. A local veterinarian may offer this kind of help.

If animals are used in the classroom, they must be lawfully acquired in accordance with state and local laws. All mammals used in a classroom should be inoculated for rabies, unless they were purchased from a reliable scientific company. All live-animal studies must comply with *EC* Section 51540 (see Appendix A).

The following animals should never be brought into the classroom: wild birds and mammals, snapping turtles, venomous snakes, and insects that may be carriers of disease. Students should not bring their pets to the classroom unless the activity is carefully planned by the teacher and approved by the administrator. Dead animals found by the side of the road should never be brought into the classroom; they may carry hazardous bacteria, viruses, or parasites.

Before a suitable small animal is allowed in the classroom for observation, plans should be made for the animal's habitat, including proper enclosure, food, and schedule of care. The living quarters of animals in the classroom should provide ample space and promote natural behavior and health. The animals' living spaces must be kept clean, free from contamination, and secure enough to confine the animals. Make plans for the care of classroom animals during weekends and vacation periods.

Animals should be handled properly, according to the particular animal, and only when necessary. Special handling is required if the animal is excited or when it is feeding, pregnant, or with its young. (See also Chapter 6, Section M, "Handling of Laboratory Animals.")

Students should wash their hands after handling animals and should be made aware of the risk of salmonella from handling reptiles and amphibians. Turtles should be purchased only from sources that certify that the turtles are free of salmonella. Make sure that the water from the animals' habitat is disposed of carefully.

Caution students never to tease the animals or to insert their fingers or objects through wire mesh cages. Any student who is bitten or scratched by an animal should be sent immediately to the school nurse for appropriate treatment.

After a period of animal observation is completed, animals should be returned to their natural environment. (See "*Caution"* in the following subsection.)

Humane Care and Treatment of Animals

Keeping animals in the classroom can be conducive to the development of many learning situations, but the decision to do so should be carefully evaluated. The capacity to maintain the long-term welfare of the animals should be a determining factor in the decision to use live animals for lessons. The humane care and handling of animals is paramount during such lessons. (See also Chapter 6, Section M, "Handling of Laboratory Animals.") Both teacher and student must have respect for living things. Respect for life shall be accorded to all animals that are kept for educational purposes.

In biological procedures involving living organisms, teachers are encouraged to select species such as plants, bacteria, fungi, protozoa, worms, snails, arthropods, or insects whenever possible. These species are especially suitable for student work because of their wide variety and ready availability in large numbers and because of the simplicity of their maintenance and of the return of native species to their natural environment or their subsequent disposal, as appropriate.

Caution: Release of nonnative and exotic organisms may be detrimental to the local environment as well as illegal. Observations of animals in their natural habitat, including the community surrounding the school, should be encouraged.

No procedure shall be performed on a vertebrate animal that might cause pain, suffering, or discomfort or otherwise interfere with its normal health. Therefore, no surgery shall be performed on any living vertebrate animal (mammal, bird, fish, reptile, or amphibian). No lesson or experiment shall subject a vertebrate animal to any of the following:

- Microorganisms that can cause disease in humans or animals
- Ionizing radiation
- Cancer-producing agents
- Chemicals at toxic levels
- Drugs that produce pain or deformity
- Extremes of temperatures
- Stressful electric or other shock
- Excessive noise
- Noxious fumes
- Exhausting exercise
- Overcrowding
- Other distressing stimuli
- Nutritional deficiencies or excesses

Animal observations must be directly supervised by a competent science teacher who approves the plan before the student starts work. Students must have the necessary comprehension and qualifications for the work contemplated. The supervisor shall oversee all experimental procedures, shall be responsible for their nonhazardous nature, and shall personally and continually inspect animals during the course of the study to ensure that their health and comfort are fully sustained.

Vertebrate-animal studies shall be conducted only in locations in which proper supervision is available—either a school or an institution of research or higher education. No vertebrate animal studies shall be conducted at a home (other than observations of normal behavior of pet animals, such as dogs or cats).

In vertebrate-animal studies, animals shall be provided palatable food in sufficient quantity to maintain normal growth. Diets deficient in essential foods are prohibited. Food shall not be withheld for periods longer than 12 hours. Clean drinking water shall be available at all times (and shall not be replaced by alcohol or drugs).

Chicken eggs subjected to experimental manipulations that may produce abnormalities shall not be allowed to hatch. Such embryos shall be killed humanely no later than the 18th day of incubation. If normal egg embryos are to be hatched, satisfactory arrangements must be made for the appropriate care or humane relocation of chicks. Alternatives to hatching projects are available that not only provide a suitable learning experience but also eliminate animal placement and welfare concerns. A list of online resources is available at ://www.bravebirds.org/chickfree.pdf (accessed November 17, 2014).

Projects involving vertebrate animals will normally be restricted to measuring and studying normal physiological functions (such as growth, activity cycles, metabolism, blood circulation, learning processes, behavior, reproduction, and communication) or isolated tissue techniques. None of these studies requires infliction of pain.

Regulations

State and local laws regulate the care and use of animals in both elementary and secondary science instruction. The treatment of animals in California public school instruction is regulated by *EC* Section 51540 as follows:

> In the public elementary and high schools or in public elementary and high school school-sponsored activities and classes held elsewhere than on school premises, live vertebrate animals shall not, as part of a scientific experiment or any purpose whatever:
>
> (a) Be experimentally medicated or drugged in a manner to cause painful reactions or induce painful or lethal pathological conditions.
>
> (b) Be injured through any other treatments, including, but not limited to, anesthetization or electric shock.

> Live animals on the premises of a public elementary or high school shall be housed and cared for in a humane and safe manner.
>
> The provisions of this section are not intended to prohibit or constrain vocational instruction in the normal practices of animal husbandry.

Regulations about the use of animals in the classroom for educational purposes are also included in the *HSC* of the state of California. These regulations state that animals used for experimental, educational purposes must be humanely treated, supplied with adequate food and water, and kept in satisfactory shelter and sanitary conditions. (See Appendix A for the applicable section of the *HSC*.)

Note: As of August 5, 2009, there is a Cal/OSHA requirement for employers that have employees who may be exposed to zoonotic aerosol-transmissible diseases to check with local health officers or the California Department of Food and Agriculture (CDFA) for alerts regarding the presence of zoonotic diseases, and for the steps that should be taken to prevent teachers and staff from contracting the diseases. Control measures are to be implemented as part of the Injury and Illness Prevention Program. The details of the requirements are in the *CCR,* Title 8, General Industry Safety Orders, Section 5199.1(m) Aerosol Transmissible Diseases, Zoonotic (see Appendix A).

C. Eye Safety

Appendix A contains sections of the *EC* 32030–32033 that regulate schools' and school districts' duties and responsibilities to protect the eyes of students, staff, and visitors during hazardous activities conducted in the classroom. Those legal requirements are summarized here, followed by information on eye-protective devices and other eye-safety practices.

Legal Requirements

School district governing boards have the duty to equip schools with eye-protective devices for the use of all students, teachers, and visitors participating in hazardous activities, such as those outlined below. Principals or teachers supervising any of those activities must require that the eye-protective devices be worn by participating students, teachers, and visitors.

Handbooks, guides, and other instructional materials designed for use by persons involved in direct supervision of hazardous situations must carry additional, detailed guidelines covering particular subject areas and concerns.

Circumstances requiring eye-protective devices. Courses in which the eye-protective devices shall be worn include, but are not limited to, vocational or industrial arts shops or laboratories and chemistry, physics, or combined chemistry–physics laboratories at any time the individual is engaged in an activity or is observing the use of hazardous substances likely to cause injury to the eyes. Such activity includes, but is not limited to, the following:

- Working with hot metal.
- Working with hot liquids or solids or with chemicals that are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, or radioactive or that generate pressure through heat, decomposition, or other means.
- Working with materials or equipment under stress, pressure, or force that might cause fragmentation, including the use of hand or power tools with such hard materials as stone or metal.

Standards for devices. The eye-protective devices used shall be industrial-quality devices that meet the standards of the American National Standards Institute (ANSI).

Sale of devices. If students and teachers wish to purchase their own eye-protective devices, the devices may be sold at a price that shall not exceed the cost of the devices to the school district.

Eye-Protective Devices

Eye-protective devices vary in type and effectiveness. There are three basic types of eye and face protection:

- Goggles—primarily intended for eye protection against impact and splash. Goggles also serve to reduce dust and fumes reaching the eye.
- Face shield—for partial personal face protection against splash or impact. Face shields should ordinarily be used in conjunction with goggles.
- Safety shield—for group protection from splash and impact. The safety shield should be used with goggles and, if appropriate, with a face shield.

Eye-protective devices must meet the following specifications:

1. Lenses must have a minimum thickness of 3 mm and be impact-resistant.
2. Frames must be a lens-retaining type made of nonflammable material.
3. Goggles must be splash-proof. See Table 5.1 for further information about recommended supplies of eye-safety devices.

Table 5.1

Recommended Supplies of Safety Devices for Eyes

Device or Equipment	Recommended Allowance
1. *Goggles*—plastic, splash-proof, vented (standard Z87.1)	One class set of 35 for each school science laboratory (This number allows for visitors, breakage, and loss.)
2. *Goggles*—plastic, splash-proof, nonvented	Five for each science laboratory
3. *Face shield*—quickly adjustable	One for each teaching station, preparation room, and project room
4. *Cabinet*—germicidal, ultraviolet capacity for 35 goggles	One for each class set of goggles
5. *Safety shield*—flat	One for two classrooms
6. *Safety shield*—curved	One for two classrooms

Note: These eye-protective devices should not be considered 100 percent effective against all potential eye hazards. Appropriate combinations of devices may be used for optimum protection. Eye-protective devices are to be used for chemical- and water-propelled rockets.

To establish an effective eye-safety program, the teacher must comply with the following practices:

1. Orient the students to the need for and use of eye-protective devices.
2. Warn students that contact lenses may not be worn in an atmosphere that may contain hazardous gases, vapors, or liquids or when there is any danger of chemicals entering the eye (see “Use of Contact Lenses” on the next page).
3. Consider eye safety when planning each science activity. Refer to Chapter 2, Section D, “Eye Injuries,” and the “Potential Eye Hazards” subsection in this chapter. Ensure that all persons performing science laboratory activities involving hazards to the eyes wear approved eye-protective devices. All persons in dangerous proximity to such activities must be similarly equipped.

4. Establish routine procedures for the distribution of the individual eye-protective devices, when needed, and for their subsequent return to the storage cabinet.
5. Establish a definite, readily accessible location in the designated areas for each type of eye-protective device. A germicidal ultraviolet storage cabinet is an appropriate location for goggles because it serves the dual purpose of storing and sterilizing the goggles.
6. Maintain reasonable standards of cleanliness because eye-protective devices will usually be shared by several persons. Use of germicidal dips or cabinets is highly recommended, along with frequent, thorough washing. Although these procedures do not sterilize, they do sanitize, which is safer than not cleaning at all. Students with unhealthy, possibly contagious skin or eye conditions should be encouraged to purchase personal safety goggles; or specific goggles should be reserved for students' exclusive use.
7. Consider the special requirements of the storeroom, preparation room, and project room activities. Because of the greater probability and severity of many eye hazards in storerooms, preparation rooms, and project rooms, all persons performing or observing hazardous activities in those areas must be equipped with the splash-proof plastic goggles and other approved eye-safety devices specified for those areas.

Use of Contact Lenses

The use of contact lenses in science laboratory instruction is strongly discouraged because the capillary action of solutions causes rapid spreading of the solution under contact lenses and possibly delays the removal of the lenses. Quick removal of contact lenses is very difficult under adverse conditions. When laboratory activities are anticipated, prescription glasses should be worn unless a student cannot see without contact lenses. Contact lenses are also not to be worn when a dust or vapor hazard exists unless vapor-resistant goggles are available. It is essential to provide approved, nonvented protective goggles promptly to students, teachers, and visitors wearing contact lenses and to ensure that the goggles are worn regularly. If adequate eye protection cannot be provided, the student should be excused from the activity and assigned to another supervised room or area.

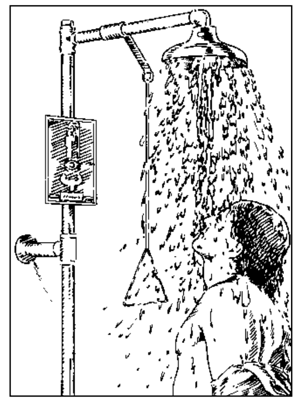
Potential Eye Hazards

Eye-protective devices must be provided for participants and observers in activities involving, but not limited to, the following conditions:

1. Impact hazards
   - Conducting pneumatic pressure or evacuation operations, including use of the pressure cooker
   - Operating power tools
   - Operating centrifugal (centripetal) devices
   - Conducting projectile and collision demonstrations
   - Handling elastic materials under stress; for example, springs, wires, rubber, glass
   - Working with or igniting explosive or implosive devices or substances
   - Working with hot, molten metals
   - Hammering, chipping, or grinding rocks, minerals, and metals
   - Cutting or breaking glass
2. Hazardous substances
   - Pouring, pumping, or dispensing corrosive substances
   - Generating toxic or potentially explosive gases
   - Mixing chemicals that react violently
   - Preserving and staining biological specimens
   - Cleaning and sterilizing with corrosive substances, including ammonia, detergents, or solvents
3. Hazardous radiation
   - Direct viewing of the sun (**Note:** No approved eye protection is provided. **Do not allow this activity.**)
   - Use of infrared and ultraviolet light sources (*Note:* No approved eye protection is provided. These sources must be shielded from direct view.)
   - Use of lasers (**Note:** There is no approved eye protection. These sources must be shielded from direct view. See Chapter 8, Section E, “Use and Hazards of Lasers.”)

An effective eye-protection program must include adequate instruction and demonstration on the hazards of laboratory work and the methods with which to avert accidental injury. This instruction must be repetitious and should become routine procedure. The eye-protective devices must be readily available whenever needed, and high standards of cleanliness must be maintained to prevent spread of infection from contagious eye or skin conditions. Students must be cautioned never to rub their eyes or touch their faces during any activity using reagents or substances that could be transferred through their hands. Students should scrub their hands thoroughly after any such laboratory exercise.

D. Exposure to Corrosive or Irritating Substances



An emergency shower must be provided in work locations in which areas of the body may come in contact with corrosive or severely irritating substances. If **both** the emergency eyewash facility and shower are needed, they must be usable simultaneously by one person. No more than 10 seconds must be required for the injured person to reach the eyewash and shower station when needed. Plumbed eyewash and shower equipment must be activated at least monthly to flush the line and to verify proper operation. (See Chapter 3, item 7, and the *CCR,* Title 8, Section 5162 [in Appendix A].)

E. Safety on Field Trips

Field trips afford unique learning opportunities and often include hazards not encountered in the classroom/laboratory. They should be carefully planned and should include provisions for transportation, protection against on-site hazards, and supervision. The teacher should visit the site beforehand to assess the hazards so that they can be considered in the pretrip orientation and in communications with parents or guardians.

A permission slip should be completed and signed by parents or guardians (see sample form in Appendix L). The document should include details of the trip and provide an opportunity for parents or guardians to indicate any reason (medical, psychological, or religious) for their children to be exempted from the activity or be given special consideration during the activity because of conditions resulting from medication, allergies, and so forth.

The nature of the field trip activity and the environment will dictate supervision needs. Ordinarily, there should be a minimum of one adult per 10 students unless district policy indicates otherwise.

A first-aid kit (see Appendix K) is required whenever a group takes a trip outside school. If the field trip is conducted in an area known to be inhabited by venomous snakes, be aware of the precautions about venomous snakebites described in Chapter 2. After a first-aid kit is used, the contents should be replenished if necessary.

Students should be informed about the most appropriate kinds of clothing to wear on particular field trips. Students should be instructed to wash their hands and faces with a strong soap immediately after any exposure to hazards, such as poisonous plants, in the environment (see the next section of this chapter).

Special precautions should be taken when trips are conducted in or near deep water. Special precautions should also be taken when trips are conducted in areas in which participants are likely to come into contact with animals or organisms that spread diseases such as Hanta virus, Lyme disease (caused by the spirochete Borrelia burgdorferi), and valley fever (coccidioidomycosis).

The Hanta virus is spread by rodents especially around and in primitive, abandoned, or seasonally used buildings in California and other states. The virus is often inhaled with the dust in which the saliva, urine, or feces from rodents have intermingled. Avoid activities that generate dust in contaminated areas. If contaminated areas are to be cleaned, consult guidance from the Centers for Disease Control and Prevention for appropriate personal protective equipment. Special decontamination measures should be taken when participants come into contact with owl pellets because of the possible consumption by the owls of infected rodents. Consult the county environmental health department for decontamination procedures.

Lyme disease is more prevalent along the north coastal region of California. The spirochete that causes the infection is injected during the bite of certain ticks and may also be transmitted to other mammals (including pets) and birds. Arthritis, heart problems, and nervous disorders may result from the disease, which is characterized in its early stages as a skin rash that is hard at its center. Students should take special precautions, such as wearing protective clothing and checking the clothes and body frequently for ticks. Students should shower as soon as they return home and carefully check for ticks again at that time.

Valley fever, or coccidioidomycosis, is discussed in detail in Chapter 6, Section E, and in Appendix M, “Outbreaks of Coccidioidomycosis Associated with Field Work.”

F. Poisonous Plants

Biology and general science teachers should be prepared to warn students about the dangers of poisonous plants that grow in California. Special attention should be given to poisonous plants or plants with poisonous parts that are (1) included in the school landscaping, (2) brought to school for plant studies, or (3) likely to grow in areas where field trips are planned. Teachers are encouraged to become acquainted with and teach about poisonous plants growing around homes, parks, streets, and recreational areas in the school district.

Because not **all** plants have been thoroughly researched for their toxicity, commonsense rules are as follows:

- Never place any plant part in the mouth.
- Never rub any sap or fruit juice into the skin or an open wound.
- Never inhale or expose the skin or eyes to the smoke of any burning plant or plant parts.
- Never pick unidentified wildflowers or cultivated plants that are unknown.
- Never eat food after handling plants without first scrubbing the hands.

The reason for these "never" precautions is that any part of a plant may be relatively toxic, even fatal, depending on the weight of the person and the amount of the plant ingested. See Table 5.2 for further information about some poisonous plants.

Students frequently place seeds in their mouths unconsciously. The danger in this habit lies in the possibility not only of swallowing a poisonous species but also that seeds may be coated with hormones, fungicides, and insecticides, a common practice of commercial distributors. Some of those items cause allergic skin responses. The remainder of seeds are usually deadly when inhaled to any degree or accidentally ingested. Teachers who purchase seeds for experiments should investigate the presence of any such coating or sprays and ask the dealer whether the seeds have been chemically coated.

Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Flower garden plants		
Amaryllis *Amaryllis* (various)	Especially the bulb	Nausea, vomiting, abdominal pain, and diarrhea.
Autumn crocus *Colchicum autumnale*	All parts, especially corm	Fatal; Common: nausea, vomiting, diarrhea, abdominal pain, increased heart rate and chest pain. Less common: decreased blood pressure, decreased heart rate, and seizures. Death is from respiratory failure or cardiovascular failure with ingestion of large amounts.
Castor bean* *Ricinus communis*	Seeds; seeds need to be chewed to release the toxin	Symptoms include nausea, vomiting, bleeding of the gastrointestinal tract, tissue sloughing, liver damage, weak but fast heart rate. Fatal; one or two chewed castor bean seeds can be a lethal dose. **(It is strongly recommended that children not have ANY exposure to this plant.)**
Daffodil *Narcissus pseudonarcissus*	Bulb	Nausea, vomiting, abdominal pain, and diarrhea. Dermatitis may occur. Symptoms usually last only three hours.
Delphinium *Delphinium* (various)	Newest growth and seeds have the highest toxicity	Burning or tingling sensation in the lips, tongue, mouth; nausea, vomiting, diarrhea, difficulty swallowing or talking.
Foxglove* *Digitalis purpurea*	Leaves, probably all parts	Serious poisoning rarely develops after “taste” ingestions of whole plant material by children. Taste/exploratory ingestions are unlikely to result in toxicity. Ingestion of large amounts first results in nausea, vomiting, abdominal pain, and cramping with headache, confusion, lethargy, and fatigue. This is followed later by a dangerously irregular heartbeat, slowed heart rate, abnormal heart beats, decreased blood pressure, and death caused by heart failure.

*Included in *Poisonous Plants of California* by Thomas C. Fuller and Elizabeth McClintock (Berkeley: University of California Press, 1987). The authors cite this and 11 other plants in this table as a frequently occurring seed plant that all Californians should learn to recognize.

Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Flower garden plants		
Hyacinth *Hyacinthus orientalis*	All parts, especially bulb	Intense nausea, vomiting, abdominal cramps, and diarrhea. Dermatitis can be seen.
Iris *Iris* (various)	Underground stems, leaves	Burning and stinging in the mouth and throat, stomach pain, nausea, vomiting, and diarrhea. Dermatitis is also possible. Severity depends on the amount ingested.
Kaffir lily *Clivia miniata*	Especially the bulb	Nausea, vomiting, abdominal pain, and diarrhea.
Larkspur *Delphinium* (various)	Newest growth and seeds have the highest toxicity	Burning or tingling sensation in the lips, tongue, mouth; nausea, vomiting, diarrhea, difficulty swallowing or talking.
Lily-of-the-Valley *Convallaria majalis*	Leaves, flowers	Serious poisoning rarely develops after "taste" ingestions of whole plant material by children. Taste/exploratory ingestions are unlikely to result in toxicity. Ingestion of large amounts first results in nausea, vomiting, abdominal pain and cramping with headache, confusion, lethargy, and fatigue. This is followed later by a dangerously irregular heartbeat, slowed heart rate, abnormal heartbeat, decreased blood pressure, and death caused by heart failure.
Monkshood *Aconitum* (various)	All parts	A tingling or burning sensation in the fingers and toes is usually seen first, followed by sweating and chills, a generalized tingling feeling, numbness, and a feeling of intense cold. This is followed by intense vomiting, diarrhea with abdominal pain, paralysis, abnormal heartbeat, and intense pain. Death is usually from abnormal heartbeats or respiratory paralysis. **(It is strongly recommended that children not have ANY exposure to this plant.)**

Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Flower garden plants		
Morning glory *Ipomoea* (various)	Seeds	Diarrhea, anxiety, and tension. Morning glory seeds are said to be hallucinogenic; however, large numbers (in the hundreds) are required, and effects cannot be confirmed.
Narcissus *Narcissus pseudonarcissus*	Bulb	Nausea, vomiting, abdominal pain, and diarrhea. Dermatitis may occur. Symptoms usually last only three hours.
Oleander* *Nerium oleander*	All parts, including dried, dead leaves and twigs	Serious poisoning rarely develops after “taste” ingestions of whole plant material by children. Taste/exploratory ingestions are unlikely to result in toxicity. Ingestion of large amounts first results in nausea, vomiting, abdominal pain and cramping, with headache, confusion, lethargy, and fatigue. This is followed later by a dangerously irregular heartbeat, slowed heart rate, decreased blood pressure, and death caused by heart failure. 
Poinsettia *Euphorbia pulcherrima*	Leaves, flowers	Ingestion of large amounts may possibly cause vomiting, but usually no ill effects are seen. Considered to be nontoxic.

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Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Flower garden plants		
Ranunculus *Ranunculus* (various)	All parts	Bad taste, burning in the mouth and throat, mouth ulcers, vomiting, sometimes vomiting blood, abdominal pain, and diarrhea.
Star-of-Bethlehem *Ornithogalum umbellatum*	Bulbs, flowers	Serious poisoning rarely develops after “taste” ingestions of whole plant material by children. Ingestion of large amounts first results in nausea, vomiting, abdominal pain, and cramping with headache, confusion, lethargy, and fatigue. This is followed later by a dangerously irregular heartbeat, slowed heart rate, decreased blood pressure, and death caused by heart failure.
Ornamental plants		
Angel’s trumpet* *Brugmansia* (various)	All parts	Dilated pupils; blurred vision; dry mouth; dry, red-hot skin; thirst; fever; increased heart rate; increased blood pressure; urinary retention; constipation; and hallucinations.
Arum *Arum* (various)	All parts	Chewing plant parts results in intense burning; irritation; pain; redness and swelling of the lips, mouth, and tongue; excessive drooling; and vomiting. Chewing the plant causes enough pain and irritation that large quantities usually are not swallowed.

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Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Ornamental plants		
Azalea *Rhododendron* (various)	All parts, especially the leaves	Burning in the mouth, numbness and tingling around the mouth area, nausea, vomiting, diarrhea, sweating, decreased blood pressure, decreased heart rate, confusion, and seizures. Small taste amounts are not expected to be dangerous. 
Black laurel *Leucothoe davisiae*	All parts	Fatal; burning sensation of mouth and throat, drooling, vomiting, diarrhea, headache, drowsiness, incoordination, muscle weakness, seizures, decreased heart rate, decreased blood pressure, paralysis, liver failure, coma, and death.
Calla lily *Zantedeschia* (various)	All parts	Chewing plant parts results in intense burning, irritation, and pain; redness and swelling of the lips, mouth, and tongue; excessive drooling; and vomiting. Chewing the plant causes enough pain and irritation that large quantities usually are not swallowed.
Carolina yellow Jessamine *Gelsemium sempervirens*	All parts	Headache, dilated pupils, double vision, droopy eyelids, dizziness, dry mouth, sweating, muscular weakness or muscle rigidity, seizures, shortness of breath, difficulty speaking, difficulty swallowing, and decreased heart rate.

Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Ornamental plants		
Cotoneaster *Cotoneaster* (various)	Berries	Shortness of breath, headache, muscle twitching and spasms, collapse, and coma are possible symptoms. It is thought that the concentration is too low to cause significant poisoning unless very large amounts are ingested.
Daphne *Daphne* (various)	All parts, especially bark and berries	Nausea; vomiting; burning of the throat, mouth, and stomach; bloody diarrhea; drowsiness; headache; weakness; delirium; coma; and death. Dermatitis with blisters, redness, swelling, and itching may result from contact with the sap.
Dieffenbachia, (dumb cane) *Dieffenbachia* (various)	Juice, all parts	Chewing plant parts results in intense burning, irritation, and pain; redness and swelling of the lips, mouth, and tongue; and excessive drooling and vomiting. Death can occur if the base of the tongue swells enough to block the air passage (but is EXTREMELY rare). Chewing the plant causes enough pain and irritation that large quantities usually are not swallowed.
Elephant's ear *Colocasia esculenta*	Juice, all parts	Chewing plant parts results in intense burning, irritation, and pain; redness and swelling of the lips, mouth, and tongue; and excessive drooling and vomiting. Chewing the plant causes enough pain and irritation that large quantities usually are not swallowed.
Golden chain *Laburnum anagyroides*	All parts	Intense vomiting, abdominal pain, decreased blood pressure, increased heart rate, fatigue, confusion, agitation, tremor, delirium, and muscle weakness.
Holly *Ilex* (various)	Leaves, but especially the berries	Nausea, vomiting, abdominal pain, diarrhea, and possibly drowsiness after ingestion of large amounts.

Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Ornamental plants		
Hydrangea *Hydrangea* (various)	Leaves and buds	Nausea, vomiting, diarrhea. Dermatitis may result. The plant contains something that can produce cyanidelike substances, but no recent cases have been reported.
Ivy *Hedera* (various)	Leaves	Drooling, headache, fever, incoordination, dilated pupils, nausea, vomiting, abdominal pain, severe diarrhea, agitation, shortness of breath, coma (although symptoms are rarely severe). Skin contact can cause dermatitis.
Jimsonweed* *Datura stramonium*	All parts	Dilated pupils, blurred vision, dry mouth, red-hot dry skin, thirst, fever, increased heart rate, increased blood pressure, urinary retention, constipation, and hallucinations.
Lantana *Lantana camara*	Unripe or green berries	Fatal; vomiting, diarrhea, incoordination, respiratory distress, dilated pupils, lethargy, muscle weakness, difficulty breathing, coma, and death.
Moonseed *Menispermum* (various)	Probably all parts but especially the fruit	Drowsiness, seizures, hallucinations, delirium, altered level of consciousness, tingling, and amnesia may occur.
Mountain laurel *Kalmia* (various)	All parts, especially the leaves	Burning in the mouth, numbness and tingling around the mouth area, nausea, vomiting, diarrhea, sweating, decreased blood pressure, decreased heart rate, confusion, and seizures. Small taste amounts are not expected to be dangerous.
Philodendron *Philodendron* (various)	Juice, all parts	Chewing plant parts results in intense burning, irritation, and pain, redness and swelling of the lips, mouth, and tongue; excessive drooling; and vomiting. Chewing the plant causes enough pain and irritation that large quantities usually are not swallowed.

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Table 5.2
Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Ornamental plants		
Red sage *Lantana camara*	Unripe or green berries	Fatal; vomiting, diarrhea, incoordination, respiratory distress, dilated pupils, lethargy, muscle weakness, difficulty breathing, coma, and death.
Rhododendron *Rhododendron* (various)	All parts, especially the leaves	Burning in the mouth, numbness and tingling around the mouth area, nausea, vomiting, diarrhea, sweating, decreased blood pressure, decreased heart rate, confusion, and seizures. Small taste amounts are not expected to be dangerous.
Rosary pea* *Abrus precatorius*	Seeds; seeds need to be chewed to release the toxin.	These plants are not grown in California but are used in seed ornaments and jewelry items. Symptoms include nausea, vomiting, bleeding of the gastrointestinal tract, tissue sloughing, liver damage, and weak but fast heart rate. Fatal; a single rosary pea has caused death. **(It is very strongly recommended that children not have ANY exposure to this plant.)**

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Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Ornamental plants		
Spanish broom *Spartium junceum*	All parts, especially the seeds	Intense vomiting, abdominal pain, decreased blood pressure, increased heart rate, fatigue, confusion, agitation, tremor, delirium, and muscle weakness.
Toyon *Photinia arbutifolia*	Leaves	Shortness of breath, headache, muscle twitching and spasms, and collapse and coma.
Death camas* *Zigadenus venenosus*	All parts. Young stages are most toxic.	Intense nausea and vomiting followed by decreased heart rate, collapse, weakness, decreased blood pressure, and abnormal heartbeats. Young plants or their bulbs can be mistaken for other plants, including wild onions or sego lilies. **(It is strongly recommended that children not have ANY exposure to this plant.)**
Plants in fields		
Nightshade *Solanum* (various)	All parts, especially unripe berry	Common symptoms include nausea, vomiting, headache, and diarrhea. Drowsiness and coma are less common. Decreases in blood pressure and heart rate, with drooling and muscle cramps, may occur but are rare.

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Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Plants in fields		
Poison hemlock* *Conium maculatum*	All parts	Fatal; resembles a large wild carrot. Symptoms include nausea, vomiting, burning in the throat, abdominal pain, confusion, seizures followed by respiratory depression, muscle pain, and then paralysis. Death is usually rapid and due to respiratory paralysis. **(It is strongly recommended that children not have ANY exposure to this plant.)** 
Thorn apple* *Datura stramonium*	All parts	Dilated pupils, blurred vision, dry mouth, red-hot dry skin, thirst, fever, increased heart rate, increased blood pressure, urinary retention, constipation, and hallucinations that are often unpleasant.
Pokeweed* *Phytolacca americana*	All parts, but especially the roots	Eating leaves and berries causes nausea, intense vomiting, and diarrhea (sometimes foamy) that lasts about 24 hours. Some people have died from eating the root.

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Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Plants in fields		
Tree tobacco* *Nicotiana glauca*	All parts	Nausea and vomiting, headache, tremors, seizures, hallucinations, confusion, and hyperventilation. Eating large amounts causes weakness, paralysis, coma, and respiratory failure leading to death. **(It is strongly recommended that children not have ANY exposure to this plant.)**
Plants in swamp or moist areas		
Water hemlock* *Cicuta douglasii*	All parts, but more concentrated in lower parts of stems and roots	Fatal; drooling, vomiting, diarrhea, increased heart rate, severe abnormal heart rate, decreased blood pressure, violent and painful seizures. Seizure can occur quickly in as little as five minutes after ingestion. Death is a common outcome. **(It is strongly recommended that children not have ANY exposure to this plant.)**

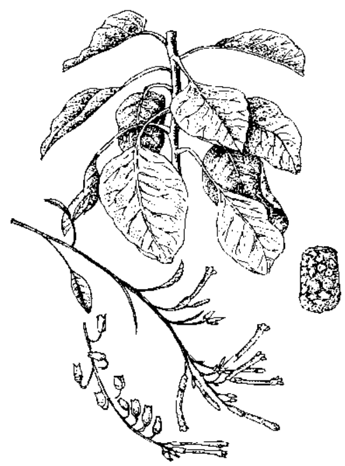

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Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Plants in wooded areas		
Black locust *Robinia pseudoacacia*	Bark, sprouts, foliage, seeds; seeds need to be chewed to release the toxin.	Symptoms include nausea, vomiting, bleeding of the gastrointestinal tract, tissue sloughing, liver damage, weak but fast heart rate. **(It is strongly recommended that children not have ANY exposure to this plant.)**
Elderberry *Sambucus* (various)	Shoots, leaves	Eating large amounts of the berries may cause nausea, vomiting, abdominal cramps, and diarrhea along with dizziness, numbness, and stupor. Eating stems, roots, or bark may cause severe diarrhea.
Mistletoe *Phoradendron* (various)	All parts, especially berries	Eating small amounts may result in mild vomiting and diarrhea. Ingesting concentrated extracts of the plant may produce serious poisoning.
Oak *Quercus* (various)	Raw acorns, young leaves, sprouts, and buds	Nausea, vomiting, and abdominal pain are common following ingestion. Constipation or bloody diarrhea, excessive thirst, liver damage, and frequent urination are other symptoms that may occur when large amounts are eaten. Do NOT allow children to chew on acorns.

Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Plants in wooded areas		
Poison oak Western *Toxicodendron* *[Rhus diversiloba]*	All parts: leaves, stems, berries, roots	Skin contact with oily fluid secreted in all parts of plant causes painful, often long-lasting skin eruptions with a burning, itching sensation that develops 30 minutes to five days after exposure. The severity of symptoms depends on the patient's degree of sensitivity, the amount of contact, and the areas of skin exposed. If the plant is ingested, severe vomiting and diarrhea may result. Avoid exposure! 
Stinging nettles *Urtica* (various)	Stinging hairs on leaves and stems	Intense itching, stinging, burning, and inflammation of the skin, often resulting in blisters. Stinging can last up to 12 hours. Avoid exposure!
Vegetable garden plants		
Eggplant *Solanum ongena*	All green parts	Common symptoms include nausea, vomiting, headache, and diarrhea. Drowsiness and coma are less common. Decreases in blood pressure and heart rate, with drooling and muscle cramps, may occur but are rare.
Potato *Solanum tuberosum*	All green parts	Common symptoms include nausea, vomiting, headache, and diarrhea. Drowsiness and coma are less common. Decreases in blood pressure and heart rate, with drooling and muscle cramps, may occur but are rare.

Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Vegetable garden plants		
Rhubarb *Rheum rhabarbarum*	Leaf blade; stems are edible	Large amounts of raw or cooked leaves can cause vomiting, diarrhea, drowsiness, weakness, kidney and liver damage, and dermatitis.
Tomato *Lycopersicon lycopersicum*	All green parts	Common symptoms include nausea, vomiting, headache, and diarrhea. Drowsiness and coma are less common. Decreases in blood pressure and heart rate, with drooling and muscle cramps, may occur but are rare.
Fruit trees in orchards or yards		
Apple *Malus* (various)	Seeds; kernels must be well chewed to release the cyanide component.	Accidentally swallowing whole seeds or pits is NOT likely to cause cyanide toxicity. Headache, dizziness, severe vomiting, abdominal pain, diarrhea, difficulty breathing, weakness, seizures, disorientation, paralysis, weakness, increased heart rate, increased blood pressure, coma, collapse, and death may occur.
Apricots *Prunus* (various)	Kernel inside hard pit; Kernels must be well chewed to release the cyanide component.	Accidentally swallowing whole seeds or pits is NOT likely to cause cyanide toxicity. Headache, dizziness, severe vomiting, abdominal pain, diarrhea, difficulty breathing, weakness, seizures, disorientation, paralysis, weakness, increased heart rate, increased blood pressure, coma, collapse, and death may occur.
Cherry *Prunus* (various)	Kernel inside hard pit; kernels must be well chewed to release the cyanide component.	Accidentally swallowing whole seeds or pits is NOT likely to cause cyanide toxicity. Headache, dizziness, severe vomiting, abdominal pain, diarrhea, difficulty breathing, weakness, seizures, disorientation, paralysis, weakness, increased heart rate, increased blood pressure, coma, collapse, and death may occur.

Table 5.2

Effects of Some Poisonous Plants

Plant	Toxic Part	Effects of Ingestion
Fruit trees in orchards or yards		
Crabapple *Malus* (various)	Seeds; kernels must be well chewed to release the cyanide component.	Accidentally swallowing whole seeds or pits is NOT likely to cause cyanide toxicity. Headache, dizziness, severe vomiting, abdominal pain, diarrhea, difficulty breathing, weakness, seizures, disorientation, paralysis, weakness, increased heart rate, increased blood pressure, coma, collapse, and death may occur.
Peach *Prunus* (various)	Kernel inside hard pit; kernels must be well chewed to release the cyanide component.	Accidentally swallowing whole seeds or pits is NOT likely to cause cyanide toxicity. Headache, dizziness, severe vomiting, abdominal pain, diarrhea, difficulty breathing, weakness, seizures, disorientation, paralysis, weakness, increased heart rate, increased blood pressure, coma, collapse, and death may occur.
Pear *Pyrus* (various)	Kernel inside hard pit; kernels must be well chewed to release the cyanide component.	Accidentally swallowing whole seeds or pits is NOT likely to cause cyanide toxicity. Headache, dizziness, severe vomiting, abdominal pain, diarrhea, difficulty breathing, weakness, seizures, disorientation, paralysis, weakness, increased heart rate, increased blood pressure, coma, collapse, and death may occur.
Plum *Prunus* (various)	Kernel inside hard pit; kernels must be well chewed to release the cyanide component.	Accidentally swallowing whole seeds or pits is NOT likely to cause cyanide toxicity. Headache, dizziness, severe vomiting, abdominal pain, diarrhea, difficulty breathing, weakness, seizures, disorientation, paralysis, weakness, increased heart rate, increased blood pressure, coma, collapse, and death may occur.

G. Ionizing Radiation

Before considering the acquisition of radiation-producing machines or radioactive materials, school administrators and science department faculty should obtain a copy of the *CCR*, Title 17, Division 1, Chapter 5, Subchapter 4. Title 17 of the *CCR* provides regulatory, licensing, and safety requirements for the use of radiation-producing machines and radioactive materials. The *CCR* regulations can be accessed online at ://www.oal.ca.gov/ccr.htm (accessed November 17, 2014). A hard-copy version can be purchased by contacting the official publisher of the *CCR* at 1-800-888-3600 or through the Barclays Web site at ://www.barclaysccr.com (accessed November 17, 2014). Any person who possesses a source of radiation that is subject to licensure or registration is required to post a current copy of the *CCR*, Title 17, Division 1, Chapter 5, Subchapter 4, along with a copy of the referenced Title 10 of the *Code of Federal Regulations* 20 (January 1, 2005).

When planning to use radiation-producing machines or radioactive materials in the classroom, teachers and administrative staff should be fully aware of the recommendations of the National Committee on Radiation Protection and Measurements and of the requirements of *CCR,* Title 17, Section 30265, that limit radiation exposure of persons under eighteen years of age to no more than 0.5 rem per year. Although the risk of reaching or exceeding that limit is exceedingly small, all uses should be planned and conducted accordingly.

Schools should not accept gifts of X-ray machines or radioactive materials until (1) the machines have been checked by a qualified health physicist or radiological physicist to determine that the equipment can be operated safely and without excessive radiation leakage; and (2) the radioactive materials have been determined not to exceed permissible quantity limits specified by *CCR,* Title 17, Section 30180(c), and have been found to be free of removable contamination in excess of 0.005 microcurie.

Radiation Machines

A radiation machine is any device capable of producing ionizing radiation when the associated control devices are operated. Examples of radiation-producing machines are medical and dental machines used in the healing arts, electron microscopes, cabinet X-ray machines, and fluoroscopes.

Registration. Every person who acquires a radiation-producing machine shall register it with the California Department of Public Health (CDPH) within 30 days. Registration forms can be obtained from the CDPH, Radiologic Health Branch, P.O. Box 997414, MS 7610, Sacramento, CA 95899-7414; telephone 916-327-5106.

Exemptions. Electrical equipment is exempt from registration if it produces radiation incidental to its operation but does not produce radiation in any accessible area to such a degree that an individual will be likely to receive a radiation dose to the whole body or to the head, trunk, gonads, lens of the eye, or active blood-forming organs in excess of 0.5 rem in a year. Examples of potentially hazardous equipment are flyback transformers, shunt regulator tubes, and cathode-ray tubes operating at an excess of 20,000 volts.

Cold Cathode-Ray Tubes

Cold cathode-ray tubes have been identified as potential sources of hazardous X-rays coincidental to the intended use of the tubes. The information in this section on cold cathode-ray tubes was provided by the City of Berkeley Division of Public Health.

Cold cathode-ray tubes are used for the study of electrons and electronic phenomena. The tubes come in a multitude of sizes, shapes, and forms. Three kinds of cold cathode-ray tubes that can produce potentially hazardous X-rays coincidental to their intended use are heat-effect tubes, magnetic-effect tubes, and shadow- or fluorescence-effect tubes. These cathode-ray tubes can produce X-rays when all the following conditions are met:

- An electron source or cathode is present.
- There is a target or anode that the electrons can strike.
- A high potential difference exists between anode and cathode. (In voltage of 10 kV or under, the electrons do not acquire sufficient energy to produce significant X-rays.)
- Low gas pressure prevails between cathode and anode; that is, a moderately good vacuum exists in the tube.

The **heat-effect tube** is used to demonstrate that cathode rays consist of rapidly moving electrons whose kinetic energy is converted to heat on collision with an object. The tube consists of an evacuated glass bulb with a thin foil target positioned between opposed electrodes. The cathode has a concave surface to focus electrons on a small spot of the foil. The focal spot on the foil can easily be heated to a dramatically visible white heat.

The **magnetic-** or **deflection-effect tube** demonstrates that cathode rays carry an electric charge and can be deflected by a magnetic field. This tube consists of an evacuated glass cylinder with an electrode at each end. An aluminum strip coated with a fluorescent material is positioned between the electrodes, and a collimating slit is at the cathode end. In a magnetic field, the luminous line caused by electron bombardment of the fluorescent strip moves up or down according to the polarity of the magnet.

The **shadow-** or **fluorescence-effect tube** demonstrates that cathode-ray energy may be converted into visible radiation by fluorescence of the glass walls of the tube, resulting from electron bombardment. A metallic object, such as a Maltese cross, is placed in a Crookes tube so that its shadow can be cast on the glass wall of the tube. By observing this shadow, one can see that the cathode rays producing this pattern travel in straight lines.

The following conclusions may be drawn about X-ray production from the cathode-ray tubes:

1. X-ray output is sporadic. Under identical conditions of operation, output may vary from one tube to another or from the same tube from day to day.
2. Gas pressure within the tube is one of the controlling factors in X-ray production. If there is sufficient gas present, the accelerated electrons will collide with gas atoms and, therefore, never gain enough energy to produce X-rays.
3. Tube composition plays an important part in producing X-rays. X-ray production is a function of the target materials that the electrons strike.
4. The tube wall, if thick enough and of proper composition, can act as a shield for X-rays.
5. The output of the tube is strongly dependent on the voltage and current capabilities of the power source.

The following procedures are recommended in the use of cold cathode-ray tubes, especially those manufactured before 2004:

- Tubes should be used only for demonstrations conducted by the instructor.
- Tubes should always be operated at the lowest possible current and voltage, and the time of operation should be kept to a minimum.
- No student should stand closer than 10 feet (3 m) from a tube when the tube is in operation.

Radioactive Materials

This section applies to situations in which individuals or groups actively participate in investigations or projects involving the use of radioactive materials. It does not refer to class demonstrations of the use of radiation detectors or cloud chambers.

The properties of radioactive materials have numerous applications in scientific research, medicine, and industry. These applications are anticipated not only to continue but also to increase dramatically in number and in kind. School district science programs should provide students with an opportunity to investigate radiological theory and the uses of radioactive materials to develop techniques and skills in handling such materials safely.

Licenses. In the *CCR,* Title 17, the law states the conditions under which persons and institutions may possess and use radioactive materials: either a school must have and use only small (exempt) quantities and concentrations of radioactive materials, or the school must have a specific license to possess and use radioactive materials. The terms are described below:

- Possession or use of exempt quantities and concentrations of materials, as defined in the *CCR,* Title 17, Section 30180, does not require the issuance of a specific license. Exempt materials include (a) any naturally occurring radioactive material (except uranium and thorium); (b) unprocessed ore, which in its natural form contains uranium and thorium; (c) radioactive materials in concentrations that do not exceed those noted in Schedule C of Title 17; and (d) radioactive materials, provided that the quantity of each material does not exceed the applicable quantity noted in Schedule A of Title 17 and provided that not more than 10 such quantities are possessed at any one time.
- Specific licenses, as defined in the *CCR,* Title 17, sections 30194 and 30195, are required if an individual or an institution intends to possess or use quantities or concentrations of radioactive materials in excess of the amounts specified in schedules A and C. Information relating to specific licenses can be obtained from the CDPH, Radiologic Health Branch, P.O. Box 997414, MS 7610, Sacramento, CA 95899-7414. Applications for specific licenses must be signed by an appropriate school district staff member who has the responsibility for ensuring that the radioactive material is used and stored safely. The direct responsibility for safe use and storage rests with an appropriately trained radiation safety officer at the site of use. Both persons must be designated on the license application.

  Strict compliance with the conditions attached to specific licenses is required for approval of the licenses. An amendment request must be submitted for any change in the personnel using radioactive materials, the radiation safety officer, or the site of use. A copy of the license must be maintained in the school district staff offices as well as at the site of use. All persons at the site of use must be aware that they have access to the license and its conditions as well as to laws and regulations set forth in the California *Penal Code* and the *HSC.*

Procurement and storage of radioisotopes. Before the first procurement of radioactive materials, the school should make certain that a radiation survey meter is available. The recommended type of radiation detection instrument is an end window Geiger-Mueller

(G-M) detector with a detection window of approximately 2 mg/. When used properly, this instrument will detect alpha, beta, and gamma radiation. G-M detectors are available at relatively low cost; assistance in choosing the correct instrument can be provided by the CDPH or a competent health physicist.

Orders for procurement of radioisotopes, whether in exempt amounts or as allowed by specific license, must be approved by the appropriate school-site administrator and school district staff member. On receipt of the material, the teacher or designated radiation safety officer must take the following steps:

- Carefully inspect the package for damage before opening it.
- If there is no damage, open the package, inspect the contents, and compare the contents with the packing slip.
- If there are any indications of external damage or contamination of the packing material or if the contents do not match the packing slip, notify the vendor immediately and request disposal instructions. In the interim, place the package and contents in a plastic bag, seal and store the bag, and monitor the storage area for contamination.

All schools where radioactive materials are used must provide secure storage. Materials must be kept locked when not in use, and access must be limited to designated persons only. The room must be properly marked and must have accurate records of each isotope or source. Records must include the type and quantity of isotope, date of assay, date of receipt, and usage information. No more than 10 scheduled quantities of isotopes may be stored in any one school, as specified in the *CCR,* Title 17.

Use of radioisotopes. The use of radioactive materials in classroom activities can provide valuable experience in preparation for subsequent vocational or university application. However, the use should be closely supervised. The standard radiation symbol with the words “Caution—Radioactive Material” should be displayed both at the storage room and in the classroom when the isotopes are in use. Normally, the use of film badges or other types of radiation dosimeters is not required when using exempt quantities of radioisotopes. However, an operable radiation survey meter should always be available and should be used after the classroom exercise to verify that there is no contamination on the hands or body or on surfaces that have come into direct contact with the isotopes.

Observance of the following rules will ensure that radioisotopes are used safely:

- Never handle radioactive sources with unprotected fingertips. The use of forceps or tongs will minimize exposure to the hands and fingers.
- Alpha emitters can be shielded easily by a sheet of paper; beta emitters should be shielded by one-quarter-inch lucite or glass. However, teachers should remember that both of these sources are often accompanied by the emission of gamma rays, which may require lead shielding. Exempt gamma-emitting sources can usually be shielded easily by one-quarter-inch lead.
- Experiments that might cause the release of gaseous radioactive products should not be performed, nor should radioactive materials be disposed of in sinks and drains or unmarked waste or trash containers.

Disposal of unneeded radioactive materials. When teachers and administrators become aware of the presence of radioactive sources and materials that are the remains of old classroom activities, they should never dispose of those materials as ordinary trash. Usually, the materials are partially or completely decayed. The only acceptable methods of removal are by disposal as radioactive waste or by transfer to a person or institution holding a specific license authorizing receipt of the material.

Disposal of radioactive waste presents unique but not unsolvable problems. Radioactive sources and trash must be kept separate from liquid materials, which must be absorbed against diatomaceous earth or a similar agent. Both types of waste must be packaged in steel drums, manifests must be prepared, and the material must be transferred to an authorized disposal company. Before that is done, the school must have an CalEPA identification number (see Chapter 7, Section E, Step 5; and Appendix N, which lists the Web site for locating the local Certified Unified Program Agency (CUPA) and a permit from one of the three states that maintain low-level waste disposal sites. (The same CalEPA identification number can be used for disposal of chemicals and other hazardous materials.) The CDPH maintains a list of licensed waste disposal companies; those companies will offer assistance with obtaining the necessary permits and licenses.

An acceptable and less costly method of disposing of unwanted radioisotopes is by transfer to a specific licensee. Universities, colleges, and research organizations may have a license for the particular type and quantity of material that needs to be disposed of. Disposal can usually be done for a minimal cost. The designated school district staff member or radiation safety officer is responsible for first obtaining a copy of the receiver's license to verify that it includes the material in question. Then the designated staff member packages the material for shipment or transfer according to the requirements of the receiver and obtains a receipt for the material.

The disposal process or transfer to a licensee must be coordinated with the appropriate school or school district staff member(s). If the material to be disposed of or transferred is material for which the school holds a license and the intent is to abandon the license, the CDPH must be notified of such intent. A final inspection will be conducted by that agency.

H. Earthquake Preparedness

The earthquake safety measures outlined in this section are intended to augment the school's general emergency/disaster plans. The central components of any earthquake response plan for seismic safety in science classes should include, but not be limited to, the following phases:

1. Survey the classroom and stock room for nonstructural hazards.
2. Perform hazard-reduction projects.
3. Create an emergency response plan.
4. Procure emergency equipment and supplies.

Completion of these four phases will help the school comply with the requirements of the law to establish earthquake emergency procedures (*EC* sections 35295 through 35297 and *EC* Section 32282(a)(B)(ii) are provided in Appendix A).

Phase 1: Survey the Classroom and Stock Room for Nonstructural Hazards

The following checklist is intended to help identify common nonstructural earthquake hazards that can be reduced or eliminated at little or no cost. For questions checked *No,* refer to Phase 2, step three, of this section, which contains suggestions for rectifying nonstructural hazards.

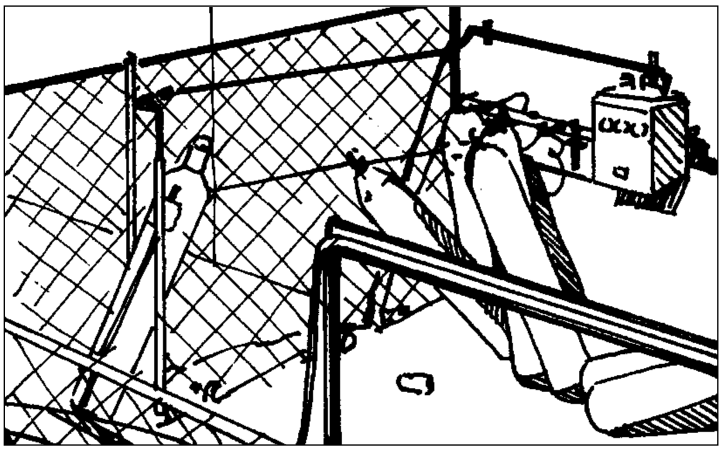
	Yes	No
1. **Equipment/furnishings/fixtures**		
a. Are freestanding cabinets, lockers, bookcases, cupboards, storage racks, and wall shelves secured to a structural support?	☐	☐
b.* Are the ceilings, overhead lights, projection screens, and air ducts secured to a structural support?	☐	☐
c. Do tall industrial storage racks have adequate bracing?	☐	☐
d. Are racks that are significantly taller than they are wide connected to the concrete slab by large anchor bolts?	☐	☐
e. Is the television monitor fastened either to a securely mounted platform or to a cart with a low center of gravity and lockable wheels?	☐	☐
f. Do desktop computers have secured monitors?	☐	☐
g. Are heavy or sharp wall decorations securely mounted (with closed eye hooks, for example)?	☐	☐
h. Have heavy objects that are stored above head level been restrained or relocated?	☐	☐
i.* Are refrigerators, water heaters, or ranges restrained by attachment to the floor or wall, not just by kitchen cabinetry?	☐	☐
j. Is specialized heavy laboratory equipment (e.g., an autoclave) on a countertop secured to protect it from sliding off and falling?	☐	☐
k. Are fire extinguishers securely mounted?	☐	☐
l. Are cabinets equipped with heavy-duty latches? (Magnetic catches can easily pop open.)	☐	☐
m. Are display cases or aquariums protected from overturning or sliding off tables?	☐	☐

* Additional help from the janitor or maintenance staff member may be needed.

		Yes	*No*
n.	Are emergency battery-operated lights protected from falling off shelf supports?	☐	☐
o.*	Are the fire-sprinkler risers secured to the wall with a vee brace, and are large-diameter sprinkler pipes secured with diagonal braces to the structure above (see NFPA Standard Number 13)?	☐	☐
p.*	Do sound-system speakers in elevated locations have positive anchorages?	☐	☐
q.*	Are suspended space heaters, especially gas-fired heaters, braced and/or equipped with flexible gas connections?	☐	☐
r.	Are hanging plants, projection screens, or displays fastened with closed eye hooks and positioned so that they would not hit a window if they were to swing?	☐	☐
s.*	Are air-distribution grills or diffusers screwed to adequately supported sheet-metal ducts or to the ceiling or wall?	☐	☐
t.*	Are large metal air-distribution ducts, especially those that are suspended a few feet, fastened with diagonal bracing?	☐	☐
u.*	Is the suspended ceiling equipped with bracing wires? (See *Uniform Building Code* [UBC], Table 23-3, and UBC Standard 47-18.)	☐	☐
v.*	Are the lay-in fluorescent light fixtures independently supported by at least two hanger wires per light fixture?	☐	☐

* Additional help from the janitor or maintenance staff member may be needed.

	Yes	No
2. Hazardous/toxic materials		
a. Is there a current inventory of hazardous chemicals that would allow someone to check the chemicals after an earthquake?	☐	☐
b. Are compressed gas cylinders tightly secured, with a nylon strap or strong chain near the top and near the bottom, or stored on a rack designed to restrain cylinders?	☐	☐



Improperly stored gas cylinders

	Yes	No
c. Are laboratory chemicals stored on shelves restrained by a wire, lip, or other barrier?	☐	☐
d. Have chemicals been stored by compatible groups to reduce the likelihood of mixing them and causing reactions?	☐	☐
e. Have chemicals been stored in plastic or other unbreakable storage containers?	☐	☐
f.* Does gas piping allow for movement at connections to equipment that could slide, swing, or tip or at points where the piping crosses expansion joints that structurally separate the wings of a building?	☐	☐
g.* Are automatic gas shut-off devices that are sensitive to excess flow designed to be actuated by leak detectors or triggered by earthquakes?	☐	☐

* Additional help from the janitor or maintenance staff member may be needed.

	Yes	No
3. **Windows.*** Have the windows in the classroom/laboratory or stock room been equipped with safety glass or covered with protective film?	☐	☐

Phase 2: Perform Hazard-Reduction Projects

After identifying the nonstructural hazards in the classroom, laboratory, stock room, and preparation room, determine the most effective method to mitigate those risks.

Step one*.* Establish an earthquake awareness program.

Central to earthquake preparedness is the earthquake drill to teach students (and staff) how to **respond immediately** with life-protecting action. The procedures for earthquake drills in science instructional areas need to be individualized for each room at each site; however, the following elements would be similar for all:

- Duck, cover, and hold. (Students duck under their desks or tables, cover their neck and head, and hold on to a table leg.)
- Guard against potential hazards.
  - — Extinguish flames
  - — Unplug electric cords
  - — Secure apparatus (Set them in sinks or on the floor.)
  - — Shut off water, gas, and electricity master controls
  - — Have fire extinguishers ready
- Evacuate to an open area when necessary or safe to do so (instructor's decision).
- Comply with administrative instructions.

The activities in this list are not necessarily in sequence. In an emergency, the severity of the earthquake will help dictate the order. If any of the actions to guard against hazards can be accomplished in the process of "duck, cover, and hold," the situation would become much safer.

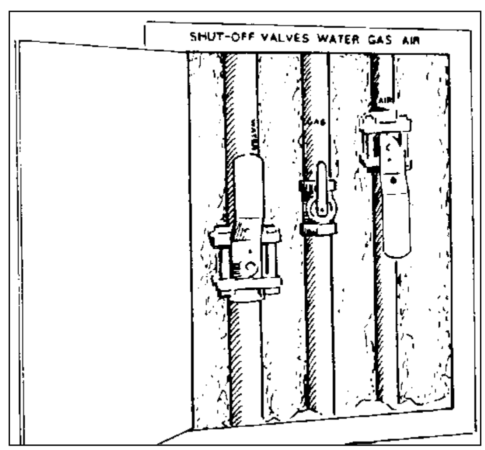
Preparation for the drill and for a sizable earthquake emergency will facilitate each step. Lead students in each class through a simulated emergency early in the course and repeat the drill occasionally during the year. This practice should carry over to staff preparation and response at home and wherever else one may be during a real emergency.

A drill is also the time when deficiencies in the preparedness of the facility should be corrected. Identify objects, structures, and furnishings that should be avoided and those that might be used for protection. Objects, glassware, instruments, or books that are on shelves without earthquake lips (even those on shelves with closed doors) are likely to dislodge and fall or become missiles. Objects standing on countertops, including containers of chemicals and solutions, will likely fall to the floor. Anything that can be used as a cover (e.g., tables, chairs, books) to provide protection from falling ceiling tiles or other objects will decrease the likelihood of injury.

Each drill should be followed by an evaluation, including the discovery of any hazardous condition that should have been corrected. The follow-up discussion should reinforce the idea of **where** to seek shelter and **how** to protect oneself. It should also provide a forum in which students can voice their concerns, thus minimizing the possibility of panic if an earthquake does occur.

In addition, science staff members should take the time to evaluate the preparedness of the entire department and go through each room to judge the consequences of a severe earthquake. Evaluation should lead to continual improvement in the preparedness of basic structures as well as improved housekeeping procedures.

Step two. Obtain or draw a map of the school and school grounds. Use the map to note potential hazards and to mark the location of utilities, emergency equipment, and supplies. Be sure to mark the locations of the following items:



- Main shut-off valves for water and gas
- Electrical-power master switch
- Stoves and heating/air-conditioning equipment
- Chemical storage areas and gas lines in laboratories
- Fire extinguishers
- First-aid equipment

The map can also be used as the basis for (a) tracing an evacuation route; (b) locating a safe assembly area; and (c) creating an earthquake-response plan (e.g., planning first-aid and search-and-rescue strategies).

Step three. Mitigate the nonstructural hazards.

The following methods are suggested to rectify the hazards that were identified in Phase 1 (a checklist of the more common nonstructural hazards found in secondary science classrooms). Each suggestion is cross-referenced to items in Phase 1.

1. Equipment/furnishings/fixtures

   a. Anchor all file cabinets, shelving, and bookcases to wall studs. *(Phase 1: 1a, 1c, and 1d)*
   b. Check cupboards and cabinets for secure latches that would stay locked during an earthquake. *(1l)*
   c. Anchor all television monitors, desktop computers and their components, aquariums, plants, sound systems, lamps, and other heavy items. *(1e, 1f, 1i, and 1m)*
   d. Remove or secure any boxes or equipment stored on top of high cabinets. *(1h)*
   e.* Check the secure attachment of any *overhead* fixtures, decorations, lighting, grills in walls, ceiling panels, or latticework. *(1b, 1g, and 1n through 1v)*
   f.* Securely affix fire extinguishers in accessible areas. (*1k*)
   g. Put chocks under wheels of objects and wheels that lack built-in brakes. *(1e and 1i)*
   h.* Restrain heavy equipment (e.g., refrigerators, ranges). *(1i and 1j)*
   i. Post safety signs, symbols, and labels to reinforce safety precautions.

2. Hazardous/toxic materials

   a. Secure compressed gas cylinders or large tanks with strong nylon straps or heavy-duty chains. *(2b)*
   b. Use wires or other barriers to restrain objects from falling from open shelving. *(1l and 2c)*
   c. Store chemicals in unbreakable containers and in accordance with the compatibility system prescribed in this handbook (see Chapter 7, Section E, Step 7), or a similar system, to reduce the possible occurrence of incompatible mixtures. *(2d and 2e)*

3. Windows

   If the windows are not made of safety glass, a protective, transparent film may be applied to reduce the danger of flying glass and provide an additional security measure against break-ins. *(3)*

* Additional help from the janitor or maintenance staff member may be needed.

Phase 3: Create an Emergency Response Plan (ERP)

In response to the Statutes of 1984, Chapter 1659 (see relevant *EC* sections in Appendix A), most schools have already developed an earthquake emergency procedure system that includes, but is not limited to:

- A school-building disaster plan.
- A "duck, cover, and hold" drill (duck under a desk, cover the neck and head, and hold on to a leg of the desk).
- Protective measures to be taken before, during, and after an earthquake.
- A training program for students and staff on the earthquake emergency procedure system.

See Phase 2, step one, for more details on procedures specific to earthquake awareness in science instructional areas.

An excellent resource for schools is the *Guidebook for Developing a School Earthquake Safety Program,* published by the Federal Emergency Management Agency (FEMA).

Phase 4: Procure Emergency Equipment and Supplies

The threat of an earthquake-related emergency varies considerably from one region of the state to another. However, the basic equipment and supplies that science laboratory/classroom personnel need to have on hand in the event of a severe earthquake are quite similar to those needed in other natural emergencies, such as fires, floods, or tornadoes, or in disasters resulting from air, railroad, or highway accidents. Furthermore, *EC* Section 40041.5 specifies that the school buildings, grounds, and equipment must be made available to public agencies, including the American Red Cross, for mass care and welfare shelters during disasters or other emergencies (see Appendix A). It is advisable and prudent to consider such possibilities in overall emergency planning. The most obvious needs would include the following:

- A source of lighting, such as a flashlight, with fresh batteries, as well as, spare batteries and bulbs.
- A battery-powered radio for receiving information and instructions.
- A well-stocked first-aid kit that contains:
  - Adhesive bandages
  - Adhesive tape
  - Antiseptic wash or ointment

  - Blanket
  - Cold pack
  - CPR mouth barrier
  - Disposable gloves
  - Flashlight
  - Gauze pads (assorted sizes)
  - Hand cleanser (alcohol-based)
  - Pad of paper
  - Pen
  - Roller gauze (assorted sizes)
  - Scissors
  - Triangular bandage
  - Tweezers
- A generous supply of water

Science rooms already have available a number of safety features, including fire extinguishers, fire blankets, chemical spill-control kits, and eyewash stations. Because of the potential in the science laboratory/classroom for injuries from flammable, toxic, and corrosive substances, the possibility of tap water being unavailable should be considered. Additions to the list of emergency supplies might include these items:

- Sterile squeeze bottles and spray bottles, useful for applying water to burns or spills of toxic or corrosive substances on the skin or in the eye.
- Extra water.
- Extra fire blanket(s), both for the primary purpose of smothering fires and for maintaining body warmth during first-aid measures.

A plan must be established for replacing components regularly to ensure that all items are fully available and functional at all times. During an emergency evacuation of the facility, the emergency supplies, as appropriate, should be a part of the orderly departure.

I. Hazardous Waste Minimization

Waste is any material that has been used or has otherwise served its intended purpose. School science laboratories generate hazardous, chemical, and other types of waste. The growing costs of the disposal of hazardous and other chemical waste, as well as, concern about the adverse effects on human health and the environment, make the reduction of these types of waste an increasingly important issue. By employing innovative strategies that minimize in school science laboratories hazardous and other chemical waste that must be treated or disposed of, schools and school districts will lower costs for waste disposal and increase organization and safety in laboratory and storage areas.

Hazardous and other chemical waste generated at schools generally consists of small quantities of many different chemicals, not large quantities of a few chemicals (as typically generated by industrial entities).[*] This section provides strategies for minimizing the use of hazardous and other chemical waste in school science laboratories. Development of a campuswide program is also discussed, since minimization of hazardous and other chemical waste in school science laboratories is most effective when included as part of a comprehensive program for the entire school.

A campuswide waste-management program that involves all departments, including those of art and photography, auto shop, agriculture, and maintenance operations, provides the district with even greater cost savings in waste reduction. Pointing out to students, faculty, administrators, and maintenance staff the benefits of reducing their personal exposure to potentially hazardous chemicals is essential in obtaining campuswide commitment to the program. Community businesses can provide professionals who will explain the advantages of source reduction. Once campuswide support for safety and reduction goals is established, the personal, fiscal, and environmental benefits will be evident almost immediately.

Additional information available through the United States Environmental Protection Agency (EPA) can help schools start campuswide chemical-management programs, including those for school science laboratories. The Schools Chemical Cleanout Campaign (SC3) Tool Kit ://www.epa.gov/schools/chemicals/ (accessed November 17, 2014) is a Web-based tool kit intended to help schools start chemical-management programs to (1) remove unnecessary

[*] Ralph Stone and Co., Inc., *Waste Audit Study of Research and Educational Institutions* (Los Angeles: Ralph Stone and Co., August 1988). Prepared for the California Department of Health Services, Toxic Substances Control Division (now the Department of Toxic Substance Control).

chemicals; (2) prevent chemical mismanagement through training, curriculum, and policies; and (3) raise awareness of chemical issues and promote sustainable solutions.

The Healthy School Environments Assessment Tool (HealthySEAT), available at ://www.epa.gov/schools/guidelinestools/healthySEAT/ (accessed November 17, 2014), is a software tool intended to help school districts evaluate and manage environmental, safety, and health issues, including chemical-management programs. HealthySEAT can be customized and used, free of charge, by district-level staff to conduct voluntary self-assessments and manage information on environmental conditions for their facilities. A California version of HealthySEAT is being developed.

Assessment of Current Waste Policy

Before designing a waste-reduction plan, school authorities should conduct an assessment of the school's current waste sources and waste-management practices. The assessment will provide insight into more effective waste-reduction methods and assist in planning and allocating resources toward the reduction of waste. Data from the assessment may serve as a baseline in monitoring the progress of a waste-reduction plan. Knowledgeable staff members or specially trained consultants should assess the school's waste policy to:

- Identify the types and amounts of hazardous materials used and the waste generated in each department.
- Identify significant losses of materials and the factors that cause the losses (for example, inaccurately measured amounts of substances used in experiments).
- Suggest strategies for decreasing waste and stemming losses of materials.
- Itemize current waste-management costs and estimate the costs of proposed waste-reduction practices.

When the assessment is complete, a flexible waste-reduction strategy can be generated.

Development of a Campuswide Plan

A campuswide waste-reduction plan should reflect changes in management practices as well as changes in everyday laboratory practices and the usage of chemicals.

Waste reduction through prudent management practices. The following management practices can help reduce waste:

1. **Appoint a waste-management coordinator.** Select a trained faculty member who has been accredited through a college program or workshop on waste management to implement an integrated waste-reduction program approved by the school board. A

prime responsibility of the waste-management coordinator would be to ensure that the school complies with all local, state, and federal waste-management regulations.

2. **Provide employees with information about waste reduction.** To enhance schoolwide awareness and participation, inform employees of the necessity of waste reduction and the ways in which it can be achieved. Hands-on experiences provide the most effective learning forum for faculty and staff. Arrange follow-up meetings within each department to give all employees the opportunity to discuss and critique the effectiveness of their reduction efforts.
3. **Centralize purchasing.** Schools should consider developing a system for buying chemicals through a centralized district or consortium purchasing agent. The purchaser would monitor all requests received from the entire district or consortium and place money-saving bulk orders for chemicals. Then the chemicals would be distributed to the schools.
4. **Use less-hazardous chemicals.** Substituting less-hazardous chemicals for chemicals that present health and environmental risks can reduce the use of more harmful chemicals.
5. **Prevent overstocking.** At each school, prevent overstocking and ensure the availability of fully potent chemicals by sharing chemicals with common users and buying chemicals only as needed. A practice that is initially slightly more expensive (but will save money in the long run) is the purchase of several small bottles of each chemical to be used. This system helps to stem the loss of large amounts of a chemical reagent through accidental contamination and makes it easier to manage unused amounts. Another successful cost-cutting strategy is to estimate the amount of a chemical reagent the school (all departments) will use in one year and order only that amount at the beginning of the year. Bulk ordering for multiple years of predicted use is discouraged. Although a school may seem to take advantage of unit cost savings by ordering large quantities, there is often no net savings for the school because of the ever-increasing cost of disposal of outdated, unused chemicals.
6. **Choose a responsible vendor.** Schools can encourage better customer service from chemical suppliers by ordering supplies from those who (1) provide quick delivery, (2) accept the return of unopened stock, and (3) offer off-site waste-management outlets or cooperatives for laboratory waste. Those expectations should be conveyed to company representatives *before* orders are placed and should be considered as the basis for future orders.

7. **Establish an inventory-control program.** An inventory-control program should be established to trace the volume of waste generated. The inventory would enable more accurate tracking of all incoming chemicals from the time they arrive until they are disposed of as hazardous waste. Improved access to accurate inventory lists by all authorized district and school personnel will enable common users to share chemicals; provide data on all courses in which potentially hazardous chemicals are used; allow instructors to track the consumption of the chemicals and locate unused reagents; and allow the monitoring of the shelf life of chemicals. The program could be implemented at the district or individual school level through a computer database and specialized software or through a standard filing system.

Waste reduction through everyday laboratory practices, proper equipment, and experimental design. Although waste audits and up-to-date waste-management practices are essential to a campuswide waste-reduction program, the full cooperation and understanding of laboratory instructors are necessary if the program is to achieve success. According to the *Waste Audit Study of Research and Educational Institutions*,[*] schools can markedly minimize waste generation by taking the following actions in the laboratory:

Before the Laboratory Experiment

1. **Perform regular inspections.** By regularly inspecting all containers, teachers can quickly replace those that are cracked or broken and thereby prevent spills and leaks.
2. **Preweigh materials.** After students master the skill of using the balance to weigh substances, it may be practical to preweigh materials for them. Students' laboratory productivity can be increased by reducing the time spent waiting for each student to weigh his or her materials. Preweighing chemicals also helps to prevent the contamination of substances, a problem that becomes more likely when many people obtain samples from the same bottle. Trained and properly supervised laboratory assistants who have reviewed the pertinent SDS for each hazardous substance to be handled may perform the preweighing tasks.
3. **Use less-hazardous chemicals.** Substituting less-hazardous chemicals for chemicals that present health and environmental risks can reduce the use of more harmful

[*] Ralph Stone and Co., Inc., *Waste Audit Study of Research and Educational Institutions* (Los Angeles: Ralph Stone and Co., August 1988). Prepared for the California Department of Health Services, Toxic Substances Control Division (now the Department of Toxic Substance Control).

chemicals. A reference on this strategy is *New Chemicals for Old: Preserving the Student Lab Experiment,* by Rena Benedict (Minnesota Department of Education, 1987).

4. **Reduce the use of metal-bearing waste.** Experiments that generate metal-bearing waste can be expensive because of the high cost of the processing treatments for heavy metals. Any commingling of less-hazardous waste with heavy metals causes the entire mixture to be classified as a heavy-metal waste and greatly increases the cost of disposal. Many heavy metals, such as hexavalent chromium, have recently been placed on the list in Table 7.3 (“Extremely Hazardous Chemicals Requiring Prompt Disposal”) because of their carcinogenic or toxic nature (see Chapter 7). Therefore, experiments that call for their use should either be modified or removed from the laboratory curriculum. Experiments that generate heavy metals should be carefully monitored so that waste streams are not mixed. If nonmetallic reagents are substituted for those containing metals, lower disposal costs are likely, which is a boon for the district.

During the Laboratory Experiment

1. **Use efficient dispensers.** Using containers that dispense the contents through pumps and spigots will reduce the likelihood of spills and measurement errors.
2. **Reduce wet chemistry.** In some circumstances, the use of instrument methods instead of wet-chemistry procedures will help in reducing waste because instrument analysis requires much smaller quantities of chemicals.
3. **Avoid waste generation.** Sometimes chemicals can be rendered safe enough to go into the sewer in the final steps of an experiment. In that case, the process will not only reduce the need for off-site disposal but also increase students’ awareness of proper waste management and waste reduction. A thorough reference on this strategy is *Prudent Practices for Disposal of Chemicals from Laboratories* (National Academies Press, 1983), Chapters 5 and 6.
4. **Conduct scaled-down experiments.** The volume of chemicals used in experiments can be reduced by practicing microscale chemistry (described in the following subsection).

After the Laboratory Experiment

1. **Recycle products used in experiments.** Recycling chemicals by using the product of one experiment in the student’s next experiment is an effective way to greatly diminish

the amounts of fresh chemicals used in the laboratory. An entire college-level laboratory curriculum that focuses on using cyclic experiments is presented in the *No-Waste Lab Manual for Educational Institutions: A Procedure That Eliminates Toxic Waste Production from Introductory Chemistry Laboratory Courses.* The manual is downloadable at ://infohouse.p2ric.org/ref/02/01565.pdf (accessed November 17, 2014) (California Department of Health Services, 1989).

2. **Clean containers according to state regulations.** Costly disposal fees may be reduced by thoroughly emptying all used chemical containers. The *CCR,* Title 22, Section 66261.7, addresses the handling of contaminated containers. It encourages recycling and other options for disposal of "empty" containers. Containers once filled with hazardous waste can be disposed of as nonhazardous waste *provided certain stipulations are met.* See Appendix O for information on how to manage empty containers.
3. **Reuse solvents.** Use spent solvents for the initial cleaning of glassware; use fresh solvent only for the final rinsing.

Waste reduction through microscale chemistry. One of the most effective ways in which waste reduction can be achieved is by using smaller volumes of chemicals to perform microscale laboratory experiments. In most microscale experiments, the chemical quantities can be reduced to between one-tenth and one-thousandth of the usual scale. The main advantages include the following: (1) less money is spent on chemicals, (2) less waste is produced, (3) exposure to hazardous chemicals is reduced, (4) reduction in the volume of reagents for environmental and safety reasons can be modeled to students, and (5) the results of the experiment can often be determined more quickly.

The transformation of a laboratory from macroscale to microscale is easily accomplished. Some new materials must be purchased but are relatively inexpensive. One cost-effective way of converting is to purchase reusable plastic or polystyrene tissue-culture plates and plastic pipettes. Because water is the solvent used most often in high school experiments, the chemical stability of the plastic is not usually a problem. If plastic is unsuitable for organic chemistry, microscale glassware can be substituted, although it is slightly more expensive. Nearly all chemical suppliers now carry the equipment necessary for microscale experiments.

Several publications are available on experiments using microscale chemistry. Most focus on organic chemistry because minimization efforts are most cost-effective with organic chemicals. Here are a few reference books on chemistry laboratories:

Mayo, D. W., R. Pike, and S. S. Butcher. *Microscale Organic Laboratory.* 2nd ed. New York: John Wiley and Sons, 1989.

Mills, J. L., and M. D. Hampton. *Microscale Experiments for General Chemistry.* 2nd ed. New York: McGraw-Hill, Inc., 1991.

Thompson, S. *Chemtrek: Small-Scale Experiments for General Chemistry.* Englewood Cliffs, NJ: Prentice Hall, 1990.

Additional information on waste minimization and pollution prevention for school science laboratories is provided in the following references:

Davis, M. E. Flores, J. Hauth, M. Skumanich, and D. Wieringa. *Laboratory Waste Minimization and Pollution Prevention, A Guide for Teachers.* Seattle, WA: Battelle, 1996. ://infohouse.p2ric.org/ref/01/text/00779/index2. (accessed November 17, 2014).

United States Environmental Protection Agency. *Pollution Prevention Measures for Safer School Laboratories.* U.S. EPA Region 8 Information Kit, EPA 908-F-06-002. (February 2006) ://yosemite.epa.gov/R10/TRIBAL.NSF/b8b7c39a103a235088256c3e007a4dd9/1e4f27736563fc3a882571db00661b15/$FILE/1PreventiveMeasuresToolKit. (accessed December 29, 2014).

J. Employee Exposure to Hazardous Chemicals

Safety in school laboratories is a high priority for Cal/OSHA, as evidenced by the addition of laboratory standards in the *CCR,* Title 8, Section 5191 (see Appendix A). That section of the law requires employers (e.g., school districts) to take specific action toward minimizing employees' exposure to hazardous chemicals. The following subsection is a summary of the major changes in the standards (all subsections cited here are from the *CCR,* Title 8):

Exposure Limits

The employer must ensure that an employee's exposure to substances regulated by Cal/OSHA does not exceed the exposure limits specified under "General Industry Safety Orders," Section 5139.

Determination of an Employee's Exposure

The employer must measure an employee's exposure to regulated substances if there is reason to believe that exposure levels for those substances exceed the action levels or permissible exposure limits (*CCR,* Title 8, Section 5191 [c] and [d]). Monitoring must be done by a person competent in industrial hygiene practice and must occur periodically if the employee's exposure level exceeds the action level or permissible exposure limit. The results of the monitoring must be made available to the employee in writing within 15 working days.

Chemical Hygiene Plan

If the workplace contains hazardous chemicals, the employer should have developed and implemented a written chemical hygiene plan (CHP) by October 31, 1991. The purpose of the CHP is to protect employees from exposure to harmful levels of hazardous substances (*CCR,* Title 8, Section 5191[e]). The plan must be made available to employees, employee representatives, and, on request, the Chief of Cal/OSHA. The employer must take the following actions:

1. Establish standard laboratory operating procedures that are relevant to the safety and health of employees using hazardous chemicals.
2. Explain control measures that reduce employees' exposure to hazardous chemicals (for example, engineering controls, protective equipment, and hygiene practices).
3. Provide properly functioning fume hoods and biological safety cabinets that comply with *CCR,* Title 8, sections 5154.1 and 5154.2 (see Appendix A) and check them regularly to ensure proper and adequate performance.
4. Provide each employee with information and training about the CHP and all hazardous chemicals in the workplace at the time of an employee's initial assignment and each time a new hazardous substance is used. The frequency of the presentation of refresher information and training must be decided by the employer (*CCR,* Title 8, Section 5191[f]). The employer must inform all employees of the regulations in *CCR,* Title 8, Section 5191, the contents of the employer's CHP, the Cal/OSHA exposure limits for regulated substances, the recommended exposure limits for hazardous substances not regulated by Cal/OSHA, medical information on symptoms associated with exposure, and the location of references (e.g., SDS) that provide information about the hazardous chemicals with which employees work. The employer must also provide training on methods used to detect the presence or release of hazardous chemicals, the hazards of each chemical used, and measures that can be taken to avoid exposure.
5. Define the circumstances under which particular laboratory operations require prior approval from the employer.

6. If an employee suspects that he or she may have been exposed to hazardous substances at work, the employer must provide medical consultation, examinations, and treatment at no cost to the employee (*CCR,* Title 8, Section 5191[g]). The employer must obtain the written opinion of the physician about conditions of the employee relating **only** to the exposure, as well as, the employee's ability to perform tasks appropriately in the workplace, and suggestions for reducing exposure in the future.
7. If an employee is exposed to a hazardous substance at work, designated safety staff should evaluate why the exposure occurred and describe how this can be prevented in the future (*CCR,* Title 8, Section 3203).
8. Designate personnel responsible for the implementation of the CHP, including a chemical hygiene officer. The officer must be qualified, by training or experience, to provide guidance in developing and implementing the CHP.
9. Provide additional employee protection when particularly hazardous substances will be handled. **Note:** Substances listed in Table 7.3, "Extremely Hazardous Chemicals Requiring Prompt Disposal," Chapter 7, should have been removed from school laboratories previously.
10. Review and analyze the effectiveness of the CHP annually and update it as necessary.

A useful reference for developing a CHP for the school or school district is the *School Chemistry Laboratory Safety Guide,* available at ://www.cpsc.gov//PageFiles/122344/NIOSH2007107. (accessed November 17, 2014).

Numerous examples of CHPs may be researched on the Internet, but two plans that California schools may find especially useful are those of the Long Beach Unified School District: ://www.lbusd.k12.ca.us/Main_Offices/Curriculum/Areas/Science/pdf/SafetyDocs/CHEMICAL%20HYGIENE%20PLAN%20-%202014. (accessed November 17, 2014), and Los Angeles Unified School District: ://achieve.lausd.net/Page/ (accessed November 17, 2014).

Recordkeeping

The employer must establish and maintain accurate records and monitor employee exposures and examinations.

K. Employee Exposure to Bloodborne Pathogens

The *CCR,* Title 22, Section 5193 (see excerpts in Appendix A), requires that each employer whose employees, in the course of their occupation, may be exposed to bloodborne pathogens must establish a written exposure control plan designed to eliminate or minimize such exposure. Selected school district employees may have such occupational exposure. A summary of the regulation follows.

Background

Certain pathogenic organisms can be found in the blood of infected individuals and may be transmitted to other individuals by blood or certain body fluids. The human immunodeficiency virus (HIV) and the hepatitis B virus (HBV) are the two most significant bloodborne pathogens. Individuals whose occupational duties may expose them to blood or other potentially infectious materials are at risk of being infected with these bloodborne pathogens and developing the disease, infecting others, and, in some cases, death.

Exposure Control Plan

The written exposure control plan (ECP) must contain the following elements:

1. **Exposure Determination.** The employer shall maintain a list of all job classifications in which employees have or may have occupational exposure and a list of the tasks and procedures that place them at risk.
2. **Methods of Compliance.** The following universal precautions shall be observed to prevent contact with blood or other potentially infectious agents. If differentiation between types of body fluids is difficult, all shall be considered potentially infectious.
    - **Engineering controls and work practice controls.** An example of an engineering control is the provision of sharps-disposal containers to isolate or remove the hazard from the workplace. Work practice controls deal with handwashing; handling of sharps; eating, drinking, smoking, and so forth in the work area; control of splashes and droplets; prohibition of mouth pipetting; leakproof containers; and labeling practices. These controls shall be established to eliminate or minimize employee exposure.
    - **Personal protective equipment** (when occupational exposure exists). Personal protective equipment may include, but is not limited to, gloves, gowns, laboratory coats, face shields or masks, eye-protective devices, mouthpieces, resuscitation bags, pocket masks, and other ventilation devices.
    - **Housekeeping.** Clean and sanitary conditions shall be maintained at the work site; equipment and environmental and working surfaces shall be cleaned and

decontaminated after exposure; and regulated waste shall be stored and disposed of appropriately. Warning labels in fluorescent orange or orange-red shall either be securely affixed to containers of regulated waste or be an integral part of the container. The label shall include the following symbol and legend:

Biohazard

Or, in the case of regulated waste, the legend **BIOHAZARDOUS WASTE** shall be used**.**

Hepatitis B Virus Vaccination

After appropriate training and within 10 days of their initial working assignment, designated employees **shall be offered, at no cost to themselves***,* vaccination against the hepatitis B virus. A record shall be kept of designated employees' acceptance or declination of the vaccine.

Postexposure Evaluation and Follow-up

All unvaccinated employees who have rendered assistance in any situation involving the presence of blood or other potentially infectious material, whether or not a specific exposure incident occurred, shall be offered vaccination against the hepatitis B virus. Incident reports shall be maintained about each such occurrence, and arrangements shall be made for a confidential medical evaluation, counseling, and appropriate postexposure prophylaxis.

Hazard Communication (Training)

All designated employees are to be trained at the time of their initial assignments and at least annually thereafter. The training must include an explanation of the following information:

- The contents of the regulatory text and its accessibility to employees
- Bloodborne diseases and their modes of transmission
- The exposure control plan
- Recognition of tasks that may involve exposure
- Ways in which exposure can be prevented or reduced
- Use and handling of protective equipment

- Appropriate action to be taken and procedures to be followed if an exposure incident occurs
- The availability, free of charge, of the hepatitis B vaccine
- Postexposure evaluation and follow-up

An opportunity for interactive questions and answers is also required.

Recordkeeping

The medical record of each designated employee shall include (1) the employee's hepatitis B vaccination status; (2) the results of related examinations, medical testing, and follow-up procedures; (3) copies of any health-care professional's written opinion or other information; (4) an incident log of all first-aid incidents; and (5) the employee's training records.

The employee's medical records shall be kept confidential and maintained for at least the duration of employment plus 30 years. Training records shall be maintained for three years from the date on which the training occurred.

All required records shall be made available to the Chief of Cal/OSHA and the National Institute for Occupational Safety and Health (NIOSH) for examination and copying.

Chapter 6

Safety in the Biology Laboratory

Biology and physiology teachers should be familiar with the following safety practices and all other sections of the handbook pertinent to their instructional program. Special attention is directed to Appendix P, “Sample Biological Science Laboratory Regulations.” General precautions are as follows:

- When experiments require special biological substances, such as nicotine alkaloid, the materials should be carefully supervised.
- Drugs and syringe needles should be used only when specifically called for in the instructional program and only for specific projects under close supervision of the instructor. Keep all drugs and syringe equipment in a safe, locked place. When using sharp instruments, take precautions to prevent injuries and exposure to bloodborne pathogens (*CCR,* Title 8, Section 5193, Bloodborne Pathogens).
- Radioactive materials used in biological research should be properly marked and, when not in use, appropriately secured.

BIOHAZARD

- Volatile solvents, such as acetone used in paper chromatography experiments, should be used only in a fume hood away from incompatible chemicals, such as acids. (See Appendix D for a list of incompatible chemicals).
- Adhere to all laws and regulations regarding the use of animals in science instruction. (See *EC* Section 51540 and *HSC* Section 1650 in Appendix A).

A. Human Blood Sampling

1. The *CCR,* Title 8, General Industry Safety Orders, Section 5193, essentially requires each school district in the state to prepare a written exposure control plan (ECP) designed to eliminate or minimize the exposure of all employees to the blood, certain body fluids, and other potentially infectious material (OPIM), as defined in *CCR*, Section 5193(b), of any other person, thus eliminating or minimizing the likelihood of employees being infected by bloodborne pathogens (see Chapter 5, Section K; and Appendix A). A similar responsibility to protect students from such infection is implied. Teachers and any other school employees who have occupational exposure to blood or OPIM are covered by the requirements of Section 5193, which includes medical surveillance (such as making hepatitis B vaccine available to them) and training.

   Although less desirable instructionally, the use of alternatives to fresh human blood is encouraged. It may be possible to acquire, from a local blood bank, blood (types A, B, O, and AB) that has been tested and found free of the hepatitis B virus and the HIV. The blood may be used either in a teacher demonstration (using an overhead projector) of the common blood types or in a student laboratory activity. Such use should be performed with all the precautions of the school district's ECP because testing for the pathogens noted above is imperfect.

   If blood typing or other microscopic analysis of fresh human blood is **permitted** by the school district, and is to be conducted in the classroom, the blood sampling must be done pursuant to the district's ECP. In the absence of more specific procedures, the sampling should be accomplished:

   - On a voluntary basis.
   - Only by those student volunteers who submit a permission note signed by a parent or legal guardian who has been provided with information on risks.
   - Through self-administered blood draws by each volunteer.

- In a manner consistent with the school's ECP.

2. Several days before providing the opportunity for voluntary blood sampling by students, discuss with the students the techniques they will learn. Emphasize that for most students this is a perfectly safe procedure (except for possible infection from someone else's blood); discuss the risks for hemophiliacs and others. Emphasize also that the results of the tests are not to be considered valid for diagnostic purposes.

   Explain to the class that students must **not** participate in the blood sampling if they have any known medical problem, especially any of the following conditions:

   - Diabetes.
   - Excessive bleeding (characteristic of hemophiliacs and users of prescribed drugs that lengthen clotting time, such as Coumadin, or drugs prescribed for a heart condition).
   - Hepatitis (during the preceding year). If hepatitis B or C is involved, a student may still be a carrier and could infect other students through contact with blood on tabletops, broken lancets, and so forth.
   - Chronic pyoderma (skin pus areas, recurring boils). Students with this condition would likely have skin contaminated with staphylococcus and streptococcus bacteria. Puncturing of such contaminated skin could produce a new infection site. If the lancet were accidentally reused, it could transmit the bacteria to other students.
   - Infection with HIV. The virus can be transmitted from an infected person to another person if it gains entrance into the blood of that other person.

   Students with any such medical problems do not need to share that information with the teacher or their classmates; they can opt out of the sampling by choosing not to bring a note of permission from their parents. Thus they need not be embarrassed about or reveal their medical condition. Obviously, the teacher should demonstrate sensitivity under such circumstances.

   The majority of students who carry hepatitis B or C or HIV are not aware that they are infected. For this reason, teachers and students must follow the universal safety precautions outlined by the school district's ECP (see Appendix A for *CCR,* Title 8, General Industry Safety Orders, Section 5193, Bloodborne Pathogens).

3. The danger of spreading infectious diseases, such as hepatitis or HIV, makes it necessary to employ precautionary measures aimed at preventing transmission of

bloodborne pathogens. These measures include the use of goggles and gloves. The teacher must wear gloves during any procedure that would expose him or her to the subject's blood. Gloves must be made available to the students. Contaminated gloves must not be used for the next subject. Contaminated disposable gloves must be discarded, and reusable gloves must be properly decontaminated.

Lancets and any other sharps devices that might be used for the study of blood and OPIM must have engineered sharps injury protection. For instance, there are lancets that automatically retract into the handle after puncturing the skin.

4. Blood should be drawn only with a new, individually packaged sterile lancet. Lancets are to be used **one time only**, then discarded promptly in a container designated for that purpose by the school district's ECP.

   (Generally, schools should not try to reuse lancets, because the sterilization process and associated equipment, handling, and liabilities for improper sterilization render such a practice imprudent).

5. The use of disposable lancets meets the requirements for this activity. Each lancet must be used only once, by and for one person. The unbroken lancet must be discarded immediately in the container that meets the requirements for a sharps container set by *CCR,* Title 8, Section 5193(d)(3)(D); the container must be rigid, puncture-resistant, leak-proof on the sides and bottom, portable, properly labeled, closable, and sealable to resist leakage and reopening, once it is closed for disposal. The disposal of the filled sharps container must comply with the current requirements of *HSC* Sections 118275–118320.

6. If several students in one class period voluntarily wish to draw blood samples for use by themselves, each student who draws a sample must have a separate sterile lancet, which is to be used to make only **one** puncture.

7. Before puncturing the skin, rub the surface of the finger from which the blood is to be drawn with sterile, absorbent cotton dipped in alcohol. After drawing blood, use a fresh piece of sterile cotton to stop the bleeding.

8. After examining the samples, use standard sterilization and disinfection procedures. Glassware, devices, or instruments that require sterilization or disinfection should first be immersed in a solution no weaker than one part bleach to 10 parts water (1:10) and then

thoroughly cleaned before being exposed to a germicide; the manufacturer's instruction for use of the germicide should be followed.

9. Cotton swabs should be processed as regulated waste for either (a) vendor pickup, by placing the waste in individual red bags prepared according to the vendor's instructions; or (b) disposal (if an outside vendor is not used) by placing the waste in containers that are:
    - Closable.
    - Constructed to hold all contents and prevent leakage of fluids during handling, storage, transport, or shipping.
    - Appropriately labeled and color-coded as containing biological waste.
    - Closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping.
10. The entire activity area should be wiped down with a 1:10 bleach solution following the experiment.
11. As usual, washing hands with soap and water after the laboratory activity is mandatory.
12. If a teacher or other employee is injured with a contaminated sharp object, Section 5193 of the *CCR,* Title 8, requires the school to record the incident in a sharps injury log with specific information about how the injury occurred, the type of sharp device that was being used, and other information about the circumstances. Each incident recorded must be reviewed in the annual review of the ECP as a means of identifying ways to prevent future accidents.

B. Epithelial Tissue Study

1. Students should exercise great care in obtaining epithelial cells from the inside of the cheek for study under the microscope. Only a cotton-tipped swab or the blunt edge of a toothpick should be used. *Never* use pointed instruments or any part of a scalpel for this purpose.
2. To participate in this experiment, each student volunteer must bring a permission note signed by a parent.
3. Precautions and cleanup procedures similar to those used in blood sampling should be followed.

C. Use of Microscopes and Hand Lenses

When students have eye infections, they should not be permitted to use school microscopes or hand lenses.

D. Experiments with Bacteria and Fungi

1. All bacteria and fungi should be handled as though they were pathogens. Pathogenic bacteria should **not** be cultured. As of August 5, 2009, Cal/OSHA—in the *CCR,* Title 8, General Industry Safety Orders, Section 5199, Aerosol-Transmissible Disease standard—requires laboratories that perform procedures that can aerosolize pathogens listed in Section 5199 (Appendix D of the *CCR,* Title 8), to conform to requirements listed in Section 5199, subsection (f). These requirements include, but are not limited to, having a risk assessment done by a qualified biological safety officer, and a biosafety plan for the laboratory to be written and implemented by the school. Pure cultures of nonpathogenic microorganisms should be used in experiments. When soil or water is used as a source of bacteria (or fungi), it is important to collect samples unlikely to be contaminated by human pathogens. For example, water should be collected from lakes, estuaries, or beaches free of sewage or animal-waste pollution. (See Section E for special concerns in studying air and soil cultures of fungi and molds).
2. Petri dishes that are passed around the classroom for inspection of cultures should be bound together with transparent tape. Any petri dish that contains fungus should be taped shut. Provide instructions that petri dishes containing bacterial or fungal cultures should not be sniffed.
3. Wire loops used for transferring bacteria cultures should be flamed until the **entire** wire is **red** hot before and after each transfer is made.
4. Inoculating loops must be used with care. The film held by a loop may break and cause substantial atmospheric contamination. A hot loop inserted into a liquid may cause spattering. Loops should be allowed to cool before insertion into liquids. The procedure may require the use of more than one loop so that as one is being used, others are cooling. When a contaminated loop is inserted into a flame for sterilization, an aerosol may be generated by the boiling and volatilization of the material before the flame can kill all pathogenic microorganisms. Whenever inoculating loops are being used, avoid any sudden actions that might result in the generation of an aerosol.

These precautions are intended for laboratory activities involving any bacteria or fungi. Even nonpathogenic microorganisms may cause disease if they enter the body accidentally. This danger is especially true if the human system is immunosuppressed because of HIV, intake of drugs, and so forth.

5. To sterilize plates before cleaning or disposal, follow these steps:
   a. Autoclave the unopened plates in the usual manner. Usually, steaming at a pressure of 15 pounds per square inch for 15 to 20 minutes kills most microbes. However, to sterilize soil samples or large volumes of culture, continue with the procedure described below.
   b. Wait one day for any resistant spores to leave the resting stage and begin to grow.
   c. Sterilize a second time.
   d. Wait one day.
   e. Sterilize a third time.

Note: All resistant spores should have been killed at this point. The plate may be safely opened for cleaning or discarded in the regular trash.

E. Special Concerns in the Study of Fungi and Molds

Whenever agar plates are inoculated with soil or plant material or exposed to the air inside or outside a building, there is the strong possibility that fungi (molds) will grow on the surface of the plates and form aerial hyphae. At the tips of these hyphae, chains of conidia (spores) will form; the conidia are often colored. These conidia are easily dislodged by air currents and can be rapidly spread through a room when the lid of the petri dish is removed. People with normal immune systems are usually not infected when they breathe in these spores. However, people with weakened or suppressed immune systems are at risk of developing a fungal infection if they inhale the spores. Immune systems can be damaged by immunosuppressant drugs, HIV infections, or other causes. Therefore, once the petri dishes are inoculated, it is good practice to *tape* the lids on with two pieces of tape opposite each other and allow manipulations of the fungal growth only in a fume hood in which a current of air draws the spores out of the room.

Fungi are microorganisms that are widespread in soil, dust, and air. The fungus **Coccidioides immitis***,* which is present in some soils of the southwestern United States, is of particular concern. After inhaling the spores, most people develop a mild flulike respiratory illness called valley fever, which quickly passes. Usually, people acquire lifelong immunity to reinfection. However, some people become very ill and may die, even with medical care. Therefore it is essential for students working with soil, or the fungi in soil, to be aware of this hazard and not expose themselves to large amounts of the dust or spores. In areas where valley fever is endemic, such as the San Joaquin and Central valleys, consider restricting the collection of soil to sites within five miles of the Pacific Ocean (in the United States) to minimize exposure to spores of the fungus that causes that disease. To be completely safe, soil collection should not be performed in areas where valley fever is known to be endemic. Additionally, soil contaminated with old chicken, pigeon, or bat droppings may contain the spores of the fungus that causes histoplasmosis. Soil from archeological sites, the land around old buildings, and animal burrows should be avoided, regardless of their location.

F. Operation of Pressure Cooker for Sterilization

1. Before using a pressure cooker, the teacher should be familiar with directions for its operation.
2. The safety valve should be examined to make sure it is in working order.
3. The gauge pressure should be kept at or below a maximum of 20 pounds per square inch.
4. The pressure should be returned to zero before the cover can be safely removed.
5. The test stopcock should be opened before the clamp can be safely released.
6. An eye-protective device should be used when working with a pressure cooker.

G. Extraction of Chlorophyll and the Use of Flammable Solvents

1. An electric heater of the immersion type or a water bath heated by an electric hot plate should be used.
2. **Never** use a water bath heated by an open flame to heat alcohol or other solvents.
3. Flames should be kept away from solvents (such as acetone or alcohol) or their vapors. If a solvent ignites in the beaker, cover the beaker with a glass plate to extinguish the fire. If burning solvent is spilled on the table, use either the carbon dioxide (or 2A-10BC dry powder) fog extinguisher or the fire blanket. These devices should be kept readily available.

H. Risks in the Use of Acrylamide

In recent years, polyacrylamide gels have been prepared in some school laboratories to achieve the isolation of specific molecules by electrophoretic techniques. Schools are cautioned to cease this practice because acrylamide in its powdered form poses a potentially serious health hazard as a neurotoxin. This substance has been classified as 2B (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC) and is included on the California Environmental Protection Agency's list of "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity" (*CCR,* Title 22, Section 12000).

Because there is a serious risk of inhalation exposure during the weighing of acrylamide powder for the preparation of gels, schools should purchase only prepoured polyacrylamide gels from laboratory supply houses. Prepoured gel presents less health risk because the acrylamide has chemically reacted (polymerized) to form a solid gel (letter from the California Department of Health Services, July 10, 1992). Once the gel has solidified and been rinsed, very little of the raw acrylamide remains. Gloves should be worn at all times to prevent dermal exposure to any residual acrylamide found on the gel. To avoid the hazard altogether, schools may purchase prepoured gels made with acrylamide substitutes.

After gels are dried or mounted on blotting paper, they may be disposed of in the trash, just as plastics are. If the gels are still wet or if they have been dyed with ethidium bromide or other markers, different disposal requirements may apply. For additional information about compliance with these requirements, please contact the local Certified Unified Program Agency (CUPA). The local CUPA can be found through the California Environmental Protection Agency Web site at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

I. Risks in the Use of Ethidium Bromide

> *Note:* Because of its high mutagenic potential, ethidium bromide should not be used in school laboratories.

Ethidium bromide is used as a stain for electrophoresis gels. Ethidium bromide is a potent mutagen, and scientists believe that chemicals that can cause mutations (by altering DNA) should be treated as though they have carcinogenic potential. The highest potential for exposure is during the weighing and preparation of stock solutions. In addition, splashing in the eye or on the skin can occur during the dyeing of gels. Therefore, *any* handling of ethidium bromide should be approached with extreme caution.

The most effective way to control exposure to ethidium bromide is to replace it with a less-hazardous substitute. Several products are commonly used as replacements for ethidium bromide in staining nucleic acids.

These include SYBRSafe ://www.lifetechnologies.com/us/en/home. (accessed November 17, 2014); GelREd ://www.biotium.com (accessed November 17, 2014); and MegaFluor ://www.euroclonegroup.it/ (accessed November 17, 2014). More information can be found at ://www.ehs.berkeley.edu/sites/default/files/lines-of-services/workplace-safety/47ethidiumbromide. (accessed November 17, 2014).

When use of ethidium bromide cannot be avoided, the California Department of Public Health recommends the following handling practices:

1. Ethidium bromide powder and stock solutions should be kept in a locked cabinet.
2. Ethidium bromide powder and ethidium bromide solutions should be handled only by the instructor. Preparation of stock solutions and the dyeing and rinsing of gels should be done only by the instructor. The instructor should use the least concentrated dye solution that still stains effectively.
3. Ethidium bromide powder should be dispensed only in a laboratory that is not subject to drafts created by doors, windows, or laboratory cross-traffic. Transfer of the powder should be done within a fume hood over a disposable working surface or over a tray that can be decontaminated if spillage occurs. To minimize contact with ethidium bromide, the instructor should weigh portions in advance, when possible, and store them for future use.
4. To prevent skin contamination and subsequent dermal absorption or hand-to-mouth exposure, the instructor should wear tight-fitting, disposable, impermeable gloves. Common surgical nonlatex gloves may offer some protection. A laboratory jacket or apron should also be worn.
5. Students should not handle dyed gels until the gels have been rinsed thoroughly. Once the dye is fixed and the excess rinsed off, there will be little free ethidium bromide. However, students should still wear nonlatex gloves and handle the gels with care. Goggles should be worn whenever exposure is likely to occur.
6. Ethidium bromide powder and solutions, dyed gels, and disposable materials contaminated with ethidium bromide should be disposed of according to applicable hazardous waste disposal regulations. For additional information about compliance with these requirements, please contact the local CUPA, which can be found through the California Environmental Protection Agency Web site at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

7. Because of its mutagenic activity, all used ethidium bromide must be collected in properly labeled waste containers. Ethidium bromide MUST NEVER be poured down the drain. Ethidium bromide powder and solutions, dyed gels, and disposable materials contaminated with ethidium bromide should be disposed of according to applicable hazardous waste disposal regulations. Please contact the local CUPA for more details.
8. Chemical degradation may be used to deactivate ethidium bromide if it is added to laboratory protocols and complies with the provisions set forth in *HSC* Section 25200.3.1. The Lunn and Sansone method is recommended (for each 100 ml of ethidium bromide [EfBr] solution):
   - Add 5 percent hypophosphorus acid.
   - Add 12 ml of 0.5 M sodium nitrate.
   - Stir briefly and let stand for 20 hours.
   - Adjust pH to 4–9 using sodium hydroxide.
   - Pour down drain with copious amounts of water.

J. Risks in the Use of Formaldehyde

Formaldehyde is a colorless, flammable gas with a strong, pungent odor that can be detected at very small concentrations. Formaldehyde is a gas at room temperature, but it is usually used in solutions with water, ethanol, or acetone. It is most commonly found in 37 percent aqueous solutions with trade names formalin or formol. Formaldehyde and formalin are used for tissue fixing, disinfections, and as a detergent in RNA gel electrophoresis.

Because of growing evidence of the carcinogenicity of formaldehyde, **schools are urged to cease the use of formaldehyde and formalin** (3 percent to 10 percent solutions of formaldehyde) and to arrange for the immediate proper removal and disposal of all formaldehyde cylinders and formalin solutions. Formaldehyde must be disposed of according to applicable hazardous waste disposal regulations. Additional information about the management of formaldehyde wastes can be obtained by contacting the local CUPA. Information on substitutes can be found at ://www.eoearth.org/view/article/150008/ (accessed November 17, 2014).

The National Toxicology Program (NTP) has rated formaldehyde as an anticipated carcinogen, which means that there is either “limited evidence” of its carcinogenicity in humans or “sufficient evidence” of its carcinogenicity in experimental animals. In addition, the IARC has categorized formaldehyde in group 2A, which means that this agent is “probably carcinogenic to humans” because “there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals.” The State of California also lists formaldehyde as a carcinogen; see ://www.oehha.ca.gov/prop65.html (accessed November 17, 2014). If formaldehyde is used at the work site, the employer is mandated by the California *Labor Code* (Section 9020) and the *CCR,* Title 8, to submit a “Carcinogen Report of Use” form (see Appendix Q) and to post a copy of the report form in a conspicuous place where formaldehyde is used.

Many dissection specimens are originally (commercially) preserved in formalin, then washed and transferred to a less hazardous medium; however, this practice has markedly diminished in recent years. All such specimens should be soaked in water for 24 hours prior to use and, occasionally, during use when residual formalin is released from the specimen. The contaminated rinse water may not be poured down the sink unless permission has been obtained from the local sanitation agency.

Schools are advised to use a properly licensed waste transporter to dispose of all preserved display specimens immersed in formalin. In the rare case that the specimen is irreplaceable, it should be properly transferred to a less hazardous solution (e.g., propylene glycol, ethylene glycol, or ethanol). For dissections of organisms preserved in this manner, adequate ventilation is still necessary. All transfers of specimens from formalin should take place within an operating fume hood, and proper personal protective equipment should be worn to avoid respiratory and dermal exposure. The remaining formalin **may not** be poured down the sink unless written permission has been obtained from the local sanitation agency.

Minimizing Formaldehyde Exposure

Formaldehyde vapors can be irritating to the eyes, nose, and upper respiratory tract. Repeated skin exposure may also cause sensitization and allergic dermatitis. All work with formaldehyde should be done within a hooded vent. Wearing two layers of gloves is advised. Safety goggles or a face shield will reduce risk of eye and skin exposure. Contact lenses should not be worn.

Cal/OSHA has classified formaldehyde as a regulated carcinogen and has adopted the permissible exposure limit of 0.75 parts per million (ppm) over an eight-hour work shift. The short-term (15-minute) exposure limit that may not be exceeded is 2 ppm. In addition, the more restrictive threshold limit value is 0.3 ppm based on sensory irritation. Cal/OSHA requires personal monitoring of the exposures of staff members who use or are exposed to formaldehyde unless objective data are provided to show that the exposures for these procedures cannot be at or above the action level of 0.5 ppm, or the short-term exposure limit. If exposures exceed the action level or short-term exposure limit, the exposed staff must be provided with medical surveillance as specified in *CCR*, Title 8, General Industry Safety Orders, Section 5217 (h). *CCR,* Title 8, Section 5217 should be reviewed for other applicable requirements.

K. Instruments and Specimens Used in Dissection

1. The decision to use preserved animal specimens in science instruction should be carefully evaluated. The instructional activity should be planned to foster in students a greater respect for life and to provide learning that cannot otherwise be achieved. Modern alternatives can achieve comparable learning outcomes and should also be considered. **In all** such activities, particularly those involving the use of vertebrates (especially mammals), consider students' level of maturity, preparedness, and ability to appreciate fully the significance of the instructional activity.
2. Students should be instructed in the safe use of dissection instruments. Special care should be taken to avoid cuts or scratches when cleaning scalpels and needles.
3. If originally preserved in formalin, specimens should have been shipped in alternative, low-toxicity preservatives (see Section J, "Risks in the Use of Formaldehyde").
4. Preserved specimens (including the abdominal cavities of large specimens) should be thoroughly washed before being handled by the students. When specimens are being removed from the preservative solution, rubber gloves should be worn or forceps or tongs should be used, depending on the size of the specimen. Use eye-protective devices (preferably face shields) to protect against splashes and fumes.
5. Preservative fumes may be irritating to the eyes, nose, and throat. Adequate ventilation should be provided whenever preservative fumes are present. Preferably, lab work with anything exuding preservative fumes should be done under an exhaust. If this is not possible, cross-ventilation with open windows is the next-best option. Doors should not be opened to common hallways, as fumes may spread to the general student body.
6. Approved goggles (preferably face shields) must be worn during dissections.
7. It is recommended that dissection be carried out only by those students who have obtained a permission note signed by a parent or guardian.

Teachers will find the following document helpful in planning and conducting their dissection activities:

"Responsible Use of Live Animals and Dissection in the Science Classroom." Position Statement of the National Science Teachers Association (NSTA). Arlington, VA: National Science Teachers Association, March 2008. ://www.nsta.org/about/positions/animals.aspx (accessed November 17, 2014).

L. Alternatives to Dissection

Students in kindergarten through grade twelve have the right to refrain from participating in activities that they feel would constitute “harmful and destructive use of animals,” pursuant to *EC* Section 32255 et seq. When courses require the use of live or dead animals, or parts of animals, students must be notified of their rights. A student’s objections must be substantiated by a note from his or her parent or guardian. Develop an alternative educational project of “comparable time and effort” or excuse the student from the project.

The pre- and postdissection activities **may** constitute appropriate assignments, which could be pursued in greater depth as alternative activities for all students. Alternative activities should be well planned (not punitive) and may include (1) studies of anatomy, using illustrated dissection manuals, study sheets, transparencies, videos, slides, films, or filmstrips; (2) computer simulations; (3) observations of live organisms; (4) library research; and (5) art activities, with models or charts.

The publications listed at the end of Section K suggest alternatives to dissections. *The Responsible Use of Animals in Biology Classrooms, Including Alternatives to Dissection* includes a comprehensive list of resources and literature on the topic.

M. Handling of Laboratory Animals

See Appendix A, *HSC* Section 1650 et seq., “Humane Care of Animals.” In addition, the following precautions should be observed:

1. Heavy rubber or leather gloves should be worn when handling live animals. (Be sure the gloves are readily available).
2. Students and visitors should be cautioned about the dangers of inserting fingers into an occupied animal cage.
3. Warning signs, such as KEEP HANDS AWAY*,* should be posted conspicuously on cages of animals that may bite.
4. Students should be trained to handle rats, mice, guinea pigs, and other animals gently and not to excite the animals; for example, poking pencils at animals encourages biting behaviors. Hamsters are not recommended for classroom use because they are nocturnal and are more likely to bite during daylight hours.
5. Venomous animals should **not** be brought to or kept at school.
6. Teachers with known allergies to laboratory animals should not use these animals for instruction. Students with known allergies to laboratory animals should not be exposed to the animals. Both students and teachers may develop allergies to laboratory animals

after repeated exposure. Students and teachers with asthma may be at increased risk of developing allergies.

N. Insect Killing Jars

Students need to be familiar with the safest ways to collect and preserve insects for science projects or for study in the classroom. A safe killing jar can be made by using any clean, large jar with a screw-type lid (mayonnaise jars are acceptable). Place a facial tissue in the bottom of the jar to absorb the killing liquid. Several liquids can be used to provide the lethal fumes, including ethyl acetate or ethyl alcohol. **(Under no conditions should carbon tetrachloride or potassium cyanide be used in insect killing jars).** Add the killing liquid to the tissue in the bottom of the jar—about six drops are generally satisfactory. To keep the insects dry, place a clean tissue on top of the tissue containing the liquid. The jar must be labeled properly as follows:

DANGER. FLAMMABLE. POISONOUS FUMES. DO NOT BREATHE.

To recharge the jar, remove the lid under the hood, remove the top tissue, and add a few more drops of the solvent. Add a clean tissue, and the jar is again ready for use.

Do not breathe any fumes. In high concentrations, both ethyl acetate and ethanol can cause headache, drowsiness, and dizziness.

An alternative method of preparing insect killing jars is as follows:

1. Place 1 inch (2 to 3 cm) of freshly prepared plaster of paris in the bottom of a glass jar (the smallest size necessary).
2. Pour in enough ethyl acetate to cover the plaster of paris at least 12 hours before use.
3. Let stand for 20 minutes; then pour off the excess. Enough ethyl acetate will be absorbed by the plaster of paris to last a week if covers are kept in place.
4. Use a facial tissue to cover the plaster of paris during use.
5. Label the jar as indicated previously.

Because of uncertainty regarding pain perception in insects, as well as students' exposure to potentially harmful fumes, alternatives to the use of insect killing jars may be explored.

Chapter 7

Safety in the Chemistry Laboratory

Students come from diverse backgrounds and have various levels of awareness of health and safety issues. Most students have no previous experience in handling chemicals, laboratory equipment, or related safety gear. In the lab, students will experience new activities, new materials, and new protocols, so the likelihood of accidents or injuries may be high. It is important to teach students how to prevent accidents and what to do in case of an emergency.

The chemistry laboratory can be one of the best places to instill good work practices and teach safety, all while learning important science lessons. Although the chemistry laboratory provides a positive, safe, and fun learning environment, science programs do have potential dangers. With careful planning, most dangers can be avoided. Safety is the responsibility of the administration, the teachers, and students—each of these groups has an important role in planning and implementing a chemistry laboratory learning program.

A. The Teacher's Responsibilities

One of the most important first steps is to be familiar with each experiment protocol, including how to use all the equipment, the identity and hazards of all chemicals used, and procedures to prevent and recover from accidents. Once a science teacher has this information, the next step is to promote a culture of safety in the chemistry classroom. Instructors should lead by example by wearing appropriate personal protective equipment.

The following checklist may be helpful in establishing a safe chemistry laboratory:[4]

Upkeep of Laboratory and Equipment

1. Regularly inspect safety stations and first aid equipment. Replace used items and make any needed repairs. (For safety shower and eyewash stations, see Chapter 5, "Additional Safety Practices.")
2. Notify the administration of any hazardous condition (e.g., malfunctioning safety equipment).
3. Never use defective equipment.

[4]. Adapted from the *School Chemistry Laboratory Safety Guide* (October 2006), Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2007–107. Available at http://www.cdc.gov/niosh (accessed November 17, 2014).

Recordkeeping

1. Keep a log of staff safety and hazardous materials training as required by school administration.
2. Keep records of all laboratory incidents for as long as required by school administration or law.

Safety and Emergency Procedures

1. Educate students on the location and use of all safety and emergency equipment prior to any laboratory activity.
2. Know what steps to take in the event of a spill.
3. Provide students with written safety procedures and orally review what to do in an emergency.
4. Keep a list of emergency telephone numbers in a visible location.
5. Conduct appropriate safety and evacuation drills regularly.
6. Explain in detail the consequences of violating safety rules and procedures.

Maintenance of Chemicals

1. Regularly inspect chemicals and other supplies. Annually update the chemical inventory and discard any leaking, damaged, empty, or unlabeled containers according to protocol.
2. Maintain a copy of the chemical inventory for local emergency responders.
3. Do not allow any food, drink, or personal care products in the chemistry classroom at any time.
4. Ensure that chemicals not currently in use are properly segregated and stored. Maintain limited access to chemical storage areas and be sure to display the proper placard and warning signage.
5. Know the storage, handling, and safety requirements for each chemical used.
6. Properly dispose of all chemicals and chemical waste. Consult the label and the SDS for disposal information and always follow appropriate chemical disposal regulations.

Before starting any laboratory activity, weigh the potential risks versus the educational value of the exercise. If possible, consider replacing chemicals with less-hazardous substances, or conduct a safer experiment that can demonstrate the same learning objectives.

B. The Student's Responsibilities

Working with chemicals can be dangerous if important safety steps are not followed. Each school year should begin with an orientation and demonstration of safety equipment and a review of expected laboratory conduct. Each experiment should begin with specific guidance, including information about the chemicals used and any required or special handling. The following checklists may acquaint students with the conduct expected in the chemistry laboratory.

General Laboratory Conduct

1. Rowdy conduct and practical jokes are not allowed.
2. Use of cell phones and music or video equipment is prohibited.
3. Unauthorized experiments are strictly forbidden; all lab work must be supervised.
4. Do not sit on laboratory benches.
5. Immediately report any spills, accidents, or injuries to a teacher.
6. Never leave experiments that are in progress, especially lit Bunsen burners or open gas valves.
7. Never threaten another student with a chemical.
8. Make sure no flammable solvents are around when lighting a flame.
9. Leave all equipment, chemicals, and experiment products in the laboratory unless authorized by the teacher.
10. Coats, bags, and other personal items should never be present in the laboratory space.

Student Safety Practices

1. Wear proper safety equipment as instructed by the teacher (e.g., goggles, gloves, lab coat or apron, and the like).
2. Always remove gloves and wash hands before handling any personal item or before leaving the lab. Do not touch doorknobs, handles, water fountains, water faucets, or anything else that might expose someone to the chemicals on gloves.
3. Wear closed-toe and closed-heel shoes.
4. Wear clothing that covers the legs, arms, and torso. Remove any loose clothing and jewelry, and tie back long hair.
5. Keep gloved hands away from skin, eyes, and mouth while using chemicals. Never eat, drink, apply makeup, or chew gum in the laboratory.
6. Never taste, smell, or touch any chemicals unless specifically approved by the teacher.

Emergency Procedures

1. Know where the emergency exits are located and where to go if the classroom or building is evacuated.
2. Ask the teacher to demonstrate how to use the fire extinguishers, fire alarms, eyewash stations and emergency showers, and first-aid kits.

C. Ensuring That the Chemistry Laboratory Is Safe

Be prepared to demonstrate laboratory techniques each time a new exercise begins. Outline the specific safety requirements for each experiment, including the type of gloves that should be used and any special precautions. Although this may take more time, deliberately demonstrating the safe way to conduct an experiment will go a long way to instill in students confidence and safe work practices. Regular safety orientations should be considered an integral part of the instruction planning process.

> Be familiar with safety practices described throughout this handbook. Other useful information can be found in the NIOSH publication *School Chemistry Laboratory Safety Guide:* http://www.cdc.gov/niosh/docs/2007-107/pdfs/2007-107.pdf (accessed November 17, 2014)

Laboratory Practices and Techniques

1. Never use squeeze bottles near open flames. Always label contents properly.
2. To insert glass tubing into rubber stoppers, polish or file the edge until smooth, aim glass away from the palm of the hand holding the stopper, and hold glass as close to the hole as possible. Use water, diluted soap solution, glycerin, or petroleum jelly as a lubricant and gently press the tube into the hole with a twisting motion.
3. Make sure hose connections between burners and gas outlets are protected from pinching or from being disconnected.
4. Fume hoods should be professionally installed, certified, and tested annually (see Appendix A, *CCR,* Title 8, Section 5154.1). A piece of light plastic or paper streamer taped at the opening is an easy way to see if the hood is operational. Never use hoods to store books or supplies. As of January 1, 2008, hoods must be equipped with a quantitative airflow monitor that continuously indicates whether air is flowing into the exhaust system during operation. Examples of acceptable devices that measure the

relative amount of inward airflow include diaphragm pressure gauges, inclined manometers, and vane gauges (*CCR,* Title 8, Section 5154.1 [e]).

5. Always handle dry ice with insulated gloves and wear eye protection.
6. Handle glass wool and steel wool carefully to avoid getting splinters in the skin or eyes.
7. Tabletops should be protected from extreme heat by using insulation underneath burners or heated objects. If using asbestos insulation, replace broken or chipped pads before using.
8. Properly dispose of broken glassware and other sharp objects (e.g., syringe needles) in designated sharps containers.
9. Demonstrate proper personal protective equipment for each experiment. Use approved eye protection, proper gloves, and lab coats or aprons.

Handing Chemicals

1. Remember: Add acid! Water should never be added to concentrated acids. To dilute an acid, add small quantities of acid to water in a heat-resistant beaker or flask, stirring constantly.
2. Never pour chemicals or chemical waste into sinks or wastebaskets; always place in properly labeled waste containers.
3. Properly dispose of weigh boats, gloves, filter paper, and paper towels (in dry chemical waste, double-bagged in lab trash cans, and so on).
4. Wear appropriate chemical-resistant gloves when handling chemicals. Gloves are not universally protective against all chemicals.
5. Check the label to verify chemical identity before using. When decanting from the original container, be sure to label the new container with chemical name, concentration, and date.
6. For dry chemicals, remove only the amount needed. Do not return the excess to the original container; dispose in the appropriate waste container.
7. Use a spatula or scoopula to remove a solid reagent from a container. To avoid explosions, never use a metal spatula when working with peroxides.
8. Use a hot-water bath to heat or evaporate flammable liquids. Never heat or evaporate directly with a flame.
9. Use the fume hood when there is a possibility of generating toxic vapors, dust, or gases. When using a hood, keep the sash as low as possible to protect the user and to make its operation efficient. Keep head and body outside the hood at all times.

10. Respond to and/or clean up all spills properly and promptly.
11. Never cap a bottle or use a solid stopper in a bottle containing dry ice or cryogenic liquids. Always plug loosely with cotton or use a stopper with a hole.

The following personal protective equipment is recommended:

- Safety goggles with side protection
- Face shield
- Lab coat
- Lab apron
- Gloves (selected based on the material being handled and the particular hazard involved)

The following safety and emergency equipment is recommended:

- Eyewash stations (conform to ANSI Z358.1–2009)
- Safety showers (conform to ANSI Z358.1–2009)
- Fire extinguishers (dry chemical and carbon dioxide extinguishers)
- Sand bucket
- Fire blankets
- Emergency signs and placards
- Fire detection or alarm system with pull stations
- First-aid kits
- Spill control kit (chemical and mercury)
- Chemical storage cabinets
- Secondary containment for bulk chemicals and waste
- Fume hood (60–100 ft/minute capture velocity, vented outside)
- Container for broken glass and sharps
- Standardized Safety Data Sheets(SDS) for all chemicals
- Emergency telephone numbers

D. Chemical Health Hazards

Chemicals can enter the body in various ways. Three principal routes of exposure include dermal (skin) exposure, inhalation, and ingestion (oral) exposure. These routes of exposure and the duration of exposure will determine the severity of effect. The most probable routes of exposure are generally identified in the SDS.

Dermal Exposure

The skin is an effective barrier for many chemicals. However, some chemicals (such as organic solvents) can easily penetrate skin and enter the bloodstream or cause damage at the skin surface. Chemicals are absorbed more readily through injured, chapped, or cracked skin. Depending on the substance and length of exposure, repeated exposure to the skin can increase the severity of reaction or effects over time.

Inhalation

Chemical gases, vapors, mists, fumes, and dusts can enter the nose or mouth and be absorbed through the mucous membranes of the nose, trachea, bronchi, and lungs. Once absorbed through the lungs, chemicals can distribute throughout the body. Chemicals can also directly irritate the interior surface of the nose, throat, and lungs.

Ingestion

Ingestion involves chemicals entering the body through the mouth. Chemical dusts, particles, and mists may be inhaled through the mouth and swallowed. Chemicals can also be swallowed when contaminated hands, food, or other objects come in contact with the mouth.

Every year, there are intentional and accidental releases of and exposures to chemicals used in primary and secondary school laboratories. A recent federal report indicated that injuries were most often the result of human error (improper chemical storage, unsafe or improper use of materials or equipment); equipment failure (broken hoses, valves, or pipes); or intentional acts (detonating homemade chemical bombs, mace or pepper-spray pranks).[5] The most commonly reported health effects included nausea, dizziness, headache, and respiratory and eye irritation. Most school incidents involved the release of a single chemical. Mercury, hydrochloric acid, ethylene glycol, sulfuric acid, chlorine, and sodium hydroxide were among the most commonly reported.

[5]. “Hazardous Chemical Incidents in Schools—United States, 2002–2007. Centers for Disease Control and Prevention (CDC) *Morbidity and Mortality Weekly Report* 57 (44):1197–1200.

Table 7.1

Chemicals Causing the Most Common Accidents in Schools*

Chemical	CAS No.	Symptoms**	First Aid
Mercury (metal)	7439-97-6	Warning: Effects may be delayed. Slight muscular tremor, loss of appetite, nausea, and diarrhea may develop. Skin and eye irritation. May cause central nervous system, kidney, and cardiovascular disturbances.	Irrigate eyes; wash skin with soap and copious water; provide fresh air and breathing support; if swallowed, get immediate medical attention. Call 9-1-1 for cleanup. Metallic mercury is not toxic if swallowed in small amounts, but inhaling fumes is a problem. Calling the poison control center when an ingestion occurs should be sufficient (rather than sending the patient to the hospital). However, schools may have a legal responsibility to send students to the hospital.
Carbon monoxide	630-08-0	Inhalation causes headache, dizziness, weakness of limbs, confusion, nausea, and unconsciousness. At low concentrations (0.04–0.06 percent), victim may feel discomfort and throbbing headache; concentrations of 0.1–0.2 percent for a half hour will cause a tendency to stagger; exposures of 1½–2 hrs may result in confusion and nausea. Concentrations of 0.20–25 percent usually produce unconsciousness in about a half hour.	Remove victim(s) from area of exposure. Provide fresh air and breathing support. Call 9-1-1. Treat skin for frostbite if exposed to compressed CO gas.

Table 7.1

Chemicals Causing the Most Common Accidents in Schools*

Chemical	CAS No.	Symptoms**	First Aid
Mace/pepper spray (2-chloroacetophenone)	532-27-4	Inhalation causes tearing, burning of the eyes, and difficulty in breathing; high concentrations may lead to development of acute pulmonary edema several hours after exposure. Other symptoms include agitation, pupil contraction, loss of reflexes, or coma; and intense skin and eye irritation. Ingestion may cause coma.	Flush eyes with water for 20–30 min; flood skin and remove all contaminated clothing. Call 9-1-1. If inhaled, provide fresh air and call 9-1-1. If swallowed and victim is conscious, give one or two glasses of water and call 9-1-1. If victim is convulsing or unconscious, call 9-1-1 and do not give anything by mouth.
Hydrochloric acid	7647-01-0	Inhalation of fumes causes coughing and choking sensation; irritates nose and lungs. Liquid causes burns and blistering.	Provide fresh air and get immediate medical attention; if contacted eyes or skin, flush with plenty of water for 15 min.; remove contaminated clothing; call 9-1-1. Do NOT induce vomiting. Provide milk or water if ingested. Water is much preferred to milk, as milk makes it more difficult to get a good look at the throat. Limit liquids to one glass (8 oz.), as large amounts may cause vomiting and can burn the throat again on the way up from the stomach.
Ethylene glycol	107-21-1	Inhalation of vapor is not hazardous. Ingestion causes stupor or coma, sometimes leading to fatal kidney injury	Irrigate eyes immediately; wash skin with plenty of water; if inhaled, provide fresh air and respiratory support. If swallowed, call 9-1-1.

Table 7.1

Chemicals Causing the Most Common Accidents in Schools*

Chemical	CAS No.	Symptoms**	First Aid
Sulfuric acid	7664-93-9	Inhalation of vapor may cause sneezing, hoarseness, choking, laryngitis, difficulty breathing, chest pain, and pulmonary edema. Contact with eyes may result in total loss of vision. Skin contact may produce severe burns. Those with respiratory or any eye and skin diseases are at greater risk. Ingestion may cause salivation, intense thirst, difficulty in swallowing, throat and stomach burns. Vomit generally resembles coffee grounds.	Remove victim from exposure; if breathing is labored, call 9-1-1. Flush eyes with lukewarm water for at least 15 min.; remove contaminated clothing and flush skin with water for at least 15 min. If swallowed, do not induce vomiting. Water or milk may be given to conscious and alert victims; rush to hospital. Water is preferred to milk, as milk makes it more difficult to get a good look at the throat. Limit liquids to one glass (8 oz.), as large amounts may cause vomiting and can burn the throat again on the way up from the stomach.
Chlorine	7782-50-5	Warning: Effects may be delayed. May be fatal if inhaled. Inhalation may cause cardiovascular collapse and pulmonary edema. The eyes, nose, throat, and chest may sting or burn. Cough with bloody sputum, a feeling of suffocation, dizziness, agitation, anxiety, nausea, and vomiting are common. Dermal exposure may result in sweating, pain, irritation, and blisters.	Acute exposure to chlorine may require decontamination and life support. Move victim to fresh air and call 9-1-1.

Table 7.1

Chemicals Causing the Most Common Accidents in Schools*

Chemical	CAS No.	Symptoms**	First Aid
Sodium hydroxide	1310-73-2	Causes eye, skin, and mucous membrane irritation; inhalation may lead to pneumonitis.	If in contact with skin or eyes, remove clothing and flush eyes or skin with running water for at least 15 min. If ingested, call 9-1-1. Do NOT induce vomiting.

*Chemicals most commonly associated with accidental or intentional release at secondary and elementary schools, 2002–2007, Hazardous Substances Emergency Events Surveillance System, CDC *Morbidity and Mortality Weekly* 57 (44):1197–1200.

**Symptoms and first-aid data from the *National Institute of Occupational Safety and Health (NIOSH) Pocket Guide,* ://www.cdc.gov/niosh/npg/npgsyn-a. (accessed November 17, 2014), and from the Computer-Aided Management of Emergency Operations (CAMEO) Chemicals Database, ://www.cameochemicals.noaa.gov/ (accessed November 17, 2014).

> *Note:* To find the physical description, proper label, recommended personal protective equipment, spill hazards, symptoms of exposure, and first-aid guidelines for a chemical, please visit either of the following federally managed databases:
>
> *NIOSH Pocket Guide to Chemical Hazards*
> National Institute of Occupational Safety and Health
> http://www.cdc.gov/niosh/npg/npgsyn-a.html (accessed November 17, 2014)
>
> *CAMEO Chemicals Database*
> U.S. EPA and the National Oceanic and Atmospheric Administration (NOAA) http://www.cameochemicals.noaa.gov/ (accessed November 17, 2014)

Hazards by Class of Chemical

All chemicals are commonly described in terms of their physical, chemical, or biological properties. Several classification systems exist, including the United Nations Globally Harmonized System of Classification and Labelling of Chemicals and the U.S. Department of Transportation (DOT) Hazardous Materials Transportation guidelines. It is important to know both classification systems when hazardous materials are transported and stored. Chemicals are classified by characteristics such as flammability, corrosivity, and radioactivity. These hazardous chemical classifications are listed on the SDS for each chemical in the laboratory.

Chemicals may also be classified based on the type of hazard they pose (acute or chronic), such as a reproductive toxicant, carcinogen, or chemical sensitizer. This classification system is based on the inherent toxicity of a substance, which is a function of the chemical's molecular structure, physical state, dose, and route of exposure. Toxicity may vary, depending on factors such as the gender, age, and health status of the victim.

In general, chemicals used in experiments are classified by their functional groups. Classification information is important for determining chemical compatibility and reactivity, experiment procedures, safe bulk storage of chemicals, and for waste collection and labeling. Knowledge of properties may also be used to predict the likely behavior of chemicals and recognize and avoid potentially dangerous situations. The following list gives examples of some functional classes of chemicals and their effects on the body.

Acids. Acetic, chromic, hydrochloric, nitric, sulfuric, and carbolic (phenolic) acids cause severe burns and tissue damage. Hydrofluoric acid exposure can cause debilitating pain and changes to bones.

Alcohols. These irritate mucous membranes. Methanol induces blindness through ingestion or prolonged inhalation.

Aldehydes and ketones. Inhalation, absorption, or ingestion of these substances irritates tissues and produces narcotic effects.

Alkalies. Sodium and potassium hydroxides and ammonium hydroxide cause severe tissue burns (especially destructive to eye tissue) and bronchial spasms.

Asphyxiants. Carbon monoxide, carbon dioxide, cyanide, and cyanogen compounds reduce the oxygen-carrying capacity of the blood; stop oxidation in tissues through the destruction of enzymes; and displace atmospheric oxygen.

Carbon monoxide. Prolonged exposure renders the hemoglobin of red blood cells ineffective for the transport of oxygen. Results are toxic and may prove deadly.

Compounds of sulfur, phosphorus, nitrogen. These substances corrode the skin and destroy respiratory tissues.

Cryogenic gases. Can be asphyxiants in enclosed spaces; burn hazard to skin and eyes.

Cyanides. Absorption, inhalation, or ingestion of cyanides produces toxic effects.

Esters. Exposure causes tissue poisoning and irritation.

Ethers. Inhalation produces a powerful narcotic effect. See Section I, "Use and Disposal of Ethers."

Halogens. Corrosive; highly irritating to tissues; can react with water.

Hydrocarbons. Inhalation causes irritation and tissue destruction. Prolonged exposure is very dangerous. Chlorinated varieties form toxic phosgene gas when burned.

Irritants. Ammonia, phosphoric halides, hydrogen chloride, chlorine, bromine, and hydrogen sulfide damage respiratory tissues.

Mercury. The handling of mercury or inhalation of its vapors causes tissue poisoning. Toxic effects are compounded with prolonged exposure.

Metal fumes. The fumes of mercury and zinc poison tissues, causing nausea, fever, and in some instances, death. Always use a fume hood.

Peroxide formers. These are shock hazards; contact with combustible material may result in spontaneous combustion.

Solvents. Cause headache, dizziness, nausea, and fainting.

More information about the storage and compatibility of chemicals and the handling of waste in California can be found in Section E ("Steps for Establishing a Safer Chemical Storage Area") and Section F ("Labeling of Chemical Reagents"). The following references may be helpful in determining the hazard classification of the chemicals used in the laboratory:

DOT Hazardous Materials Table, 49 *CFR* 172.101 ://www.gpo.gov/fdsys/pkg/CFR-2001-title49-vol1/content-detail.html (accessed November 17, 2014)

Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA) and Section 112(r) of the Clean Air Act ://www2.epa.gov/epcra/epcra-section- (accessed November 17, 2014)

Standardized Safety Data Sheet (SDS) Search ://www.msdssearch.com/DBLinksN.htm (accessed November 17, 2014)

E. Steps for Establishing a Safer Chemical Storage Area

Safe storage and use of chemicals and the supervision of laboratory safety are addressed in several sections of the *EC* and the *CCR,* Title 8 (see excerpts in Appendix A). The following is a summary of some of the relevant stipulations in those codes:

- Each school that offers laboratory work should designate a trained member of the professional staff as the person “responsible for the review, updating, and carrying out of the school’s adopted procedures for laboratory safety” (*EC* Section 49341[b]).
- School districts are encouraged “to take steps to ensure hazardous materials are properly used and stored” (*EC* Section 49401.5 [a]).
- School districts shall have guidelines “for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed” (*EC* Section 49411[b]).
- Employers are required to have a written hazard communication program for employees working in laboratories where the employees may be exposed to hazardous substances, except for those laboratories “under the direct supervision and regular observation of an individual who has knowledge of the physical hazards, health hazards, and emergency procedures associated with the use of the particular hazardous substances involved and who conveys this knowledge to employees in terms of safe work practices.” Such excluded laboratories must also maintain labels and Standardized Safety Data Sheetsof “incoming shipments of hazardous substances and ensure that they are readily available to laboratory employees” (*CCR,* Title 8, Section 5194 [b]).

Note: Preparation of a written hazard communication program may not be necessary if the school can show that the required elements of Section 5194 are contained in the school’s chemical hygiene plan, prepared pursuant to the *CCR,* Title 8, Section 5191. (See the beginning of this chapter and the relevant code sections in Appendix A). School districts or school sites should determine the necessity of drafting and implementing a written hazard communication program by examining the extensive excerpts from the *CCR,* Title 8, Section 5194, cited in Appendix A. The laws noted require schools to establish a chemical storage area that is as safe as possible and to develop a plan that ensures the continued maintenance of the area.

The present condition of the area may have existed for some time and is not likely to deteriorate significantly while the situation is assessed and options are considered. However, an ideal chemical storage area should have the following characteristics:

- The area is clean and orderly.

- A telephone is readily available.
- A current list of emergency telephone numbers is posted.
- Emergency procedures are up-to-date and posted.
- An appropriate first-aid kit is available.
- An appropriate spill kit is available.
- Safety equipment and supplies (goggles, aprons, face shields, fire blanket, fire extinguisher, eyewash, spill pillow, and, if appropriate, deluge shower, safety shields, and fume hood) are available and functional.
- There are no chemicals in storage that have been designated unsafe for school laboratory use (see Tables 7.1 and 7.2).
- Only chemicals that are used are stored (assuming chemicals not needed have already been disposed of).
- Chemicals on hand will be consumed within the next year (except for items with unlimited shelf life, such as iron filings).
- Chemicals are stored in compatible groups.
- Chemicals are properly labeled and stored in appropriate containers.
- A Standardized Safety Data Sheet (SDS) is on file for each chemical that is received in the normal course of the school year and is made accessible to teachers and students for review.
- There is a continually updated inventory of all chemicals, including quantity, location, date of purchase, shelf life, and projected disposal date.
- No chemicals are stored above eye level.
- No chemicals are stored on the floor.
- Shelves or cabinets are secured firmly to the walls.
- Earthquake lips or barriers are in place on storage shelves.
- Storage cabinets for corrosive chemicals (separate cabinets for acids and for bases) are on site and are used appropriately.
- A storage cabinet for flammables is on site and is used appropriately.

- Poisons are secured.
- The temperature of the storage area never exceeds 25°C (75°F).
- The storeroom door is self-closing and is locked.
- There is adequate ventilation (including a fume hood, if needed), and the area is isolated from the rest of the building. Room air is changed at least four times per hour.
- Compressed gas cylinders are secured upright to the wall, with caps in place. Flammable gases are separated from oxidizing gases by a one-hour fire wall or at least 25 feet (7.5 m).
- Nonreactive waste receptacles are made of plastic or crockery.
- Staff members are adequately trained in chemical storage policies.

If an inventory of the chemical storage area has not been conducted or the area purged of dangerous and unnecessary chemicals in recent years or it is unfamiliar to staff, follow the procedures below (many of these suggested procedures may have been followed already).

Step 1: Assign Responsibility for Laboratory Safety

Several legal citations indicate that persons knowledgeable about the safe use and storage of hazardous chemicals and associated waste should be assigned responsibility for laboratory safety at the school district and school-site levels (*CCR,* Title 8, sections 5191 and 5194; *EC* sections 49341 and 49411; *HSC*, Division 20, Chapter 6.11, Section 25404 et seq.; and *CCR,* Title 27, Division 1, Subdivision 4, Chapter 1, Section 15100 et seq.). Logically, the school-site administrator would have the responsibility for assigning such a person at the school-site level. The school-site administrator should carefully select and assign a staff member who has the greatest knowledge of and expertise in laboratory safety, giving special consideration to someone with knowledge of chemical processes and hazardous materials management.

Step 2: Conduct an Inventory and Remove Explosives

Identify and dispose of any explosive chemicals that may be present. When this is done, it is possible to proceed in relative safety with the creation of a chemical storage area.

Note: During the initial inventory, if any of the chemicals listed in Table 7.2 are found in the area, the containers should **not** be touched or moved by anyone other than a trained county sheriff or police bomb squad or other qualified official. If any explosive chemicals are present, call the appropriate district staff member or the local fire or sheriff's department.

Caution: Table 7.2 does not list all possible explosive chemicals. It is a list of chemicals that were once recommended for use by various laboratory manuals and curriculum guides and, therefore, are most likely to be present in the school laboratory. Be alert for other explosives in addition to the ones noted in Table 7.2. Explosive chemicals are hazardous materials and, when discarded, are considered hazardous wastes. As such, management of these chemicals and associated wastes is subject to the unified hazardous waste and hazardous materials management regulatory program (*HSC*, Division 20, Chapter 6.11, Section 25404 et seq. and *CCR*, Title 27, Division 1, Subdivision 4, Chapter 1, Section 15100 et seq.). Below are the program requirements most likely to be applicable to school laboratories:

- Hazardous Waste Generators and Hazardous Waste Onsite Treatment Permit Programs (*HSC*, Division 20, Chapter 6.5, Section 25100 et seq.; and *CCR*, Division 4.5, Chapter 12, Section 66262.10 et seq. and Chapter 45, Section 67450.1 et seq.)
- Hazardous Material Release Response Plans and Inventories, also known as Business Plans (*HSC*, Division 20, Chapter 6.95, Section 25500 et seq. and *CCR*, Title 19, Division 2, Chapter 4)
- California Accidental Release Prevention Program, formerly known as the Risk Management and Prevention Program (*HSC*, Division 20, Chapter 6.95, Article 2, Section 25500 et seq. and *CCR*, Title 19, Division 2, Chapter 4.5)
- Uniform Fire Code Hazardous Material Management Plans and Inventories (*HSC* Section 13143.9 and *California Fire Code*, Article 80, Section 8001.3)

For information about compliance with these requirements, please contact the local Certified Unified Program Agency (CUPA). The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the California Environmental Protection Agency at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

Table 7.2

Explosive Chemicals

(for immediate disposal *only* by explosives technicians)

Substance	**Notes on Handling**
Benzoyl peroxide	Benzoyl peroxide may be exploded by heat, shock, or friction
Carbon disulfide	The flashpoint (-30°C) is well below room temperature, and small amounts of the vapor in air can be explosive.
Diisopropyl ether (if stored longer than 12 months)	This chemical becomes dangerous as it ages. If its age is unknown or if it has been in storage for more than 12 months, assume that explosive peroxides have formed.
Ethyl ether/diethyl ether (if stored longer than 12 months)	See notes for diisopropyl ether.
Nitrogen triiodide	When it is dry, it will explode on being touched, vibrated, or heated slightly; even a puff of air will cause an explosion. May be stored in wet ether.
Perchloric acid	Although the mixture of 70 percent perchloric acid and water is not explosive by itself, the use of perchloric acid often leads to the formation of perchlorates, which are very explosive. Perchloric acid may be set aside in a safe storage area until commercial disposal is arranged.
Phosphorous (white/yellow)	Phosphorous is packed under water and will ignite spontaneously on contact with air at 30°C.
Picric acid	Picric acid should always contain 10 to 20 percent water, and bottles should be disposed of after two years. Dry picric acid is explosive and can be detonated by shock or heat. Bouin solution contains picric acid.
Potassium metal	Potassium metal becomes dangerous with age. It forms explosive peroxides if not stored under kerosene.
Sodium azide	Sodium azide is unstable and explosive. Keep it away from heavy metals.

Once the explosives have been removed, it is appropriate to prepare for the storage and transportation of hazardous materials. Some of the following steps can and should be done simultaneously.

Step 3: Conduct an Inventory of Chemicals

1. **Purpose of the inventory.** The inventory will enable staff to:

   a. Meet the various requirements of the unified hazardous waste and hazardous materials management regulatory program (*HSC*, Division 20, Chapter 6.11, Section 25404 et seq. and *CCR*, Title 27, Division 1, Subdivision 4, Chapter 1, Section 15100 et seq.), which may include submission of an annual inventory to the local CUPA. The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the California Environmental Protection Agency at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

   b. Learn of any extremely hazardous chemicals (acutely toxic, carcinogenic, mutagenic, and so forth) that should be disposed of immediately. Step 6 presents instructions for disposing of extremely hazardous (waste) chemicals. (See relevant legal citations in Appendix A.)

   c. Assess which chemicals are not used and should be disposed of.

   d. Provide a cursory check of whether the chemicals have deteriorated and are no longer usable. (Most chemicals are affected very little by age; however, some oxidize, others either collect or lose moisture, and still others become more hazardous.) Loose or rusted caps call for a closer look.

   e. Relabel items when labels become obscure. Identify any chemicals whose labels are missing. All hazardous chemical waste must be identified before disposal.

Although all the preceding purposes are important, it is best to complete the inventory first and then carry out the steps for the collection, storage, and disposal of waste. Finish by reshelving the chemicals in compatible groups.

2. **Preparation for the inventory.** Follow the precautions described below:

   a. For safety purposes, at least two persons (no students) should perform the inventory.

   b. Allow sufficient, uninterrupted time to complete the task.

   c. Make sure a telephone or other reliable means of communication is available.

   d. Wear proper protection for the task (including goggles, apron, gloves, and closed-toe shoes).

e. Have safety items available (e.g., fire extinguisher, eyewash, spill kit, fume hood, fire blanket, and half-mask respirator).

f. Have a flashlight and ladder available, if necessary.

g. Make sure the room is properly ventilated.

h. Have a plastic broom, plastic dustpan, and plastic receptacle available for cleanup.

i. Be prepared to encounter unknown substances.

j. Have alternate containers (bottles, cans, resealable plastic bags) available in case a broken container is discovered.

k. Have replacement caps available.

l. Use a method of recording the inventory that will allow the perpetual maintenance of the inventory.

m. Give advance notice to school and local fire authorities administrators and maintenance personnel about the inventory effort.

n. Plan how to record the chemicals on a substance-by-substance basis.

3. **Methods of recording inventory.** Some suggestions are as follows:

   a. Use a digital voice recorder to document the chemical name, the concentration or purity, the type and size of the container, and the approximate amount of the chemical in the container (e.g., “Ferric oxide, practical, in a 500-gram plastic container, about one-third full”). If a clerk or someone not familiar with chemicals will transcribe the information, spell out the name of each substance.

   b. Use a computerized chemical inventory system that includes features such as printouts of all chemicals used in the laboratory, the related hazard class, the location of the chemical in the laboratory, the minimum desirable amount to be maintained, and the amount available at the site.

   c. Start alphabetically. Write the name, type of container, and quantity of each chemical in storage; leave spaces to add hazard class, future storage and disposal information; and so forth. (See Appendix D for a sample chemical inventory.)

Step 4: Collect Laboratory Residues and Waste

1. **Solids.** Use the following procedures:
   - Solid residues should be collected in stone crocks or plastic containers, not in a wastebasket.
   - Hazardous wastes should be placed in compatible containers, separated from incompatible wastes.
   - Solid residues should not be put in sinks or toilets. Plumbing problems can be avoided by providing a screen or strainer for the drain in each sink.
2. **Liquids.** Observe the following precautions:
   - Pour flammable liquids into a safety can labeled HAZARDOUS WASTE.
   - Place hazardous wastes in compatible containers, separated from incompatible wastes.
   - Never flush flammable liquids into the plumbing system. Dangerous explosions might result from an accumulation of vapors.

Step 5: Temporarily Store Hazardous Waste for Eventual Transportation

A secondary school may possess chemicals that are included on the Cal/OSHA "Hazardous Substances List" (*CCR,* Title 8, Section 339)—not only in the science department, but also in the art department, industrial arts department, and custodial office. When material is discarded, schools must determine whether the waste is hazardous (*CCR*, Title 22, Division 4.5, Chapter 11):

- Is the waste toxic, reactive, ignitable, or corrosive (*CCR*, Title 22, Section 66262.11)?
- Is the waste listed as a hazardous waste in *CCR*, Title 22, Division 4.5, Chapter 11, Article 5, Appendix X?

If the site generates hazardous waste, school officials must be prepared to store and dispose of the waste appropriately.

Hazardous waste treatment and disposal practices. Hazardous waste may not be disposed of in the regular trash or on the surface of the ground. In addition, it may not be dumped into the sewer system (through a sink or toilet) unless the site has an industrial waste discharge permit from the local sanitation agency.

To dispose of, treat, or recycle hazardous waste to render it less hazardous or nonhazardous at the school site, schools must meet the requirements for accumulation and treatment of laboratory hazardous waste (*HSC* Section 25200.3.1) or obtain authorization from the local CUPA. The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the CalEPA at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014). If it is determined that the waste is not hazardous (*CCR,* Title 22, Section 66262.11), the kind and quantity of nonhazardous chemicals (waste) that may legally be flushed down sink drains is a local decision. School officials should consult with the county health department and regional water quality control board and obtain approval from the local, publicly owned treatment facility. If the school site is serviced by on-site sewage disposal fields, there may be severe limitations on what may be flushed down the drain. Check with the local department of health services for advice.

If it is necessary to temporarily accumulate some hazardous waste on site prior to disposal, schools must meet the requirements for accumulation and treatment of laboratory hazardous waste (*HSC,* Section 25200.3.1) or obtain authorization from the local CUPA. The local CUPA can be found through the California Environmental Protection Agency Web site at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2017).

Temporary accumulation of hazardous waste. Waste storage practices are designed to minimize the seriousness of a hazardous waste accident, should one occur. Although most science departments do not generate more than 100 kilograms (220 pounds) of hazardous waste or 1 kilogram (2.2 pounds) of extremely hazardous waste during any calendar month, a school campus might collectively generate those amounts, considering the waste generated by industrial arts, auto shop, and other on-campus maintenance activities. Therefore, schools should be aware that there is a 90-day storage limit for hazardous waste when a site has accumulated the quantities noted above (*HSC* Section 25123.3b and *CCR,* Title 22, Section 66262.34). Hazardous waste should be stored in appropriate containers in a way that minimizes the possibility of spills and escape of waste into the environment. For example, waste chemicals should remain in their shelf containers when placed in storage drums; the chemicals themselves should be segregated for separate handling and disposal.

Requirements exist for accumulation in containers, in tanks, on drip pads, and in containment buildings; however, accumulation at schools is likely to occur in containers. Therefore, the following information specifically addresses temporary accumulation of hazardous wastes in containers. According to *CCR,* Title 22, Division 4.5, Chapter 15, Article 9, schools are subject to the following requirements for use and management of containers:[6]

- All containers must be kept in good condition (*CCR*, Title 22, Section 66265.171).
- Use containers compatible with contents (*CCR*, Title 22, Section 66265.172).
- Keep containers closed when hazardous waste is not being added or removed (*CCR*, Title 22, Section 66265.173).
- Manage containers to avoid rupture or leaks (*CCR*, Title 22, Section 66265.173).
- Inspect containers weekly (*CCR*, Title 22, Section 66265.174).
- Properly label each container with the date accumulation began, the words "Hazardous Waste," composition and physical state of waste, particular hazardous properties of the waste (e.g. flammable, reactive, and so on), and the name and address of the generator (*CCR*, Title 22, Section 66262.34).
- Place containers holding ignitable or reactive wastes at least 15 meters (50 feet) from the facility's property line (*CCR*, Title 22, Section 66265.176).
- Avoid placing incompatible waste in the same container (*CCR*, Title 22, Section 66265.177).
- Any hazardous waste that is incompatible with waste or other materials transferred or stored nearby must be stored **separately** from other containers of hazardous waste (*CCR*, Title 22, Section 66265.177).
- Provide secondary containment if required by local codes.

Schools may also use an authorized schools hazardous waste collection, consolidation, and accumulation facility (SHWCCAF) for hazardous waste generated by the routine operation or maintenance of a K–12 school (*CCR,* Title 11, Division 4.5, Chapter 45, Article 5, Section 67450.40 et seq. and *CCR,* Title 22, Section 66270.60[d][7]). These regulations establish SHWCCAF requirements related to the following subjects:

- Eligible wastes (*CCR*, Title 22, Section 67450.42). These include waste not listed under the Resource Conservation and Recovery Act (RCRA) (*CCR*, Title 22, Section 66261.101) and RCRA hazardous waste (*CCR*, Title 22, Section 66261.100) if

6. From the Department of Toxic Substances Control fact sheet, *Hazardous Waste Generator Requirements* (January 2002). Available at http://www.dtsc.ca.gov/HazardousWaste/upload/HWM_FS_Generator_Requirements.pdf (accessed November 17, 2014).

transportation and management of that waste at the SHWCCAF is exempt from or not otherwise regulated by the federal RCRA.

- Waste management restrictions (*CCR*, Title 22, Section 67450.42) include treatment of wastes, acceptance of reactive wastes (shock-sensitive or explosive), and wastes generated by nonroutine operations (demolition, construction, or renovation wastes).
- Location of a SHWCCAF. It must be an off-site, nonschoolyard location where operation is consistent with local land use zoning or land use patterns (e.g., a school district corporation yard) (*CCR*, Title 22, Section 67450.42).
- Acceptance of wastes. A SHWCCAF may accept waste only when personnel designated by the SHWCCAF owner or operator are present to accept and sign for the waste (*CCR*, Title 22, Section 67450.42).
- Notification of intent to operate a SHWCCAF (*CCR*, Title 22, Section 67450.43).
- Operations (*CCR*, Title 22, Section 67450.44).
- Recordkeeping (*CCR*, Title 22, Section 67450.45).
- Transportation (*CCR*, Title 22, Section 67450.46).
- Training (*CCR*, Title 22, Section 67450.47).
- Closure of a SHWCCAF (*CCR*, Title 22, Section 67450.48).

Specific requirements are provided for hazardous wastes generated by school science laboratories, including chemistry, physics, and biology classes managed at a SHWCCAF. Hazardous wastes from school science laboratories may be managed at a SHWCCAF only if all of the following conditions are met (*CCR,* Title 22, Section 67450.42, subsection [c]).

- At a contributing school:
    - Science laboratory hazardous wastes, except laboratory specimens preserved in formalin and formaldehyde solutions, are lab packed in accordance with the requirements of *CCR,* Title 22, Section 66264.316, prior to transport to prevent reactions with the contained waste and to ensure that incompatible wastes are not placed within the same outer container.
    - At a contributing school, lab packs containing science laboratory hazardous wastes are marked according to the type and amount of wastes contained in the lab pack and the lab packs are not reopened during transportation to the SHWCCAF.

- At the SHWCCAF:
  - Reopened lab packs are repackaged in accordance with the requirements of *CCR,* Title 22, Section 66264.316, to prevent reactions with the contained waste and ensure that incompatible wastes are not placed in the same outer container.
  - Repackaged lab packs are marked with the types and volumes of wastes contained in the lab pack, and the lab packs are not reopened during transportation to authorized recycling or disposal facilities.
  - All lab pack reopening/repackaging is conducted within an appropriate spill containment system.
  - Only the outer lab pack may be reopened/repackaged, unless the primary container is damaged or leaking or the waste is eligible for consolidation. Wastes eligible for consolidation may include duplicating fluid, compatible formalin or formaldehyde solutions, compatible laboratory specimens, compatible solvents, water-based or latex paints, oil-based paints, antifreeze, gasoline, used oil, compatible organic resins (e.g., roofing tar, caulking and patching compounds, and adhesives), and photo-imaging solutions that are hazardous solely because of silver content (*CCR,* Title 22*,* Section 37450.42, subsection [d]).
  - Leaking or damaged lab packs and primary waste containers shall be immediately managed in accordance with the contingency plan and spill response and cleanup procedures required by *CCR,* Title 22, Section 67450.44.
  - Personnel who reopen/repackage lab packs at the SHWCCAF are trained, and work practices are managed, in accordance with applicable requirements of the Occupational Safety and Health Administration (*CCR,* Title 8, sections 3380 and 5192).
- Personnel who handle laboratory hazardous wastes at the contributing school, in transit to the SHWCCAF, or at the SHWCCAF, are trained in hazardous waste management and transport in accordance with *CCR,* Title 22, sections 66265.16 and 67450.47.

For additional information about compliance with these requirements, please contact the local CUPA. The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the California Environmental Protection Agency at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

Transportation of hazardous materials or waste. *HSC* Section 25163(c) (see Appendix A) states that a person transporting hazardous waste to a permitted hazardous waste facility in quantities not exceeding five gallons, or 50 pounds, does not need to be registered with the California Department of Toxic Substances Control (DTSC) as a hazardous waste transporter if all of the following conditions are met:

(1) The hazardous wastes are transported in closed containers and packed in a manner that prevents the containers from tipping, spilling, or breaking during the transport.
(2) Hazardous waste materials are not mixed within a container during the transporting.
(3) If the hazardous waste is extremely hazardous waste or acutely hazardous waste, the extremely hazardous waste was not generated in the course of any business and is not more than 2.2 pounds.
(4) The person transporting the hazardous waste is the producer of that hazardous waste, and the person produces **not** more than 100 kilograms of hazardous waste in any month.
(5) The person transporting the hazardous waste does not accumulate more than a total of 1,000 kilograms of hazardous waste on site at any one time.

Although passenger vehicles generally are exempt from the requirement to post placards and label containers, trucks are **not** exempt and must comply with the Department of Transportation's regulations. Anyone transporting hazardous materials should place the materials as far away from himself or herself as possible. Care should be taken to separate the chemicals according to their compatibility. Absorbent packing materials add an extra dimension of safety in cases of accidental spills.

For hazardous waste exceeding 50 pounds (22.5 kilograms) or 5 gallons (19 liters), a generator must:

- Use transporters and transfer, treatment, storage, and disposal facilities that are registered or permitted by DTSC and have been assigned a United States Environmental Protection Agency (EPA) ID number (*CCR*, Title 22, Section 66262.12). Transporters and facilities that do not meet these criteria cannot be used.
- Comply with Department of Transportation requirements for packaging, labeling, and marking and ensure that the transport vehicle has the correct placard (*CCR*, Title 22, Section 66262.32).

- Mark each container of 119 gallons or less with the following words and information (*CCR*, Title 22, Section 66262.32):

  HAZARDOUS WASTE— State and Federal Law Prohibit Improper Disposal. If found, contact the nearest police or public safety authority, the U.S. Environmental Protection Agency, or the California Department of Toxic Substances Control.
  Generator's Name and Address ____________________.
  Generator's EPA Identification Number ____________________.
  Manifest Tracking Number ____________________.

- Use a Uniform Hazardous Waste Manifest (EPA Form 8700-22) and, if necessary, a Continuation Sheet (EPA Form 8700-22A). A manifest is the paperwork that accompanies hazardous waste from the point of generation to the point of ultimate treatment, storage, or disposal (*CCR*, Title 22, sections 66262.20 and 66262.21). Manifest forms are available from private printers approved by the EPA. The EPA posts "Approved Registered Printers for the Manifest" on its Web page at ://www.epa.gov/epawaste/hazard/transportation/manifest/registry/printers.htm (accessed November 17, 2014). Additional information regarding hazardous waste manifests is available at the DTSC Web site at ://www.dtsc.ca.gov/IDManifest/upload/HWM_Manifest_Fed_Instr_Paged.pdf (accessed November 17, 2014).

- Complete the generator and waste section and sign the manifest certification according to the instructions in *CCR*, Title 22, Division 4.5, Chapter 12 (see Appendix A).

- Include the handwritten signature of the initial transporter and date of acceptance on the manifest (*CCR*, Title 22, Section 66262.23).

- Retain one copy of the manifest and give the transporter the remaining copies (*CCR*, Title 22, Section 66262.23).

- Keep the one copy of the manifest with the transporter signature for three years or until the generator receives a signed copy from the designated facility that received the waste (*CCR*, Title 22, sections 66262.23 and 66262.40). This signed copy shall be retained as a record for at least three years from the date the waste was accepted by the initial transporter (*CCR*, Title 22, Section 66262.40).

- Within 30 days of each shipment of hazardous waste, submit to the following DTSC address a legible copy of each manifest (*CCR*, Title 22, sections 66262.21 and 66262.23):

  DTSC Generator Manifests
  PO Box 400
  Sacramento, CA 95812-0400

- Contact the transporter and/or the owner or operator of the designated facility to determine the status of the hazardous waste if a copy of the manifest signed by the facility operator is not received within 35 days of the date the waste was accepted by the original transporter (*CCR*, Title 22, Section 66262.42).
- Submit an Exception Report to the DTSC if a copy of the manifest signed by the facility operator is not received within 45 days of the date the waste was accepted by the initial transporter. Generators of less than 1,000 kilograms of hazardous waste per month who meet requirements specified in *HSC* Section 25123.3, subdivision (h), have 60 days to file an Exception Report. These reports must be retained for a period of three years (*CCR*, Title 22, Section 66262.42). For generators of less than 100 kilograms of hazardous waste per month, there are certain transportation allowances in *HSC* Section 25163, subdivision (c). Exception Reports shall be forwarded to:

  DTSC Report Repository
  Generator Information Services Section
  PO Box 806
  Sacramento, CA 95812-0806

For additional information about compliance with these requirements, please contact the local CUPA. The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the California Environmental Protection Agency at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

Biennial reports. On March 1 of each even-numbered year, a Biennial Hazardous Waste Report, EPA Form 8700-13A/B, ://www.dtsc.ca.gov/HazardousWaste/AnnualReports/upload/BHWR_Supp-Inst.pdf (accessed November 17, 2014) must be submitted to the DTSC for waste generated at the school site during the previous odd-numbered year (*CCR,* Title 22, Section 66262.41). Copies must be retained for three years (*CCR,* Title 22, Section 66262.40). Careful recordkeeping of all the school-site manifests and receipts will be helpful in completing the appropriate forms. For additional information about compliance with these requirements, please contact the local CUPA. The local CUPA can be found through the Unified Program Regulator Directory search engine maintained by the California Environmental Protection Agency at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014). A report request will be sent automatically if the school or district has an EPA identification number.[7]

Once the equipment and details are in place for waste storage and transportation, a complete inventory of chemicals should be conducted (see Step 3).

Step 6: Dispose of Waste

Because these procedures are similar to those for conducting a chemicals inventory (see Step 3), it is often efficient to conduct an inventory and dispose of waste at the same time.

In preparing waste for disposal, follow these procedures:

1. For safety purposes, at least two persons (no students) should perform the procedures.
2. Allow sufficient, uninterrupted time to complete the task.
3. Wear proper protection for the task (including goggles, apron, gloves, and closed-toe shoes).
4. Have safety items available (e.g., fire extinguisher, fire blanket, eyewash, spill kit, and fume hood).
5. Have a flashlight and ladder available, if necessary.
6. Make sure the room is properly ventilated.
7. Have a plastic broom, plastic dustpan, and plastic receptacle available for cleanup.
8. Be prepared to handle unknown substances if they are encountered.
9. Have alternate containers (bottles, cans, resealable plastic bags) available in case a broken container is discovered.
10. Have replacement caps available.
11. Notify school authorities and maintenance personnel of the reshelving to be undertaken.

[7]. On applying for an EPA identification number, the school or district will receive a package from the DTSC called "Notification of Hazardous Waste Activity." For assistance in completing the package, call DTSC Public and Business Liaisons at 1-800-72-TOXIC. However, unless a school is new, it is likely to have an EPA number.

12. Adapt plastic water bottles for solid-residue disposal by cutting off the top of the bottle and punching small drain holes in the bottom. Place the container in the sink for the disposal of solids. Only small amounts of nonregulated, nonflammable, water-miscible liquids may go down the drain. Check with the local public works department or sanitation district (water quality control division) for specified limitations on disposable items.
13. Dispose of small quantities of nonregulated, nonflammable, water-miscible liquid residues by pouring them down the sink drain and using large amounts of water to dilute and flush the material through the plumbing system. Do not pour acids into a porcelain-lined sink. If corrosive, caustic, poisonous, or other controlled liquids need to be discarded, consult with the appropriate school district staff member.
14. Discard nonflammable solid waste and broken glassware in a container separate from the trash container. Either of those kinds of waste substances can present a serious hazard to custodial employees during collection and disposal. Broken glassware should be wrapped in heavy paper, taped, and properly labeled "DANGER: BROKEN GLASS."
15. Arrange for emergency communications in case a serious problem occurs, such as a spill or a fire.
16. Have space available in which materials can be placed temporarily.
17. Do as much preliminary housekeeping as possible to avoid physical obstacles that could lead to accidents.
18. Eliminate all potential sources of ignition.
19. Identify and label shelves or cabinet spaces for each category if reshelving chemicals.
20. If each item is to be labeled by its hazard class, have the correct information and labels available.
21. Plan how to accommodate (or dispose of) the many bottles of solutions prepared and stored during recent years.

Disposal of extremely hazardous chemicals. The most serious potential explosives should have been disposed of in Step 2. However, there are additional chemicals whose potential hazards outweigh any benefit they may provide to the instructional program. None of the chemicals shown listed in Table 7.3 should be stored in schools; if any are present, they should be properly disposed of (the hazard class is included in the table). In addition, all schools that use, handle, or store carcinogenic chemicals (whether stored from the past or used at present) should be registered with Cal/OSHA (see Appendix Q for a "Report of Use" form).

Special permits are no longer required for the storage, treatment, transportation, or disposal of extremely hazardous waste. Such waste is subject to the same requirements as those for hazardous waste. However, producers and transporters of extremely hazardous waste are required to notify and to send a tax return to the California State Board of Equalization (BOE) each year. An annual fee is to be paid on receipt of a billing from the board (see Appendix A, *HSC* sections 25153 and 25205.7[o]). To acquire a reporting form and tax return, write or call the BOE Special Taxes and Fees Division, PO Box 942879, MIC: 88, Sacramento, CA 94279-0088; telephone 1-800-400-7115.

Disposal of excess and deteriorated chemicals. Once the extremely hazardous chemicals have been disposed of, an assessment of the remaining inventory must be made to determine which portion will be used during the next year (or at most, two years). The remainder should be disposed of appropriately. The process of determining which chemicals to keep should involve all staff members who draw from the storage area for the instructional program. When the decision is made about what to keep, the remainder can be disposed of by a commercial disposal service (see Step 5).

Notes on Classification of Carcinogens

The carcinogenicity findings depicted in Table 7.3 were derived by three agencies. Each one used different criteria for classifying chemicals. The agencies, and classifications unique to each agency, are identified below.

National Toxicology Program **(NTP)**

"Known" carcinogen: substance for which there is evidence (from human studies) indicating a causal relationship between exposure to the substance and human cancer.

"Anticipated" carcinogen: substance for which there is limited evidence of its carcinogenicity in humans or sufficient evidence of its carcinogenicity in experimental animals.

International Agency for Research on Cancer **(IARC)**

Group 1: Agent that is carcinogenic to humans; used only when there is sufficient evidence of its carcinogenicity in humans.

Group 2A: Agent that is probably carcinogenic to humans; used when there is limited evidence of its carcinogenicity in humans and sufficient evidence of its carcinogenicity in experimental animals.

Group 2B: Agent that is possibly carcinogenic to humans; used either when there is limited evidence of its carcinogenicity in humans but an absence of sufficient evidence of such in experimental animals, or when there is inadequate or nonexistent evidence of the agent's carcinogenicity in humans and sufficient evidence of such in experimental animals.

Group 3: Agent that is not classifiable about its carcinogenicity in humans (agents are placed in this group when they do not fall into any other group.)

Group 4: Agent that is probably not carcinogenic to humans; used when the evidence suggests its lack of carcinogenicity in both humans and experimental animals.

California Health and Welfare Agency (California H and W)

An **X** marked in this column denotes a substance whose characteristics match one or more of the following criteria: (1) the substance has been shown through scientifically valid testing to cause cancer or reproductive toxicity; (2) an authoritative body, such as the U.S. Environmental Protection Agency, U.S. Food and Drug Administration, IARC, National Institute for Occupational Safety and Health (NIOSH), or the NTP has identified the substance as causing cancer or reproductive toxicity; or (3) a state or federal agency has required the substance to be identified as causing cancer or reproductive toxicity. (See *CCR,* Title 22, Section 12000, Safe Drinking Water and Toxic Enforcement Act of 1986, Chemicals Known to the State to Cause Cancer or Reproductive Toxicity).

If any of the chemicals in Table 7.3 are found in the school laboratory, they should be promptly removed from the premises by following the procedures specified in this handbook.

Table 7.3

Extremely Hazardous Chemicals Requiring Prompt Disposal

Chemical Name	NTP	IARC	California H and W	Hazard Class (DOT)	CAS Number
2-Acetylaminofluorine	Anticipated		X	Not listed	53-96-3
Acrylamide (neuro toxin)	Anticipated	2A	X	Keep away from food/ Poison 6.1	79-06-1
4-Aminodiphenyl	Known	1	X	Keep away from food/ Poison 6.1	92-67-1
Aniline		3	X	Poison 6.1	62-53-3
Arsenic powder	Known	1	X	Poison 6.1	7440-38-2
Arsenic trioxide	Known	1	X	Poison 6.1	1327-53-3
Asbestos	Known	1	X	Misc. hazard 9	1332-21-4
Benzene	Known	1	X	Flammable liquid 3	71-43-2
Benzidine	Known	1	X	Poison 6.1	92-87-5
Beryllium	Anticipated	1	X		7440-41-7
Beryllium compounds	Anticipated	1	X		
Cadmium powder	Anticipated	1	X	Poison 6.1	7440-43-9
Cadmium salts	Anticipated	1	X	Poison 6.1	
Carbon tetrachloride	Anticipated	2B	X	Poison 6.1	56-23-5
Chloroform	Anticipated	2B	X	Poison 6.1	67-66-3
Chromium (VI) oxide and all hexavalent chromium compounds	Known	1	X	Oxidizer corrosive 5.1	1333-82-0
Cobalt		2B	X		7440-48-4

Table 7.3

Extremely Hazardous Chemicals Requiring Prompt Disposal

Chemical Name	NTP	IARC	California H and W	Hazard Class (DOT)	CAS Number
Cobalt II oxide		2B	X		1307-96-6
p-Dichlorobenzene	Anticipated	2B	X	Keep away from food/ Poison 6.1	106-46-7
3,3-Dichlorobenzidine and salts	Anticipated	2B	X	Not listed	91-94-1
4 Dimethylaminoazo-benzene	Anticipated	2B	X	Not listed	60-11-7
Ethylene dichloride (1,2 Dichloroethane)	Anticipated	2B	X	Flammable liquid/ Poison 3	107-06-2
Formaldehyde	Anticipated	2A	X	Misc. hazard 9	50-00-0
Hydrazine (anhydrous)	Anticipated	2B	X	Flammable liquid/ corrosive/ Poison 3	302-01-2
Hydrofluoric acid				Corrosive material/ Poison 8	7664-39-3
Lead acetate	Anticipated	2B	X	Keep away from food/ Poison 6.1	301-04-2
Lead arsenate	Known	1	X	Poison 6.1	7784-40-9
Methylchloromethyl ether	Known	1	X	Not listed	107-30-2
4,4'-Methylene bis (2-Chloroaniline)	Anticipated	2A	X	Poison 6.1	101-14-4

Table 7.3

Extremely Hazardous Chemicals Requiring Prompt Disposal

Chemical Name	NTP	IARC	California H and W	Hazard Class (DOT)	CAS Number
Methylene chloride (Dichloromethane)	Anticipated	2B	X	from food/ Poison 6.1	75-09-2
Alpha naphthylamine		3	X	Poison 6.1	134-32-7
Beta naphthylamine	Known	1	X	Poison 6.1	91-59-8
Nickel powder	Anticipated	2B	X	Metal	7440-02-0
Nickel compounds	Anticipated	1	X	Metals	
4-Nitrobiphenyl		3	X	Not listed	92-93-3
Beta propiolactone	Anticipated	2B	X	Not listed	57-57-8
Sodium arsenate	Known	1	X	Poison 6.1	7631-89-2
Sodium arsenite	Known	1	X	Poison 6.1	7784-46-5
Vinyl chloride	Known	1	X	Flammable gas 2.1	75-01-4

Step 7: Develop Storage Patterns

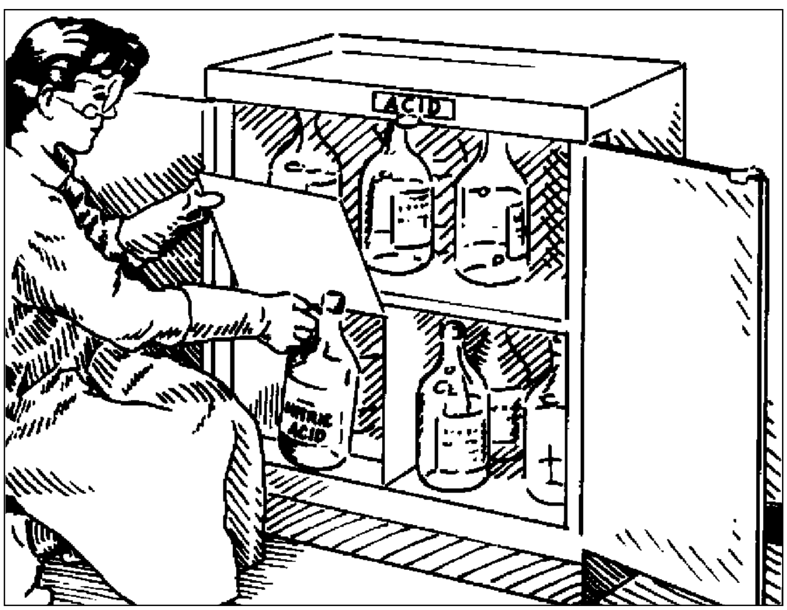
Safe storage patterns for hazardous chemicals have been developed and used in schools, colleges, and universities. The chemicals are arranged first by compatibility and then alphabetically within each compatibility category. The common alphabetical system pattern must be abandoned in favor of one, for example, that separates the oxidizers from metals and separates the flammables, the corrosives, and the poisons.

A single, safe, and practical storage compatibility system must be agreed on and used by all site staff. A mix of systems on one site might be dangerous. A system suggested for use in all California secondary schools is described below, with the 10 recommended storage compatibility groups noted in Table 7.4. In the recommendations that follow, special consideration has been given to separating and isolating chemicals and preventing their commingling should a disaster occur, such as a major earthquake or fire. This system also considers the hazard classes established in the *Code of Federal Regulations,* Title 49 (Transportation). See Appendix R for more information on those classes.

All storage shelves and cupboards should be fixed rigidly to the walls and be equipped with restraining lips, wires, or other barriers. Storage of chemicals within or near the main chemicals storage area should be selected on the basis of described needs. Storage may be handled with lockable cupboards, under-the-counter cabinets, or specially constructed (or purchased) cabinets, such as cabinets for acids, bases, and flammables.

Each cabinet chosen should be clearly and permanently (or at least semipermanently) marked for its designated storage purpose. To the extent possible, chemicals should be kept in special storage containers used by the supplier (for both storage and shipping).

Chemicals should be stored only in approved, locked cabinets in designated science storage rooms. Such storage rooms must be well ventilated and dry and must have adequate protection from direct sunlight. Lighting should be adequate. All cabinets should be locked when not in use, and the storage room should be kept locked. The instructor should be the only person with access to the storage room. No student should be permitted in the storage room unless accompanied and supervised by the teacher.



Recommendations for the safe storage of chemicals are as follows:

1. Chemical substances must be stored in an orderly manner. All substances must be properly labeled, and an efficient retrieval system must be in place to locate the chemicals. Alphabetical order is not appropriate **except** within compatible groups. Instead, refer to the recommended storage compatibility categories in Table 7.4.

2. Properly labeled safety containers must be used to store liquids that are highly volatile, potentially explosive, or flammable. Local fire departments should be consulted about minimum quantities for which safety containers are required. If possible, highly corrosive chemicals, such as inorganic acids and bases, should be stored in separate corrosives storage cabinets that are:
   - Constructed of dense, one-inch plywood and contain no uncoated metal hinges or locks (hinges and locks fabricated from wood or an appropriate plastic material are preferred)
   - Fabricated to ensure that shelf supports will not corrode and thus allow shelves to collapse
   - Provided with a recessed area or pan on the floor that will collect corrosives and not suffer damage
   - Constructed in compliance with local safety requirements
   - Equipped with self-closing doors and locks and are painted with intumescent, fire-resistant paint
   - Marked CORROSIVES, ACID, or other appropriate inscription in large, contrasting letters
3. Flammable liquids should never be stored in open or ordinary metal cabinets. Ordinary metal cabinets have no insulation against heat and will produce more shrapnel if an explosion occurs. Cabinets approved for flammable liquids should be constructed of dense, one-inch plywood with a recessed area or pan on the floor to collect spills. The cabinets should be painted with intumescent or fire-resistant paint; have a self-closing door, a positive latch, and locks; and be clearly marked in large, contrasting letters: **FLAMMABLE—KEEP FIRE AWAY!** Verify that cabinets are in compliance with local safety requirements.
4. Spacing between containers must be adequate to ensure proper air circulation and the safe retrieval of chemicals. Therefore, do not overorder.
5. Extremely hazardous, unlabeled, or unidentifiable chemicals must not be kept in schools. Follow recommended procedures for the disposal of dangerous, unwanted, or outdated chemicals.

6. Periodic **on-site** inspections of chemical storage cabinets must be conducted. (See Appendix F, “Sample Safety Checklist for Science Instruction, Preparation, and Storage Areas”).
7. An updated inventory list must be maintained for all chemical substances.
8. Bottles of acids or volatile organic liquids should be kept away from heating pipes or direct sunlight to avoid pressure buildup within the storage vessel.
9. Bottled gas cylinders should be secured to a wall or counter to prevent upsetting the cylinders. The rupture or unintentional opening of the release valve may cause serious personal injury and destruction of laboratory facilities, especially if the cylinder is not secured and becomes a projectile.
10. Larger gas cylinders must be kept on a cart provided for transport. Valves should be in perfect working order. When not in use, each cylinder must be secured and movement prevented; that is, each must be held by a sturdy chain or strap connected to ring bolts that will not pull free. The cylinders must be located in an approved storage area. Move large gas cylinders only when regulator valves have been removed and safety covers have been installed.

A relatively safe and practical pattern for storage of chemicals is one that has separate storage provisions for different categories of chemicals. Table 7.4 provides guidance on storage of chemicals by categories. Figure 7.1 provides a sample room layout for storing chemicals. Appendix D (“List of Incompatible Chemicals”), also contains useful information.

Table 7.4
Categories of Compatible Chemicals

1. **Metals.** All metals except mercury (see item 8). Phosphorus should also be stored here (red only; white or yellow phosphorus is not recommended for school usage). Flammable solids should be stored in the flammables cabinet. **Location:** Keep separate from oxidizers (including ammonium nitrate), halogens, organic compounds, and moisture.
2. **Oxidizers**. All except ammonium nitrate. Includes nitrates, nitrites, permanganates, chlorates, perchlorates, peroxides, and hydrogen peroxide (30 percent or greater). **Location:** Keep separate from metals, acids, organic materials, and ammonium nitrate.

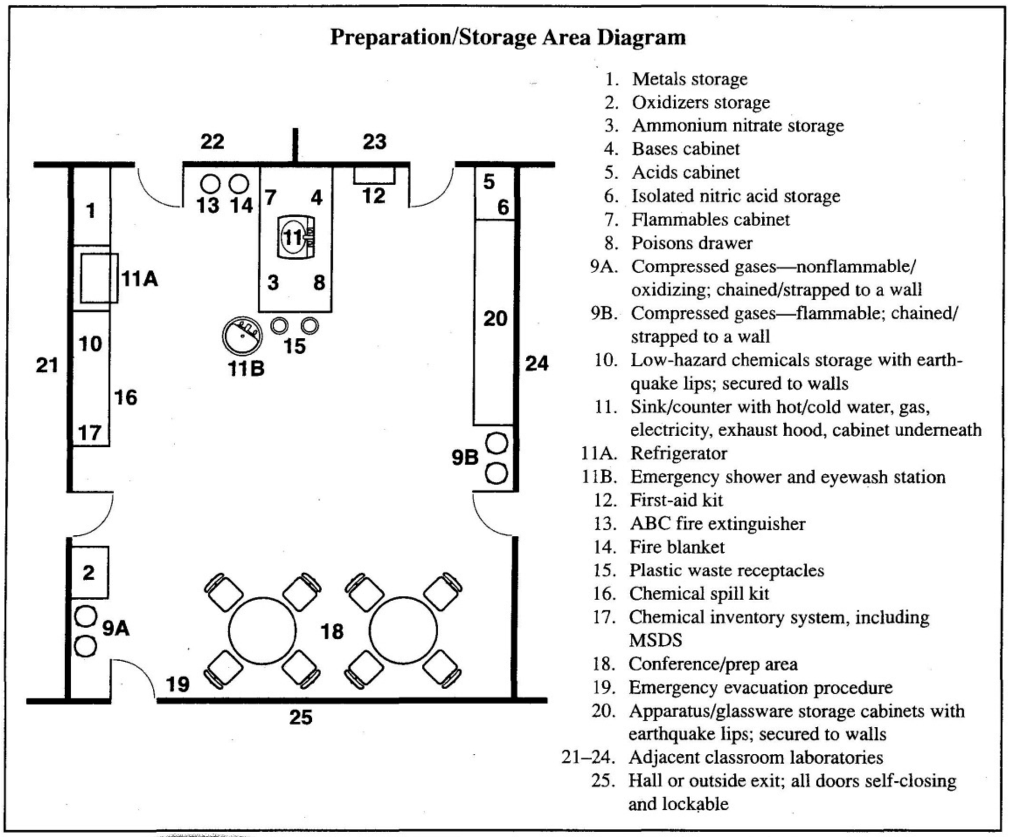
Table 7.4

Categories of Compatible Chemicals

	Preferably, isolate oxidizers from the flammable liquids storage cabinet by a minimum of eight meters (25 feet) or by a one-hour fire wall.
3.	**Ammonium nitrate.** Store in isolation from all other chemicals, especially acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, and finely divided organic combustible materials.
4.	**Bases.** Strong bases—sodium hydroxide, potassium hydroxide, and other regulated bases—and ammonium hydroxide. Store in a dedicated corrosive-chemicals storage cabinet that has an interior constructed entirely of corrosion-resistant materials.
5.	**Acids.** Inorganic (except nitric acid) and regulated organic acids. **Location:** Store in a dedicated corrosive-chemicals storage cabinet that has an interior constructed entirely of corrosion-resistant materials.
6.	**Nitric acid.** Must be stored separately from acetic acid. **Location:** Store either in an isolated compartment in the acids cabinet or in special Styrofoam containers available for that purpose from vendors of chemicals. Fuming nitric acid should never be used.
7.	**Flammables.** Preferably, isolated from all oxidizers by a minimum of eight meters (25 feet) or by a one-hour fire wall. **Location:** Store in a dedicated flammables storage cabinet painted with heat- or flame-resistant paint.
8.	**Poisons.** Cyanides (no longer recommended for school programs), mercury and mercury compounds, nicotine, and other poisons. **Location:** Use a lockable drawer remote from the acids storage cabinet.
9.	**Compressed gases.** Cylinders must be chained or strapped to the wall, with caps on tight. **Location:** (a) keep oxidizing gases remote from flammable liquids, metals, and flammable gases; (b) keep flammable gases remote from oxidizers and oxidizing gases by a distance of eight meters (25 feet) or by a one-hour fire wall.
10.	**Low-hazard chemicals.** Many of the salts not otherwise specified (of course, *not* the nitrates), weak bases, oxides, carbonates, sulfides, dyes, indicators, stains, noncorrosive organic acids, amino acids, sugars, and so forth. Store on open shelves that have earthquake barriers.

Figure 7.1

Sample Layout of Preparation/Storage Area



F. Labeling of Chemical Reagents

Whenever feasible, store chemicals in the containers in which they were received and retain the vendors' labels. Labels on prepared chemical reagent bottles or containers should display the following information (see also Table 7.3):

1. Generic name of the chemical and its chemical formula
2. Degree of hazard:
    - DANGER
    - WARNING
    - CAUTION
3. Type of hazard(s):
    - Poison
    - Causes burns

- Flammable
- Harmful vapors
- Explosive
- Toxic
- Corrosive

4. Date of receipt or preparation
5. Precautionary measures on how to avoid injury:
   - Keep away from heat, sparks, or open flame.
   - Avoid contact with eyes, skin, or clothing.
   - Use only with adequate ventilation.
6. Instructions in the event of ingestion, contact, or exposure.

Figure 7.2 shows an example of how to meet the labeling requirements. Proper labels can be obtained from most chemical or safety supply houses.

Figure 7.2

Sample Label for a Chemical Container

HCl

Hydrochloric Acid

WARNING:

- Causes burns.
- Avoid contact with skin and eyes. Avoid breathing vapor.
- In case of contact, immediately flush skin or eyes with large amounts of water for at least 15 minutes. For eyes, get immediate medical attention.

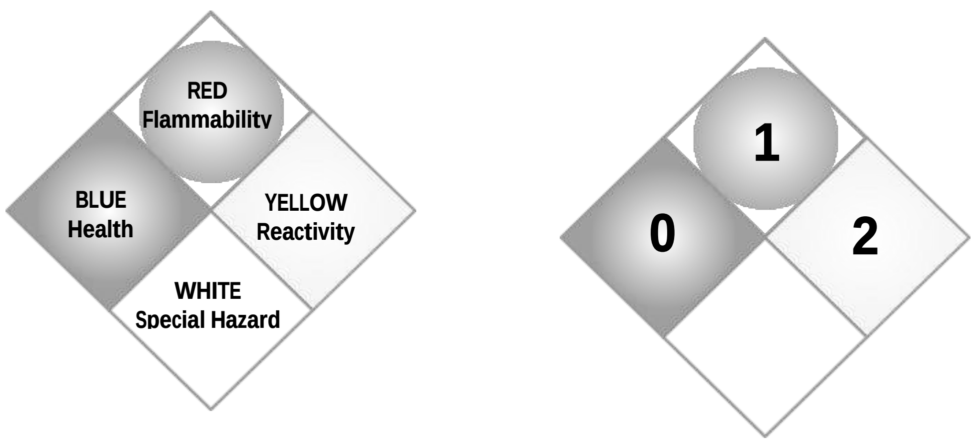
G. Potentially Hazardous Chemicals

Many potentially hazardous chemicals may be found in school science laboratories. District staff members are advised to make their own decisions about the acquisition and use of laboratory chemicals. If an especially hazardous chemical is deemed essential to the program, school staff members must assume the corresponding responsibility to ensure safe storage and use of the chemical. When in doubt, they should contact district staff members or other appropriate agencies.

The diamond-shaped National Fire Protection Association (NFPA) symbol (see figure 7.3) shows, at a glance, the inherent hazards of a chemical and the order of severity of those hazards under emergency conditions, such as spills, leaks, or fires. The information can be especially useful to firefighters and safety personnel in emergency situations. Figure 7.3 is not intended to identify the nonemergency health hazards of chemicals.

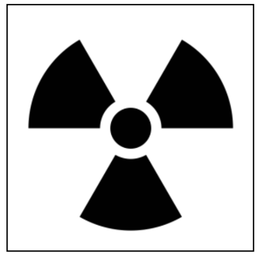
Figure 7.3

NFPA Symbol on a Chemical Container



The NFPA symbol identifies the **health**, ***flammability,*** and **reactivity** hazards of a chemical. **Reactivity** refers to the instability and water reactivity of a chemical that is likely to explode or burn, not to the corrosive or reactive nature of a chemical. The symbol also indicates the order of severity of each hazard by using one of five numeral gradings, ranging from four (severe hazard or extreme danger) to zero (no special hazard). Colored backgrounds or colored numbers usually supplement the spatial arrangement to identify the hazard categories: blue denotes health; red, flammability; and yellow, reactivity. (Because of fiscal limitations, the color code is not used in this handbook.)

In the diamond-shaped symbol, the **health** hazard is identified on the left; **flammability** at the top; and **reactivity** on the right, as illustrated in figure 7.3. The bottom space is used to identify special hazards, primarily unusual reactivity with water. A **W** with a line through its center, **~~W~~**, indicates a possible hazard in the use of water, as in the NFPA symbol for magnesium depicted in figure 7.3. Oxidizing chemicals are identified by **OXY** or **OX**, and a radiation hazard by this symbol:



The following is a brief summary of the meaning of each hazard category and the precautions necessary in a hazardous situation:

Health (Blue)

4—A few whiffs of the gas or vapor might cause death. Special protective clothing and equipment are usually required. Examples in this category are hydrogen cyanide and bromine.

3—Materials are extremely hazardous to health. In a hazardous situation, persons must wear full protective clothing and breathing apparatus before entering areas where these materials are present. Examples in this category are hydrochloric acid and sodium hydroxide.

2—Materials are hazardous to health, but areas may be entered freely by persons using self-contained breathing apparatus. An example in this category is ethyl ether.

1—Materials are only slightly hazardous to health. Self-contained breathing apparatus may be desirable. An example in this category is acetone.

0—No health hazard is present beyond that of ordinary combustible material.

Flammability (Red)

4—Extremely flammable gases; volatile flammable liquids; and materials that, in the form of dusts or mists, readily form explosive mixtures when dispersed in air are in this category. An example is propane.

3—Liquids that can be ignited under almost all normal temperature conditions; solids that form coarse dusts; solids in shredded or fibrous form that create flash fires; solids that burn rapidly, usually because they contain their own oxygen; and any material that ignites spontaneously at normal temperatures in air are in this category. Examples are acetone and methanol.

2—Liquids must be moderately heated before ignition will occur; solids readily give off flammable vapors. An example is kerosene.

1—Materials must be preheated before ignition can occur. Most combustible solids have a flammability rating of 1. Examples are sulfur and magnesium ribbon.

0—Materials will not burn.

Reactivity (Yellow)

4—Materials are readily capable of detonation, explosive decomposition, or explosive reaction at normal temperatures and pressures, or they are sensitive to mechanical or localized thermal shock. An example is picric acid (dry).

3—Materials are capable of detonation, explosive decomposition, or explosive reaction but require a strong initiating source or must be heated under confinement before initiation. Materials are sensitive to thermal or mechanical shock at elevated temperatures and pressures or react explosively with water. An example is ammonium nitrate.

2—Materials are normally unstable and readily undergo violent chemical change but do not detonate. Materials can undergo chemical change with rapid release of energy at normal temperatures and pressures and undergo violent chemical change at elevated temperatures and pressures. Materials react violently with water or may form potentially explosive mixtures with water. Examples are sodium peroxide and sodium metal.

1—Materials are normally stable but may become unstable at elevated temperatures and pressures or may react with water to release some energy, although not violently. Examples are zinc metal and red phosphorous.

0—Materials are normally stable, even under fire-exposure conditions, and are not reactive with water.

H. Substances Containing Asbestos

Asbestos-covered wire-gauze heating pads are no longer available commercially and should not be used in schools. Newer materials, such as ceramic, silica-base, or synthetic fibers, are now used to coat wire gauze and other heat-resistant laboratory equipment. The newer materials generally have better heat-resistant qualities than asbestos and are less subject to chemical damage. After use, the new materials often look like asbestos; therefore, permanent marking, such as the addition of wires or staples on the edge, is recommended to identify the material.

Asbestos gloves and other soft or crumbly materials should be removed for disposal. Asbestos is a recognized carcinogen; asbestos fibers enter the body by inhalation. Avoid any use of asbestos.

I. Use and Disposal of Ethers

The use of ethers for instructional purposes may present a danger to students and school staff members. Therefore, the use of ethers in the school laboratory is discouraged. The most common types of ethers used in high schools are petroleum ether and diethyl ether (anesthetic ether). Petroleum ether is not a true ether (and does not produce peroxides during storage) but is a volatile fraction of petroleum made up of pentanes and hexanes. Petroleum ether may also be known as ligroin or benzine.

Anesthetic ether that has been stored for several years may form crystalline solids, called ether peroxides, on the inside lid of the container. Once peroxides have formed, this diethyl ether is dangerously explosive.

The following procedures should be closely followed in any use of anesthetic ethers:

Ordering Guidelines

1. Order only as much diethyl ether as will be used during the school year, because exposure to air causes the formation of peroxides that are explosive and sensitive to heat. Small, single-use bottles (25 ml and 50 ml) are available. After use, allow the remainder to evaporate, if appropriate.
2. Order only diethyl ether. Other types of ethers are not to be used in schools. (Petroleum ether is not herewith restricted because it is not a true ether.)

Storage and Inventory

1. Date each container when received.
2. Use oldest cans first.
3. Use the entire can of ether as soon as possible after the seal is broken.
4. Never store ether in a glass container.
5. Never store diethyl ether for more than 12 months.
6. Store ether in a cool, dark location.
7. Never store ether in a refrigerator, unless the refrigerator is certified explosion-proof.
8. Never open a container of ether if the age or condition is uncertain. Any shock or vigorous motion might cause an explosion. Do not open the cap or stopper because the motion might be sufficient to cause an explosion.

Use of Ether in the Classroom

1. Use only when no alternative solvent is available.

2. Never have an open flame or spark source in a room in which ether is being used.
3. Keep the work area well ventilated. Use only in a properly ventilated fume hood.
4. Use minimal quantities.
5. Use appropriate gloves, as skin irritation may occur on contact.
6. Remember that ether vapor is heavier than air. The hazardous area is enlarged because vapors spread along the floor.

Ether Spills

Evacuate students and others from the area and ensure adequate ventilation by opening windows and turning on exhaust fans.

Disposal of Ether

To dispose of any old, rusty, swollen, or suspect container of diethyl ether or waste diethyl ether, immediately call the appropriate school district staff member or the local fire or county sheriff's department. Also refer to Step 5.

J. Standards in the Use of Lead

The California Department of Public Health (CDPH) has recommended that lead and lead compounds should **not** be used in the high school laboratory. Overexposure to lead may cause damage to the reproductive systems of both men and women. Effects of the damage include stillbirth, miscarriage, and learning disorders in children whose mothers were exposed to lead during pregnancy. Lead also damages the nervous system, kidneys, blood-forming system, and digestive system and causes high blood pressure. (See also Table 7.3.)

If lead must be used in the laboratory, the Cal/OSHA lead standard must be followed (see *CCR,* Title 8, Section 5198). Key points of the lead standard are as follows:

1. When lead is used, the amount of lead in the air in the work area must be measured at least once.
2. If the levels of lead in the air exceed the action level (an average of 30 micrograms of lead per cubic meter of air throughout an eight-hour workday), the employer must:
   a. Measure the level of lead in the air every six months
   b. Inform employees, in writing, of the amount of lead to which they are exposed
   c. Establish an exposure reduction program if employees are exposed to more than the action level for more than 30 days each year.

3. Employee exposure must not exceed the permissible exposure limit (PEL) on any day. If employee exposure to lead on a given day exceeds the PEL (an average of 50 micrograms of lead per cubic meter of air throughout an eight-hour workday), the employer must:
    a. Measure the level of lead in the air every three months
    b. Share with employees, in writing, the results of air monitoring and explain what will be done to reduce exposures
    c. Provide employees with proper respirators until the exposure has been lowered by other controls
    d. Prohibit eating, drinking, or applying makeup in areas where lead levels are above the PEL
    e. Make sure that employees wash hands before applying makeup, eating, or drinking
    f. Provide a changing room, lunchroom, and shower facility at no extra cost to employees.
4. If employees are exposed to lead at or above the action level, the employer must offer medical evaluations at no cost to the employees.

The CDPH strongly recommends that instructors replace lead and lead compounds with less-hazardous substances. If lead will be used, the CDPH recommends the following procedures:

- Only instructors should handle powdered lead and lead compounds.
- When handling solid lead compounds (other than lead weights) or solutions containing lead, students must wear laboratory coats, gloves, and goggles.
- The instructor must inform students of the need for strict personal hygiene and adherence to safety guidelines when using lead.
- The instructor is responsible for cleaning up any spills. (**Note:** The school district is responsible for any adverse health effects among instructors, so adequate education, training, and restriction of substances used in labs (enforced with a centralized purchasing policy) must be in place. Instructors must justify in writing the use of substances such as lead and other P65 [from Proposition 65] substances—those known to cause cancer or reproductive toxicity.)

K. Handling and Cleanup of Mercury

Mercury may be toxic to the central nervous system and other organs such as the liver or gastrointestinal tract. Teachers should use the smallest possible quantity of metallic mercury to perform the experiment and keep the mercury away from heat at all times. When mercury is handled, it should be done closely over a glass or plastic tray to facilitate any cleanup that may be necessary. (Drops of mercury that fall on a counter or floor will spatter and spread in fine particles.) Take care that mercury is not handled or placed in a sink. All spills should be properly documented in writing and carefully cleaned up.

Mercury spills must be cleaned up as thoroughly as possible to reduce the long-term presence of mercury vapors in the classroom or preparation area. The following precautions should be taken in cleanup:

- **Do not sweep the spill with a broom.** (The broom becomes contaminated, and free mercury vapor is produced.)
- **Do not use a standard vacuum cleaner.** (The vacuum cleaner becomes contaminated, and free mercury vapor is produced.)

Suggestions for cleaning up mercury spills are as follows:

1. The county health department should be called to assist in cleanup of mercury spills. Cleanup is usually performed by environmental health department staff members. School staff should not attempt to clean up spills, except as noted in item 3, below.
2. Assess the extent of the spillage. If the spill is minor (e.g., a broken mercury thermometer) and confined to a small area, clear the area and restrict access; provide maximum ventilation; and proceed with the cleanup. If the spill is more extensive, clear the room of students and ensure that ventilation is sufficient before cleaning up. Placing plastic bags over shoes may be advisable to avoid extending the mercury contamination beyond its original area.
3. Use index cards to push drops of mercury together into pools. Droplets may scatter a considerable distance and adhere to vertical surfaces as well.
4. Use a medicine dropper with a fine point to pick up the mercury and place it in a plastic bottle. Continue gathering and confining the mercury until all visible droplets have been found.
5. Use commercially available mercury “sponges” to continue to clean up tiny and hidden droplets. (**Caution:** if zinc metal powder is in the “sponge” or used, keep the zinc metal powder dry because it is spontaneously combustible when wet and may even explode if

confined. Zinc metal reacts with mercury to form a safe amalgam, which is easier to collect and dispose of than the mercury itself).

Mercury indicators (detectors) and mercury cleanup kits, which would be effective for small or modest spills, are available at relatively low cost through chemical and safety supply companies. Special attention should be given to larger spills, possibly including the rental of a mercury vacuum cleaner. Mercury must be disposed of as a hazardous waste (see Step 5).

Chapter 8

Safety in the Physics Laboratory

Physics teachers should be familiar with the following safety practices and all other sections of the handbook pertinent to their instructional program. Special attention should be directed to Chapter 3, "General Laboratory Safety Precautions"; Appendix F, "Sample Safety Checklist for Science Instruction, Preparation, and Storage Areas"; and Appendix S, "Sample Physical Science Laboratory Regulations".

A. General Safety Practices

1. In wiring an electric circuit, make the live plug-in, or turn-on switch connection, the last act in assembling and the first act in disassembling the circuit. This practice is applicable to all portable electrical apparatus. All alternating current (AC) circuits above 12 volts should be shielded to avoid direct contact.
2. When using an electric current, avoid bringing both hands in contact with live sections of the circuit. If possible, use only one hand at a time in all manipulations involving an electric circuit.
3. Electrical cords and extension cords used in the classroom should be inspected regularly for defects in insulation or connections. All extension cords should be the heavy-duty, three-wire, grounded type. Extension cords should never be used to connect electrical equipment permanently to the circuit.
4. If electric current is constantly used near any metal object, the object should be permanently protected with an insulating cover to avoid possible contact. Make sure that live wires do not contact grounded metallic objects.
5. Multiple plugs shall not be used in electrical wall outlets. Semipermanent electrical connections shall not be made to wall outlets. Under no circumstances shall a motor requiring a starting current of more than 20 amps be connected to a wall outlet.
6. During the charging of a student-made wet storage cell, keep students away from the fine spray that develops. The spray is harmful when inhaled or when it comes in contact with the skin or the eyes.

7. Teachers and students should be cautious when handling a lead/acid or similar storage battery. It is a source of danger in spite of its low voltage because of the acid it contains and because of the high current that may be drawn from it on a short circuit. Storage batteries should be charged only in a well-ventilated space. Battery sparks have enough energy to ignite flammable vapors. Hydrogen gas, which is potentially explosive, is produced during charging.
8. Induction coils of any type should be clearly marked for low-voltage and high-voltage connections to avoid the possibility of shocks.
9. Instructors and students should be shielded at all times from ultraviolet apparatus and during the use or production of X-rays, microwaves, and lasers.
10. When handling electronic equipment, teachers and students should observe the following precautions:
    - Make certain that the current is off before putting hands into a radio or any electronic equipment.
    - Be sure that there is a bleeder (high resistance) across the output of a power supply; otherwise, a severe shock from a charged condenser may result.
    - Exercise extreme caution in demonstrating, adjusting, or using image tubes of television receivers or cathode-ray oscilloscopes when the tubes are removed from their protective housing. Such tubes should be removed only when necessary to the experiment.
11. When evacuating a bulb during the air-density experiments, wrap the bulb in a towel to avoid flying glass should the bulb be crushed. Use round-bottom flasks for the experiment; they are stronger than flat-bottom flasks.
12. When using a pressure cooker to demonstrate the variation of boiling points under pressure, be sure to examine the safety valve on the cooker before use to make sure it is in working order. Do not allow the pressure to exceed 20 pounds per square inch (137.8 kPa).
13. Observe caution in the use of all rotating apparatus, such as the whirling table, Savart's Wheel, siren disk, and centrifugal hoops. Make certain the safety nut is securely fastened at all times. The apparatus should revolve at moderate speeds only.

14. Care should be taken to prevent injuries from the sharp edges on mirrors, prisms, and glass plates. Inspect the items before handing them to students and remove sharp edges by grinding them with emery cloth or a silicon carbide stone or painting them with quick-drying enamel. Instruct students to report at once any sharp-edged apparatus.
15. Remove thermometers, glass tubing, and so on from rubber stoppers as soon as possible after use. This will reduce the likelihood of the rubber adhering to the glass. The best ways to remove a thermometer, rod, or glass tubing that is stuck in a rubber stopper are as follows:
    - Use a wet cork-borer, just large enough to slip over the tubing, and slowly work the cork-borer through the stopper, thus boring the stuck tube out of the stopper.
    - Use a single-edge razor blade or razor knife to slit open the rubber stopper surrounding an immobilized thermometer.

B. The Student's Responsibilities

Conducting experiments may present a real danger if important safety steps are not followed. Each school year should begin with an orientation about and demonstration of safety equipment and a review of expected laboratory conduct. Each experiment should begin with specific guidance, including information about the equipment and materials used and any required or special handling. The following can serve as a general checklist for students to acquaint them with the conduct expected in the physics laboratory.

General Laboratory Conduct

1. Rowdy conduct and practical jokes are not allowed.
2. Use of cell phones and of music or video equipment is prohibited.
3. Unauthorized experiments are strictly forbidden; all laboratory work must be supervised.
4. Do not sit on laboratory benches.
5. Immediately report any spills, accidents, or injuries to a teacher.
6. Never leave experiments while in progress. For example, do not walk away from lit Bunsen burners or open gas valves.
7. Never threaten another student with laboratory equipment, chemicals, or products related to experiments.

8. Make sure there are no flammable solvents around when lighting a flame.
9. Leave all equipment, chemicals, and experiment products in the laboratory unless authorized by the teacher.
10. Coats, bags, and other personal items are not allowed in the laboratory space.

Student Safety Practices

1. Wear proper safety equipment as instructed by the teacher (indirectly ventilated goggles, gloves, lab coat or apron, and the like).
2. Always remove gloves and wash hands before handling any personal item or before leaving the laboratory.
3. Wear closed-toe and closed-heel shoes.
4. Wear clothing that covers the legs, arms, and torso. Remove loose clothing and jewelry, and tie back long hair.
5. Never apply makeup, eat, drink, or chew gum in the laboratory.

Emergency Procedures

1. Know where the emergency exits are located and where to go if the classroom or building is evacuated.
2. Ask the teacher to demonstrate how to use the fire extinguishers, fire alarms, eyewash stations, emergency showers, and first-aid kits.

C. Electrical Devices and Connectors

The use of electricity may present a serious hazard in the classroom or laboratory. Electrical devices used in the laboratory or classroom should be only those listed by Underwriters Laboratories (UL), or equivalent, for 110-volt outlet application or those listed for use with 6-volt or 12-volt direct current furnished by batteries.

Electrical devices should never be used or placed near any source of water or in an area subject to wetting from any source. Exercise special care in the placement and use of aquariums, particularly when using a 110-volt light source.

Instructors should caution students that any projects they submit must meet the specifications noted above or will not be accepted.

Some guidelines for safety in the use of electrical equipment are as follows:

1. Use only those 110-volt devices listed by Underwriters Laboratories (or equivalent).
2. Use 6-volt or 12-volt direct current for all possible applications.
3. Operate electrical devices with dry hands and in a dry location.
4. Be sure the floor is dry. Never stand on metal or any other conducting surface when using electrical devices. Electrical outlets near sinks should have ground fault circuit interrupters (GFCIs).
5. Never become part of an electrical circuit, intentionally or unintentionally.
6. Ensure that power equipment and devices are double-insulated, or have them safely grounded (with a three-prong plug) by a competent electrician.
7. Use extreme care with aquariums that have an electrically operated pump or electrical light source.
8. Exercise extreme caution when using extension cords and never allow them to lie across areas of foot traffic.
9. Be sure multiple-outlet bars have fuse protection or some other circuit breaker.

In compliance with *CCR,* Title 8, Electrical Safety Orders, Section 2395.44, exposed noncurrent-carrying metal parts of cord- and plug-connected equipment that are likely to become energized must be grounded. This includes motor-driven equipment and hand tools, time clocks, fans, lamps, vacuum cleaners, and similar equipment, as well as, heating devices that have exposed heating elements. Heating appliances that have a metal frame must be grounded. Heating appliances with Cal-rod types of fully enclosed elements do not require grounding.

All nonportable electrical devices must be plugged directly into permanent electrical outlets, not into extension cords.

D. Model Rocket Launchings on School Sites

California state fire laws permit the launching of model rockets on school sites if the following safety precautions are followed (see Appendix J for further guidelines):

1. The teacher should use prudent judgment and limit the number of launchings when students are present in the audience.
2. Only authorized classes or clubs should engage in this kind of activity on school sites.

3. Application for a special permit may be required by local fire protection agencies. If a permit is issued in the name of the school administrator, the instructor must comply with all safety standards. The school administrator should determine compliance.
4. The length of the rocket must not measure less than 10 inches (25 cm) or more than 15 inches (38 cm).
5. Only commercially produced class A or smaller engines are recommended.
6. The minimum size of the launch site for class A or smaller engines should extend to a radius of 100 feet (30 m) from the firing position.
7. Launches must not pose a fire hazard. This means the launch radius cannot include dry vegetation or forest areas.
8. No buildings, other structures, roads, or high-voltage electrical lines may be within the launch radius.
9. The firing area should be at the center of the launch radius. In no case should the firing area be closer than 25 feet (8 m) from the boundary of the launch site.
10. Teachers should caution their students about the dangers of experimenting with rockets and missiles, especially the dangers in the preparation and use of noncommercial rockets and propellants. Teachers must refrain from the following practices:
    - Providing chemicals for rockets or missiles or helping students to obtain them
    - Using, or permitting to be used, liquid or solid fuels in the classroom (such use essentially constitutes a controlled explosion)
    - Permitting the construction of rockets, missiles, or component parts in the classroom or shop
    - Allowing students proximity to the firing area
    - Launching anything other than commercially produced rocket engines of known size and predictable range

E. Use and Hazards of Lasers

Lasers are valuable sources of light to use in exciting demonstrations and laboratory experiments in school. Most school lasers are relatively low powered, with a light emission of less than a thousandth of a watt (1 milliwatt). However, science teachers should always take appropriate precautions to limit exposure from laser light to students, teachers, and other attending personnel. Before using lasers in demonstrations or in research, make sure all participants—students and other involved personnel—are aware of the potential hazards in the operation of lasers. In general, lasers used in school demonstrations emit light in the visible-light portion or infrared portion of the electromagnetic spectrum. Therefore, students and teachers face hazards typical of visible and near-infrared light.

Eye Hazards

Possibly the greatest danger in the use of lasers is the accidental penetration of the laser beam into the eye. Damage to the different structures of the eye from laser light depends on the wavelength of light being emitted. Retinal burns that cause partial or complete blindness are possible when using beams in the visible (400–700 nm) and near-infrared (700–1400 nm) regions. At those wavelengths, the eye will focus the beam on a tiny spot on the retina and create a blind spot. If the irradiated retinal area is the macula, its fovea (area of extremely fine vision), or the optic nerve, severe and permanent visual damage may result.

Skin Hazards

The effects of laser light on the skin are basically those of thermal burns. Skin damage can occur from exposure to infrared or ultraviolet light. For infrared exposure, the results can be thermal burns or excessively dry skin, depending on the intensity of the radiation. Lighter skin with little melanin pigment is affected to a lesser degree, but skin with high melanin content (overall or in spots, such as moles) may be burned severely. Conversely, lighter skin does not protect deeper-lying tissue from visible and near-infrared irradiation damage as well as darker skin does.

Exposure to ultraviolet irradiation may result in “sunburn” and possibly skin cancer in susceptible individuals.

Regulations

The Center for Devices and Radiological Health (CDRH) of the U.S. Food and Drug Administration requires manufacturers of lasers to classify their lasers according to a federally mandated system and specifies appropriate safety features for each level. Lasers are classified on the basis of emitted beam power. These regulations are detailed in the Federal Laser Product Performance Standard (*Code of Federal Regulations,* Title 21, Part 1040), and all commercially available lasers must comply with the standard.

Laser Classification

Lasers are classified by potential hazard according to a system described in the American National Standards Institute (ANSI) standard Z136.1–2007. The classification is based on the laser's potential to cause immediate injury to the eye or skin. Several factors are considered in classification: wavelength, power output, accessible emission level, and emission duration. Table 8.1 shows the level of hazard associated with each class of lasers.

Table 8.1
Classes of Lasers

Classification	Description
Class 1	Lasers in this class are of very low risk ("eye safe"), even with optical-aided viewing; incapable of causing eye damage; and exempt from labeling requirements. Examples of such products include laser printers and compact disc players.
Class 1M	Lasers produce either a highly divergent beam or a large-diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments. Some of the lasers used for fiber-optic communication systems are Class 1M laser products.
Class 2	Lasers are limited to a maximum output power of 1 milliwatt (mW) which is one-thousandth of a watt, and the beam must have a wavelength in the visible region between 400 and 700 nanometers (nm). A person receiving an eye exposure from a Class 2 laser beam, either accidentally or as a result of someone else's deliberate action (misuse), will be protected from injury by his or her own natural aversion response (0.25 sec). This natural, involuntary response causes the individual to blink and avert his or her head, thereby terminating the eye exposure. Deliberate exposure to the laser beam may not be safe. Some laser pointers and bar-code scanners are Class 2 laser products.

Table 8.1
Classes of Lasers

Classification	Description
Class 2M	Lasers produce either a highly divergent beam or a large-diameter beam within the wavelength range of 400 to 700 nm. Therefore, only a small part of the whole laser beam can enter the eye, and this is limited to 1 mW, similar to a Class 2 laser product. However, these products can be harmful to the eye if the beam is viewed using magnifying optical instruments or for long periods of time. Some lasers used for civil engineering applications, such as level and orientation instruments, are Class 2M laser products.
Class 3a	Class 3a lasers emit visible light with a maximum power of 5 mW. A 5mW power may be too high for the blink reflex to provide protection against eye injury. The lasers may have an output power of up to 500 mW (half a watt).
Class 3b	Class 3b lasers may have sufficient power to cause an eye injury, both from the direct beam and from reflections. The higher the output power of the device, the greater the risk of injury. Class 3b lasers are therefore considered hazardous to the eye. Examples of Class 3b products include lasers used for physiotherapy treatments and many research lasers. Lasers in this class are capable of causing eye damage from short-duration (< 0.25s) viewing of the direct beam.

Table 8.1
Classes of Lasers

Classification	Description
Class 3R	These lasers are higher-powered devices than Class 1 and Class 2 lasers and may have a maximum output power of 5 mW in the visible region. Class 3R lasers that emit outside the visible spectrum may be limited to lower power output. Class 3R laser beams exceed the maximum permissible exposure for accidental viewing and can potentially cause eye injuries, but the actual risk of injury following a short, accidental exposure is still small. Safety features of Class 3R lasers include the safety requirements for Class 2 lasers (e.g., a key switch and a connector for optional remote-control operation).
Class 4	The lasers have an output power greater than 500 mW (half a watt). There is no upper restriction on output power. Class 4 lasers are capable of causing injury to both the eye and skin and will also present a fire hazard if sufficiently high output powers are used. Lasers used for many laser displays, laser surgery, and cutting through metals may be Class 4 products. Many Class 4 laser products are safe during normal use, but they may not have all the protection measures required for a Class 1 product.

According to the CDRH, Class 1 lasers do not require warning labels. The CDRH believes that no injury can result from their use, even from direct, continuous long-term exposure to the beams.

A Class 2 laser is identified by a yellow **Caution** label: **Do not stare into beam.**

A Class 3R laser is identified by a red **Danger** label: **Avoid direct eye exposure.**

In addition to the CDRH label, each laser that is Class 2 or higher should have the following label placed near the beam exit: **AVOID EXPOSURE. LASER LIGHT IS EMITTED FROM THIS APERTURE.**

The CDRH also requires manufacturers to provide users with the following information: **Caution—Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous light exposure.**

Laser Pointers

Laser pointers are readily available and commonly used. These devices are designed to be safe if used for their intended purpose. Unfortunately, however, laser pointers can easily be misused.

Early laser pointers were red helium–neon (HeNe) gas lasers and generated laser light in the visible laser range (400–700 nm), operating at less than 1 milliwatt power (Class 2 lasers), for which the blink reflex normally affords adequate eye protection. Retinal injury is possible with a Class 2 laser if a person deliberately overcomes the natural aversion response in looking at the beam.

Laser Precautions

Most lasers used in secondary schools are continuous-wave (cw) helium–neon lasers that emit a beam of red light. No invisible, exotic, or other harmful radiation is emitted. These lasers are typically Class 2 or Class 3R lasers. It is important to know the classification of the laser being used so that the necessary engineering controls or administrative procedures are applied.

Class 2 lasers have a maximum power of 1 milliwatt, a power judged to be eye-safe because the natural blink reflex prevents excessive power absorption in the eye. However, deliberate, direct staring into the beam for periods longer than one-quarter second may result in injury. Safety features include warning labels, a pilot lamp that glows when the electrical power is on, and a mechanical beam stop that may be used to block the beam when the power is on.

Class 3a lasers that emit visible light have a maximum power of 5 milliwatts, a power that may be too high for the blink reflex to provide protection against injury. Class 3R lasers that emit outside the visible spectrum may be limited to lower power output. Class 3R lasers include the same safety requirements as those for the Class 2 laser: a key switch and a connector for optional remote-control operation. Tests have shown that lasers rated at 1 milliwatt radiated in the range of 0.19 to 3 milliwatts.

Lasers with cw outputs greater than 5 milliwatts, pulsed lasers, and lasers emitting radiation at wavelengths outside the visible and near-infrared light present additional hazards. Schools using such lasers should have a copy of the *American National Standard for Safe Use of Lasers,* ANSI Z136.1–2014 ://webstore.ansi.org/RecordDetail.aspx?sku=ANSI+Z136.1- (accessed November 17, 2014), published by the Laser Institute of America, 13501 Ingenuity Drive, Suite 128, Orlando, Florida 32826.

Even though the power of a laser may be low, treat the beam with caution and common sense. Many laser hazards can be avoided by implementing the following measures:

1. **Avoid direct viewing of the beam.** Instruct students not to look directly into the laser beam or its bright reflections, just as they should not look directly at the sun or at arc lamps. As a general practice, no portion of the body should be in the path of the beam. These practices become increasingly important as the power of the laser device’s output increases. Good work practices, developed early, will assist the individual later in working safely with more-hazardous lasers.

2. **Know the location of the beam’s path and keep it clear of extraneous objects.** Before propagating a laser beam, fix all optical components into position to ensure that the beam’s path does not change in an uncontrolled manner. Objects with mirrorlike finishes (e.g., plumbing fixtures, personal jewelry, and tools) reflect laser beams in unexpected directions. If possible, remove such surfaces from the vicinity of the beam’s path. Demonstration equipment, such as support rods, bench surfaces, and adjustment tools, should be painted or treated to produce a dull, nonreflective surface.

3. **Block the beam when it is not needed.** Remove beam stops or open mechanical shutters only to allow measurements or observations. Shutters or beam stops must be in place when inserting or relocating an optical element.

4. **Terminate laser beams.** Block off the beam at a point beyond the farthest point of interest, a target, or an optical table. Terminate all laser beams with a nonreflective, light-absorbing material. For higher-power lasers (greater than 500 milliwatts), the material should also be nonflammable.

5. **The instructor must prepare and test demonstrations when no one else is present.** Identify and track down all stray beams and reflections by eliminating or blocking them.

6. **Deflect the beam in a vertical plane in complex demonstrations.** In normal experiments, the laser beam's path must be kept in a horizontal plane at a level below or above the eye level of the instructor and observers. Complex demonstrations involving reflection or refraction should be conducted with the beam's deflection angles contained in a vertical plane to reduce the possibility of directing a stray reflection into the audience. The laser display system should be contained in a box that is open on the side(s) but closed on the ends, top, and bottom. If the beam must travel a long distance, keep it close to the ground or overhead so that it does not cross walkways at eye level.
7. **Affix expanding lenses rigidly to the laser.** When using the laser to illuminate large surfaces, such as in the viewing of holograms, fix beam-expanding (diverging) lenses rigidly to the laser.
8. **Equip the laser with a key switch.** The laser should be equipped with a key switch in the primary power circuit, rather than with the more commonly used toggle switch. Key switches are available from electronic supply stores for a relatively small charge. An additional switch that requires constant pressure is also desirable.

   Although installing a key switch is desirable, a retrofit may void the manufacturer's warranty. It is advisable to have an electrical technician perform this operation.
9. **Do not leave an operable laser in an accessible, unattended location.** Remove the key and place it in a secure location to prevent unauthorized use of the laser and possible injurious exposures. For the same reason, when experiments or demonstrations take place in areas that might permit access to the beam by individuals not under the control of the teacher, assign a responsible person to stop the beam's emission, if warranted.
10. **Reduce the optical power of the laser.** Reduce the optical power to the minimum level necessary to accomplish the objective of the experiment or demonstration. Use neutral-density filters or colored plastic to effectively reduce radiated optical power.
11. **Keep the area well lighted at all times.** Good lighting tends to keep the pupil of the eye relatively contracted and reduces the amount of light that might accidentally impinge on the retina when the laser system is in use.
12. **Provide and use adequate eye-protective devices.** Choose the appropriate laser glasses or goggles specific to the wavelength emitted by the laser system. No goggle offers protection against all the wavelengths and levels of transmittance (optical density).

Make sure proper goggles are available and used (see Chapter 5, Section C, “Eye Safety”).

13. **Shield the pump source.** Flashlamps or arc lamps are used to transmit energy into the laser material in solid-state lasers. The high-intensity light generated by those lamps should not be viewed directly. The broadband white light of the lamps is not completely blocked by laser safety glasses. Enclosure of the lamp in an opaque housing is essential.

Electrical Safety with Lasers

Helium–neon lasers employ high voltages similar to those employed inside a small television receiver. Capacitors within the power supply retain the potentially harmful voltage for some time after the input of power has ceased. Flashlamp power supplies typically involve higher stored energies and higher voltages than those involved in the helium–neon lasers. Maintenance of these systems, such as changing the lamps, requires direct personal contact with the high-voltage conductors.

School personnel must avoid the possibility of electrical shocks from high- and low-voltage equipment, including storage capacitors and power supplies. Disconnect the equipment from the primary power source and use proper techniques for the removal of stored energy before performing maintenance or service activities.

Each laser should be equipped with a UL-listed line cord and a grounded, three-prong plug. **Always plug the laser into a grounded outlet.**

Additionally, conductive optical tables must be effectively grounded.

Appendix A
Legal Citations

This appendix presents excerpts from the *EC,* the *CCR,* and the *HSC* on topics that are of special significance to science educators. Text in brackets represents a summary of the regulation.

Education Code

- School Eye Safety: Sections 32030, 32031, 32032, 32033
- Alternatives to Dissection: Sections 32255.1, 32255.3, 32255.4, 32255.5
- Earthquake Emergency Procedures: Sections 32282(a)(B)(ii), 35295, 35296, 35297, 40041.5
- Hazardous Materials Education: Sections 49340, 49341, 49401.5, 49411
- Instruction in Personal and Public Health and Safety: Section 51202
- Use of Animals in Public Instruction: Section 51540

***CCR,* Title 8,** General Industry Safety Orders

- Ventilation Requirements for Laboratory-Type Hood Operations: Section 5154.1
- Ventilation Requirements for Biological Safety Cabinets: Section 5154.2
- Emergency Eyewash and Shower Equipment: Section 5162
- Spill and Overflow Control: Section 5163
- Storage of Hazardous Substances: Section 5164
- Occupational Exposure to Hazardous Chemicals in Laboratories (Chemical Hygiene Plan): Section 5191
- Bloodborne Pathogens: Section 5193
- Hazard Communication; Standardized Safety Data Sheets: Section 5194

***CCR,* Title 22**

- Standards Applicable to Generators of Hazardous Waste: [Excerpts from] Section 66262.10 et seq.

Health and Safety Code

- Humane Care of Animals: Sections 1650, 1651, 1660, 1662
- Repeal of Requirement for Obtaining an Extremely Hazardous Waste Disposal Permit: Sections 25153, 25205.7(o)
- Transporting Hazardous Waste: Sections 25163, 25163.1
- Hazardous Materials Release Response Plans and Inventory: [Summary of] Section 25500 et seq.

School Eye Safety

***EC* Section 32030.** Duties regarding eye protective devices

It shall be the duty of the governing board of every school district, and of every county superintendent of schools, and of every person, firm, or organization maintaining any private school, in this state, to equip schools with eye protective devices as defined in *EC* Section 32032, for the use of all students, teachers, and visitors when participating in the courses which are included in *EC* Section 32031. It shall be the duty of the superintendents, principals, teachers or instructors charged with the supervision of any class in which any such course is conducted, to require such eye protective devices to be worn by students, teachers, or instructors and visitors under the circumstances prescribed in *EC* Section 32031.

***EC* Section 32031.** Courses in which devices are to be used; substances and activities dangerous to eyes

The eye protective devices shall be worn in courses including, but not limited to, vocational or industrial arts shops or laboratories, and chemistry, physics or combined chemistry-physics laboratories, at any time at which the individual is engaged in, or observing, an activity or the use of hazardous substances likely to cause injury to the eyes.

Hazardous substances likely to cause physical injury to the eyes include materials which are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition or other means as defined in the California Hazardous Substances Labeling Act.[8]

Activity or the use of hazardous substances likely to cause injury to the eyes includes, but is not necessarily limited to, the following:

1. Working with hot molten metal.
2. Milling, sawing, turning, shaping, cutting, grinding, and stamping of any solid materials.
3. Heat treating, tempering, or kiln firing of any metal or other materials.
4. Gas or electric arc welding.
5. Repairing or servicing of any vehicles, or other machinery or equipment.
6. Working with hot liquids or solids or with chemicals which are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition, or other means.

***EC* Section 32032.** Standards for devices

For purposes of this article the eye protective devices utilized shall be industrial quality eye protective devices which meet the standards of the American National Standards Institute for “Practice for Occupational and Educational Eye and Face Protection” (Z87.1–1968), and subsequent standards that are adopted by the American National Standards Institute for “Practice for Occupational and Educational Eye and Face Protection.”

***EC* Section 32033.** Sale of devices at cost to pupils and teachers

The eye protective devices may be sold to the pupils and teachers or instructors at a price which shall not exceed the actual cost of the eye protective devices to the school or governing board.

Alternatives to Dissection

***EC* Section 32255.1.** Notice to teacher of objection; development of alternate education project; prohibition of discrimination against pupil; note from parent or guardian:

(a) Except as otherwise provided in *EC* Section 32255.6, any pupil with a moral objection to dissecting or otherwise harming or destroying animals, or any parts thereof, shall notify his or her teacher regarding this objection, upon notification by the school of his or her rights pursuant to *EC* Section 32255.4.

[8] *HSC* Section 28740 et seq.

(b) If the pupil chooses to refrain from participation in an education project involving the harmful or destructive use of animals, and if the teacher believes that an adequate alternative education project is possible, then the teacher may work with the pupil to develop and agree upon an alternate education project for the purpose of providing the pupil an alternate avenue for obtaining the knowledge, information, or experience required by the course of study in question.

(c) The alternative education project shall require a comparable time and effort investment by the pupil. It shall not, as a means of penalizing the pupil, be more arduous than the original education project.

(d) The pupil shall not be discriminated against based upon his or her decision to exercise his or her rights pursuant to this chapter.

(e) Pupils choosing an alternative educational project shall pass all examinations of the respective course of study in order to receive credit for that course of study. However, if tests require the harmful or destructive use of animals, a pupil may, similarly, seek alternative tests pursuant to this chapter.

(f) A pupil's objection to participating in an educational project pursuant to this section shall be substantiated by a note from his or her parent or guardian.

***EC* Section 32255.3.** Teacher's determination whether pupil may pursue alternative educational project; pursuit of grievance procedures

(a) A teacher's decision in determining if a pupil may pursue an alternative educational project or be excused from the project shall not be arbitrary or capricious.

(b) Nothing in this chapter shall prevent any pupil from pursuing the grievance procedures in existing law.

***EC* Section 32255.4.** Duty to inform pupils of rights

Each teacher teaching a course that utilizes live or dead animals or animal parts shall also inform the pupils [and their parents] of their rights pursuant to this chapter.

***EC* Section 32255.5.** Application of chapter to all levels of instruction

Notwithstanding any provision of law to the contrary, this chapter applies to all levels of instruction in all public schools operating programs from kindergarten through grades 1 to 12, inclusive.

Earthquake Emergency Procedures

***EC* Section 32282(a)(B)(ii)**

Establishing a procedure to allow a public agency, including the American Red Cross, to use school buildings, grounds, and equipment for mass care and welfare shelters during disasters or other emergencies affecting the public health and welfare. The district or county office shall cooperate with the public agency in furnishing and maintaining the services as the district or county office may deem necessary to meet the needs of the community.

***EC* Section 35295.** Legislative findings and declarations

The Legislature finds and declares the following:

(a) Because of the generally acknowledged fact that California will experience moderate to severe earthquakes in the foreseeable future, increased efforts to reduce earthquake hazards should be encouraged and supported.

(b) In order to minimize loss of life and disruption, it is necessary for all public or private elementary schools and high schools to develop school disaster plans and specifically an earthquake emergency procedure system so that students and staff will act instinctively and correctly when an earthquake disaster strikes.

(c) It is therefore the intent of the Legislature in enacting this article to authorize the establishment of earthquake emergency procedure systems in kindergarten and grades 1 through 12 in all the public or private schools in California.

***EC* Section 35296.** Establishment of systems

The governing board of each school district and the county superintendent of schools of each county shall establish an earthquake emergency procedure system in every public school building under its jurisdiction having occupant capacity of 50 or more pupils or more than one classroom. The governing board of each private school shall establish an earthquake emergency procedure system in every private school building under its jurisdiction having an occupant capacity of 50 or more pupils or more than one classroom. Governing boards and county superintendents may work with the Office of Emergency Services and the Seismic Safety Commission to develop and establish the earthquake emergency procedure systems.

***EC* Section 35297.** Components of system

The earthquake emergency procedure system shall include, but not be limited to, all of the following:

(a) A school building disaster plan, ready for implementation at any time, for maintaining the safety and care of students and staffs.

(b) A drop procedure. As used in this article, “drop procedure” means an activity whereby each student and staff member takes cover under a table or desk, dropping to his or her knees, with the head protected by the arms, and the back to the windows. A drop procedure practice shall be held at least once each school quarter in elementary schools and at least once a semester in secondary schools.

(c) Protective measures to be taken before, during, and following an earthquake.

(d) A program to ensure that the students and that both the certificated and classified staff are aware of, and properly trained in, the earthquake emergency procedure system.

***EC* Section 40041.5.** Mass care and welfare shelters

The Governing Board shall grant the use of school buildings, grounds and equipment to public agencies, including the American Red Cross, for mass care and welfare shelters during disasters or other emergencies affecting the public health and welfare. The Board shall cooperate with such agencies in furnishing and maintaining whatever services it deems necessary to meet the community's needs.

Hazardous Materials Education

***EC* Section 49340.** This article shall be known and may be cited as the California Hazardous Materials Education Act of 1982.

EC Section 3 of Stats. 1982, c. 785, p. 3046, provides: “This act shall not be construed to impose any change in the duty of care required of school districts.”

***EC* Section 49341.** The Legislature hereby finds and declares as follows:

(a) Because school science laboratories pose a potentially serious threat to the health and safety of school pupils and school personnel due to the use and storage of hazardous materials in these laboratories, educational efforts are needed to increase the awareness of persons dealing with these materials in these settings so that possible losses of life, injuries, loss of property, and social disruption which could result from the improper and unsafe use of hazardous materials will be minimized.

(b) Effective safety in school laboratories requires informed judgment, decision making, and operating procedures by those responsible for laboratory and related instruction. It is desirable that each high school and junior high, middle, or elementary school offering laboratory work have a trained member of the professional staff who is designated as the building laboratory consultant and who **is responsible for the review, updating, and carrying out of the school's adopted procedures for laboratory safety**.

(c) Efforts by state and local agencies to implement training programs designed to provide qualified individuals with the necessary information, organizational skills, and materials to assist schools and teachers in the development of their laboratory safety policies and procedures are nonexistent or inadequate, and it is necessary that this situation be remedied. The state should assume leadership through the policy and guidance of the State Department of Education in the development, support, and implementation of a statewide training program.

(d) The Legislature requests that the Department of Education consider making this program a part of the department's energy and environmental education program which is conducted pursuant to Chapter 4 (commencing with Section 8700) of Part 6.

***EC* Section 49401.5.** Use and storage of hazardous materials; consultation services

(a) It is the intent of the Legislature in enacting this section to express its concern for the health and safety of school pupils and school personnel at schools where hazardous materials are stored on the school premises, and to encourage school districts to take steps to ensure hazardous materials are properly used and stored.

(b) The governing board of any school district may request consultation services from the California Occupational Safety and Health Consultation Service to ensure hazardous materials are being used and stored safely in school laboratories.

***EC* Section 49411.** Chemical listing; compounds used in school programs; listing; determination of shelf life; disposal

(a) The State Department of Education, in cooperation with the Division of Occupational Safety and Health within the Department of Industrial Relations, shall formulate **a listing of chemical compounds used in school programs that includes the potential hazards and estimated shelf life of each compound**.

(b) The Superintendent of Public Instruction, in cooperation with the Division of Occupational Safety and Health within the Department of Industrial Relations, shall develop guidelines for school districts for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed.

(c) The county superintendent of schools may implement a system for disposing of chemicals from schools within the county or may permit school districts to arrange for the disposal of the chemicals.

[See Appendix I of this handbook for information on the reimbursable costs of implementing *EC* Section 49411. *Ed.*]

Instruction in Personal and Public Health and Safety

***EC* Section 51202.** Personal and public safety and accident prevention

The adopted course of study shall provide instruction at the appropriate elementary and secondary grade levels and subject areas in personal and public safety and accident prevention, including emergency first aid instruction, instruction in hemorrhage control, treatment for poisoning, resuscitation techniques, and cardiopulmonary resuscitation when appropriate equipment is available; fire prevention; the protection and conservation of resources, including the necessity for the protection of our environment; and health, including venereal disease and the effects of alcohol, narcotics, drugs, and tobacco upon the human body. The health instruction may include prenatal care for pregnant women and violence as a public health issue.

Use of Animals in Public Instruction

EC **Section 51540.** Treatment of Animals

In the public elementary and high schools or in public elementary and high school school-sponsored activities and classes held elsewhere than on school premises, live vertebrate animals shall not, as part of a scientific experiment or any purpose whatever:

(a) Be experimentally medicated or drugged in a manner to cause painful reactions or induce painful or lethal pathological conditions.

(b) Be injured through any other treatments, including, but not limited to, anesthetization or electric shock.

Live animals on the premises of a public elementary or high school shall be housed and cared for in a humane and safe manner.

The provisions of this section are not intended to prohibit or constrain vocational instruction in the normal practices of animal husbandry.

CCR, Title 8, General Industry Safety Orders

Ventilation Requirements for Laboratory-Type Hood Operations
8 *CCR* 5154.1.

. . . Laboratory-Type Hood. A device enclosed except for necessary exhaust purposes on three sides and top and bottom, designed to draw air inward by means of mechanical ventilation, operated with insertion of only the hands and arms of the user, and in which hazardous substances are used. These devices are also known as laboratory fume hoods.

(c) Ventilation Rates.

(1) Laboratory-type hood face velocities shall be sufficient to maintain an inward flow of air at all openings into the hood under operating conditions. The hood shall provide confinement of the possible hazards and protection of the employees for the work which is performed. The exhaust system shall provide an average face velocity of at least 100 linear feet per minute (lfm) with a minimum of 70 lfm at any point, except where more stringent special requirements are prescribed in other sections of the General Industry Safety Orders, such as Section 5209. The minimum velocity

requirement excludes those measurements made within 1 inch of the perimeter of the work opening.

(2) When a laboratory-type hood is in use to contain airborne hazardous substances and no employee is in the immediate area of the hood opening, the ventilation rate may be reduced from the minimum average face velocity of at least 100 feet per minute to a minimum average face velocity of 60 feet per minute if the following conditions are met:

(A) The reduction in face velocity is controlled by an automatic system which does not require manual intervention. The automatic system shall increase the airflow to the flow required by (c)(1) when the hood is accessed.

(B) The laboratory-type hood has been tested at the reduced flow rate according to the tracer gas method specified in Section 7, Tracer Gas Test Procedure, of ANSI/ASHRAE 110-1995, Method of Testing Performance of Laboratory Fume Hoods, which is hereby incorporated by reference, and has a hood performance rating of 4.0 AU 0.1 or less. The test may be performed with or without the mannequin described in the ANSI/ASHRAE 110-1995 tracer gas method.

The tracer gas test need only be performed once per hood. However, if employers have chosen to perform the tracer gas test on subsequent occasions, it is the most recent record of test results and test configuration that shall be maintained pursuant to subsection (c)(2)(C).

(C) The record of the most recent tracer gas test results and the "as used" test configuration shall be maintained as long as the automatic system is operable and thereafter for five years.

(d) Operation. Mechanical ventilation shall remain in operation at all times when hoods are in use and for a sufficient time thereafter to clear hoods of airborne hazardous substances. When mechanical ventilation is not in operation, hazardous substances in the hood shall be covered or capped off.

(e) Special Requirements.

(1) The face velocity required by subsection (c) should be obtainable with the movable sashes fully opened. Where the required velocity can be obtained by partly closing the sash, the sash and/or jamb shall be marked to show the maximum opening at which

the hood face velocity will meet the requirements of subsection (c). Any hood failing to meet requirements of subsection (c) and this paragraph shall be considered deficient in airflow and shall be posted with placards, plainly visible, which prohibit use of hazardous substances within the hood.

(2) When flammable gases or liquids are used, or when combustible liquids are heated above their flashpoints, hoods that are not bypassed shall have permanent stops installed which will restrict closure of the sash so that sufficient airflow is maintained to prevent explosions. Concentrations in the duct shall not exceed 20% of the lower explosive limits.

(3) In addition to being tested as required by Section 5143(a)(5), hoods shall meet the following requirements:

(A) By January 1, 2008, hoods shall be equipped with a quantitative airflow monitor that continuously indicates whether air is flowing into the exhaust system during operation. The quantitative airflow monitor shall measure either the exact rate of inward airflow or the relative amount of inward airflow. Examples of acceptable devices that measure the relative amount of inward airflow include: diaphragm pressure gauges, inclined manometers, and vane gauges. The requirement for a quantitative airflow monitor may also be met by an airflow alarm system if the system provides an audible or visual alarm when the airflow decreases to less than 80% of the airflow required by subsection (c).

(B) Qualitative airflow measurements that indicate the ability of the hood to maintain an inward airflow at all openings of the hood as required by subsection (c)(1) shall be demonstrated using smoke tubes or other suitable qualitative methods. This demonstration shall be performed:

1. Upon initial installation;

2. On an annual basis;

Exception to subsection (3)(B)2.: The frequency of the tests may be reduced to every two years if a calibration and maintenance program is in place for the quantitative airflow monitor or alarm system.

3. After repairs or renovations of the hood or the ventilation system in that part of the facility where the hood is located; or

4. After the addition of large equipment into the hood.

(4) Exhaust stacks shall be located in such a manner with respect to air intakes as to preclude the recirculation of laboratory-type hood emissions within a building . . .

Ventilation Requirements for Biological Safety Cabinets
8 *CCR* 5154.2.

. . . (4) Biological safety cabinet. A ventilated cabinet which serves as a primary containment device for operations involving biohazard agents or biohazardous materials. Three classes of biological safety cabinets are described below:

Class I. The Class I biological safety cabinet is an open-fronted, negative pressure, ventilated cabinet. Exhaust air from the cabinet is filtered by a high-efficiency particulate air (HEPA) filter and discharged without internal recirculation. This cabinet may be used in three operational modes: with a full width open front, with an installed front closure panel not equipped with gloves, and with an installed front closure panel equipped with arm-length protective gloves.

Class II. The Class II vertical laminar flow biological safety cabinet is an open-fronted, ventilated cabinet. Exhaust air is filtered with a high-efficiency particulate air filter (HEPA). This cabinet provides HEPA-filtered downward air flow within the work space . . .

Class III. The Class III biological safety cabinet is a totally enclosed, negative pressure, ventilated cabinet of gas-tight construction . . .

Emergency Eyewash and Shower Equipment
8 *CCR* 5162.

(a) Plumbed or self-contained eyewash or eye/facewash equipment which meets the requirements of sections 5, 7, or 9 of ANSI Z358.1-1981, Emergency Eyewash and Shower Equipment, incorporated herein by this reference, shall be provided at all work areas where, during routine operations or foreseeable emergencies, the eyes of an employee may come into contact with a substance which can cause corrosion, severe irritation, or permanent tissue damage or which is toxic by absorption. Water hoses, sink faucets, or showers are not acceptable eyewash facilities. Personal eyewash units or drench hoses which meet the requirements of sections 6 or 8 of ANSI Z358.1-1981, incorporated herein by reference, may support plumbed or self-contained units but shall not be used in lieu of them.

(b) An emergency shower which meets the requirements of sections 4 or 9 of ANSI Z358.1-1981, incorporated herein by reference, shall be provided at all work areas where, during routine operations or foreseeable emergencies, areas of the body may come into contact with a substance which is corrosive or severely irritating to the skin or which is toxic by skin absorption.

(c) Location. Emergency eyewash facilities and deluge showers shall be in accessible locations that require no more than 10 seconds for the injured person to reach. If both an eyewash and shower are needed, they shall be located so that both can be used at the same time by one person. The area of the eyewash and shower equipment shall be maintained free of items which obstruct their use.

(d) Performance. Plumbed and self-contained eyewash and shower equipment shall supply potable water at the flow rate and time duration specified in ANSI Z358.1-1981. The control valve shall be designed so that the water flow remains on without requiring the use of the operator's hands, and so that the valve remains activated until intentionally shut off for all but hand-held drench hoses. Personal eyewash units shall deliver potable water or other eye-flushing solution approved by the consulting physician.

(e) Maintenance. Plumbed eyewash and shower equipment shall be activated at least monthly to flush the line and to verify proper operation. Other units shall be maintained in accordance with the manufacturer's instructions.

Spill and Overflow Control
8 *CCR* 5163.

(a) Where a corrosive substance is handled in an open container or drawn from a reservoir or pipe line, safe means shall be taken to neutralize or dispose of spills and overflows promptly . . .

Storage of Hazardous Substances
8 *CCR* 5164.

(a) Substances which, when mixed, react violently, or evolve toxic vapors or gases, or which in combination become hazardous by reason of toxicity, oxidizing power, flammability, explosibility, or other properties, shall be separated from each other in storage by distance, by partitions, or otherwise, so as to preclude accidental contact between them. . .

(b) Hazardous substances shall be stored in containers which are chemically inert to and appropriate for the type and quantity of the hazardous substance.

(c) Containers of hazardous substances shall not be stored in such locations or manner as to result in damage to the container. Containers shall not be stored where they are exposed to heat sufficient to rupture the containers or to cause leakage.

(d) Containers used to package a substance which gives off toxic, asphyxiant, suffocant, or anesthetic fumes in hazardous amounts (e.g., fuming sulfuric acid, hydrofluoric acid, compressed or liquefied toxic gases) shall not be stored in locations where it could be reasonably anticipated that employees would be exposed . . .

Occupational Exposure to Hazardous Chemicals in Laboratories (Chemical Hygiene Plan) 8 *CCR* 5191.

(a) Scope and Application.

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

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

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

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

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

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

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

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

(b) Definitions.

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

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

Chemical Hygiene Plan. A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that:

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

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

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

Laboratory use of hazardous chemicals. Handling or use of such chemicals in which all of the following conditions are met:

(1) Chemical manipulations are carried out on a “laboratory scale”;

(2) Multiple chemical procedures or chemicals are used;

(3) The procedures involved are not part of a production process, nor in any way simulate a production process; and

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

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

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

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

(1) It is regulated by CalOSHA as a carcinogen; or

(2) It is listed under the category “known to be carcinogens” in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) . . . ; or

(3) It is listed under Group 1 (“carcinogenic to humans”) by the International Agency for Research on Cancer Monographs (IARC) . . . ; or

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

(A) After inhalation exposure of 6–7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;

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

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

(c) Exposure limits. For laboratory uses of CalOSHA regulated substances, the employer shall ensure that laboratory employees’ exposures to such substances do not exceed the exposure limits specified in *CCR*, Title 8, Group 16, Section 5139 et seq., of the General Industry Safety Orders.

(d) Employee exposure determination.

(1) Initial monitoring. The employer shall measure the employee’s exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance exceed the action level (or in the absence of an action level, the exposure limit) . . .

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

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

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

(e) Chemical hygiene plan.

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

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

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

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

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

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

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

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

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

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

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

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

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

1. Establishment of a designated area;
2. Use of containment devices such as fume hoods or glove boxes;
3. Procedures for safe removal of contaminated waste; and
4. Decontamination procedures.

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

(f) Employee information and training.

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

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

(3) Information. Employees shall be informed of:

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

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

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

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

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

(4) Training.

(A) Employee training shall include:

1. Methods and observations that may be used to detect the presence or release of a hazardous chemical . . . ;

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

3. The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals . . .

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

(g) Medical consultation and medical examinations.

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

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

(3) . . . The employer shall provide the following information to the physician:

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

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

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

(4) Physician's written opinion.

(A) . . . The employer shall obtain a written opinion from the examining physician, which shall include the following:

1. Any recommendation for further medical follow-up;

2. The results of the medical examination and any associated tests; . . .

3. Any medical condition . . . which may place the employee at increased risk . . . ; and

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

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

(h) Hazard identification.

(1) With respect to labels and Standardized Safety Data Sheets:

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

(B) Employers shall maintain in the workplace any Standardized Safety Data Sheets that are received . . . and ensure that they are readily accessible to laboratory employees . . .

(i) Use of respirators.

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

(j) Recordkeeping.

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

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

(k) Dates.

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

Bloodborne Pathogens
8 *CCR* 5193.

(a) Scope and Application. This section applies to all occupational exposure to blood or other potentially infectious materials as defined by subsection (b) of this section.

(b) Definitions. For the purposes of this section, the following shall apply: . . .

"**Blood**" means human blood, human blood components, and products made from human blood.

"**Bloodborne Pathogens**" means pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV) . . .

"**Contaminated**" means the presence or the reasonably anticipated presence of blood or other potentially infectious materials on a surface or in or on an item.

"**Decontamination**" means the use of physical or chemical means to remove, inactivate, or destroy bloodborne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles and the surface or item is rendered safe for handling, use, or disposal. Decontamination includes procedures regulated by *HSC*, Section 11875.

"**Engineering Controls**" means controls (e.g., sharps disposal containers, needleless systems and sharps with engineered sharps injury protection) that isolate or remove the bloodborne pathogens hazard from the workplace.

“**Exposure Incident**” means a specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that results from the performance of an employee’s duties.

“**Handwashing Facilities**” means a facility providing an adequate supply of running potable water, soap, and single use towels or hot air drying machines.

“**HBV**” means hepatitis B virus.

“**HIV**” means human immunodeficiency virus . . .

“**Occupational Exposure**” means reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee’s duties.

“**One-Hand Technique**” means a procedure wherein the needle of a reusable syringe is capped in a sterile manner during use. The technique employed shall require the use of only the hand holding the syringe so that the free hand is not exposed to the uncapped needle.

“**Other Potentially Infectious Materials**” means:

(1) The following human body fluids: semen, vaginal secretions, cerespinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any other body fluid that is visibly contaminated with blood, such as saliva or vomitus, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids, such as emergency response;

(2) Any unfixed tissue or organ (other than intact skin) from a human (living or dead); and

(3) Any of the following, if known or reasonably likely to contain or be infected with HIV, HBV, or HCV:

(A) Cell, tissue, or organ cultures from humans or experimental animals;

(B) Blood, organs, or other tissues from experimental animals;

(C) Culture medium or other solutions.

“**Parenteral Contact**” means piercing mucous membranes or the skin barrier through such events as needlesticks, human bites, cuts, and abrasions.

“**Personal Protective Equipment**” is specialized clothing or equipment worn or used by an employee for protection against a hazard. General work clothes (e.g., uniforms, pants, shirts, or blouses) not intended to function as protection against a hazard are not considered to be personal protective equipment . . .

“**Regulated Waste**” means waste that is any of the following:

(1) Liquid or semi-liquid blood or OPIM;

(2) Contaminated items that:

(A) Contain liquid or semi-liquid blood, or are caked with dried blood or OPIM; and

(B) Are capable of releasing these materials when handled or compressed . . .

“**Source Individual**” means any individual, living or dead, whose blood or OPIM may be a source of occupational exposure to the employee. Examples include, but are not limited to, . . . trauma victims . . .

“**Universal Precautions**” is an approach to infection control. According to the concept of Universal Precautions, all human blood and certain human body fluids are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

“**Work Practice Controls**” means controls that reduce the likelihood of exposure by defining the manner in which a task is performed (e.g., prohibiting recapping of needles by a two-handed technique and use of patient-handling techniques).

(c) Exposure Response, Prevention and Control.

(1) Exposure Control Plan.

(A) Each employer having an employee(s) with occupational exposure as defined by subsection (b) of this section shall establish, implement and maintain an effective Exposure Control Plan which is designed to eliminate or minimize employee exposure and which is also consistent with Section 3203.

(B) The Exposure Control Plan shall be in writing and shall contain at least the following elements:

1. The exposure determination required by subsection (c)(3);

2. The schedule and method of implementation for each of the applicable subsections:
(d) Methods of Compliance, (e) HIV, HBV and HCV Research Laboratories and

Production Facilities, (f) Hepatitis B Vaccination and Post-exposure Evaluation and Follow-up, (g) Communication of Hazards to Employees, and (h) Recordkeeping, of this standard;

3. The procedure for the evaluation of circumstances surrounding exposure incidents as required by subsection (f)(3)(A) . . .

(C) Each employer shall ensure that a copy of the Exposure Control Plan is accessible to employees . . . in accordance with Section 3204(e).

(D) The Exposure Control Plan shall be reviewed and updated at least annually and whenever necessary as follows:

1. To reflect new or modified tasks and procedures which affect occupational exposure;

2. a. To reflect changes in technology that eliminate or reduce exposure to bloodborne pathogens; and

   b. To document consideration and implementation of appropriate commercially available needleless systems and needleless devices and sharps with engineered sharps injury protection;

3. To include new or revised employee positions with occupational exposure;

4. To review and evaluate the exposure incidents which occurred since the previous update;

5. To review and respond to information indicating that the Exposure Control Plan is deficient in any area . . .

(F) The Exposure Control Plan shall be made available to the Chief or NIOSH or their respective designee upon request for examination and copying . . .

(3) Exposure Determination.

(A) Each employer who has an employee(s) with occupational exposure shall prepare an exposure determination. This exposure determination shall contain the following:

1. A list of all job classifications in which all employees in those job classifications have occupational exposure;

2. A list of job classifications in which some employees have occupational exposure; and

3. A list of all tasks and procedures . . . in which occupational exposure occurs and that are performed by employees in job classifications listed in accordance with the provisions of subsection (c)(3)(A)2 of this standard.

(B) This exposure determination shall be made without regard to the use of personal protective equipment.

(d) Methods of Compliance.

(1) General. Universal precautions shall be observed to prevent contact with blood or other potentially infectious materials. Under circumstances in which differentiation between body fluid types is difficult or impossible, all body fluids shall be considered potentially infectious materials.

(2) Engineering and Work Practice Controls.

(A) Engineering and work practice controls shall be used to eliminate or minimize employee exposure.

(B) Engineering controls shall be examined and maintained or replaced on a regular schedule to ensure their effectiveness.

(C) Work practice controls shall be evaluated and updated on a regular schedule to ensure their effectiveness.

(D) All procedures involving blood or OPIM shall be performed in such a manner as to minimize splashing, spraying, spattering, and generation of droplets of these substances . . .

(B) Prohibited Practices.

1. Shearing or breaking of contaminated needles is prohibited.

2. Contaminated needles and other contaminated sharps shall not be bent, recapped, or removed from devices . . .

8. Mouth pipetting/suctioning of blood or OPIM is prohibited.

9. Eating, drinking, smoking, applying cosmetics or lip balm, and handling contact lenses are prohibited in work areas where there is a reasonable likelihood of occupational exposure.

10. Food and drink shall not be kept in refrigerators, freezers, shelves, cabinets, or on countertops or benchtops where blood or OPIM are present . . .

(F) Handling Specimens of Blood or OPIM.

Specimens of blood or OPIM shall be placed in a container which prevents leakage during collection, handling, processing, storage, transport, or shipping.

1. The container for storage, transport, or shipping shall be labeled or color-coded according to subsection (g)(1)(A) . . .

(I) Hygiene . . .

3. Employers shall ensure that employees wash their hands immediately or as soon as feasible after removal of gloves or other personal protective equipment.

4. Employers shall ensure that employees wash hands and any other skin with soap and water, or flush mucous membranes with water immediately or as soon as feasible following contact of such body areas with blood or OPIM.

(4) Personal Protective Equipment.

(A) Provision. When there is occupational exposure, the employer shall provide, at no cost to the employee, appropriate personal protective equipment such as, but not limited to, gloves, gowns, laboratory coats, face shields or masks and eye protection, and mouthpieces, resuscitation bags, pocket masks, or other ventilation devices. Personal protective equipment will be considered “appropriate” only if it does not permit blood or OPIM to pass through to or reach the employee’s work clothes, street clothes, undergarments, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time which the protective equipment will be used . . .

(B) Use. The employer shall ensure that the employee uses appropriate personal protective equipment unless the employer shows that the employee temporarily and briefly declined to use personal protective equipment when, under rare and extraordinary circumstances, it was the employee’s professional judgment that in the specific instance its use would have prevented the delivery of health care or public safety services or would have posed an increased hazard to the safety of the worker or co-worker. When the employee makes this judgment, the circumstances shall be investigated and documented in order to determine whether changes can be instituted to prevent such occurrences in the future. The employer shall encourage employees to report all such instances without fear of reprisal in accordance with Section 3203.

(C) Accessibility. The employer shall ensure that appropriate personal protective equipment in the appropriate sizes is readily accessible at the worksite or is issued to employees. Hypoallergenic gloves, glove liners, powderless gloves, or other similar alternatives shall be readily accessible to those employees who are allergic to the gloves normally provided.

(D) Cleaning, Laundering and Disposal. The employer shall clean, launder, and dispose of personal protective equipment required by subsections (d) and (e) of this standard, at no cost to the employee.

(E) Repair and Replacement. The employer shall repair or replace personal protective equipment as needed to maintain its effectiveness, at no cost to the employee.

(F) Removal.

1. If a garment(s) is penetrated by blood or other potentially infectious materials, the garment(s) shall be removed immediately or as soon as feasible.
2. All personal protective equipment shall be removed prior to leaving the work area.
3. When personal protective equipment is removed it shall be placed in an appropriately designated area or container for storage, washing, decontamination, or disposal.

(G) Gloves shall be worn when it can be reasonably anticipated that the employee may have hand contact with blood, OPIM, mucous membranes, and non-intact skin; when performing vascular access procedures except as specified in subsection (d)(4)(G)4; and when handling or touching contaminated items or surfaces. These requirements are in addition to the provisions of Section 3384.

1. Disposable (single use) gloves, such as surgical or examination gloves, shall be replaced as soon as practical when contaminated or as soon as feasible if they are torn, punctured, or when their ability to function as a barrier is compromised.

2. Disposable (single use) gloves, shall not be washed or decontaminated for re-use.

3. Utility gloves may be decontaminated for re-use if the integrity of the glove is not compromised. However, they must be discarded if they are cracked, peeling, torn, punctured, or exhibit other signs of deterioration or when their ability to function as a barrier is compromised . . .

(H) Masks, Eye Protection, Face Shields, and Respirators.

1. Masks in combination with eye protection devices, such as goggles or glasses with solid side shields, or chin-length face shields, shall be worn whenever splashes, spray, spatter, or droplets of blood or other potentially infectious materials may be generated and eye, nose, or mouth contamination can be reasonably anticipated. These requirements are in addition to the provisions of Section 3382.

2. Where respiratory protection is used, the provisions of Sections 5144 and 5147 are required as applicable . . .

(I) Gowns, Aprons, and Other Protective Body Clothing.

1. Appropriate protective clothing, such as, but not limited to, gowns, aprons, lab coats, clinic jackets, or similar outer garments, shall be worn in occupational exposure situations. The type and characteristics will depend upon the task and degree of exposure anticipated. These requirements are in addition to the provisions of Section 3383 . . .

(f) Hepatitis B Vaccination and Post-exposure Evaluation and Follow-up.

(1) General

(A) The employer shall make available the hepatitis B vaccine and vaccination series to all employees who have occupational exposure, and post-exposure evaluation and follow-up to all employees who have had an exposure incident . . .

EXCEPTION: Designated first aid providers who have occupational exposure are not required to be offered pre-exposure hepatitis B vaccine if the following conditions exist:

1. The primary job assignment of such designated first aid providers is not the rendering of first aid.

   a. Any first aid rendered by such persons is rendered only as a collateral duty responding solely to injuries resulting from workplace incidents, generally at the location where the incident occurred . . .

2. The employer's Exposure Control Plan, subsection (c)(1), shall specifically address the provision of hepatitis B vaccine to all unvaccinated first aid providers who have rendered assistance in any situation involving the presence of blood or OPIM (regardless of whether an actual exposure incident, as defined by subsection (b), occurred) and the provision of appropriate post-exposure evaluation, prophylaxis and follow-ups for those employees who experience an exposure incident as defined in subsection (b), including:
   a. Provisions for a reporting procedure that ensures that all first aid incidents involving the presence of blood or other potentially infectious material shall be reported to the employer before the end of the work shift during which the first aid incident occurred.
      i. The report must include the names of all first aid providers who rendered assistance, regardless of whether personal protective equipment was used and must describe the first aid incident, including time and date.
         A. The description must include a determination of whether or not, in addition to the presence of blood or other potentially infectious material, an exposure incident, as defined in subsection (b) occurred.
         B. This determination is necessary in order to ensure that the proper post-exposure evaluation, prophylaxis and follow-up procedures required by subsection (f)(3) are made available immediately if there has been an exposure incident, as defined in subsection (b).
      ii. The report shall be recorded on a list of such first aid incidents. It shall be readily available to all employees and shall be provided to the Chief upon request.
   b. Provision for the bloodborne pathogens training program, required by subsection (g)(2), for designated first aiders to include the specifics of the reporting requirements of subsection (f)(3) and of this exception.

c. Provision for the full hepatitis B vaccination series to be made available as soon as possible, but in no event later than 24 hours, to all unvaccinated first aid providers who have rendered assistance in any situation involving the presence of blood or OPIM regardless of whether or not a specific exposure incident, as defined by subsection (b), has occurred.

3. The employer must implement a procedure to ensure that all of the provisions of subsection 2 of this exception are complied with if pre-exposure hepatitis B vaccine is not to be offered to employees meeting the conditions of subsection 1 of this exception.

(B) The employer shall ensure that all medical evaluations and procedures, including the hepatitis B vaccine and vaccination series and post-exposure evaluation and follow-up, including prophylaxis, are:

1. Made available at no cost to the employee;
2. Made available to the employee at a reasonable time and place;
3. Performed by or under the supervision of a licensed physician or by or under the supervision of another licensed healthcare professional; and
4. Provided according to recommendations of the U.S. Public Health Service current at the time these evaluations and procedures take place, except as specified by this subsection (f).

(C) The employer shall ensure that all laboratory tests are conducted by an accredited laboratory at no cost to the employee.

(2) Hepatitis B Vaccination.

(A) Hepatitis B vaccination shall be made available after the employee has received the training required in subsection (g)(2)(G)9 and within 10 working days of initial assignment to all employees who have occupational exposure unless the employee has previously received the complete hepatitis B vaccination series, antibody testing has revealed that the employee is immune, or the vaccine is contraindicated for medical reasons.

(B) The employer shall not make participation in a prescreening program a prerequisite for receiving hepatitis B vaccination.

(C) If the employee initially declines hepatitis B vaccination but at a later date while still covered under the standard decides to accept the vaccination, the employer shall make available hepatitis B vaccination at that time.

(D) The employer shall assure that employees who decline to accept hepatitis B vaccination offered by the employer sign the statement in Appendix A.

(E) If a routine booster dose(s) of hepatitis B vaccine is recommended by the U.S. Public Health Service at a future date, such booster dose(s) shall be made available in accordance with section (f)(1)(B).

(3) Post-exposure Evaluation and Follow-up.

Following a report of an exposure incident, the employer shall make immediately available to the exposed employee a confidential medical evaluation and follow-up, including at least the following elements:

(A) The employer shall document the route(s) of exposure, and the circumstances under which the exposure incident occurred;

(B) The employer shall identify and document the source individual, unless the employer can establish that identification is infeasible or prohibited by state or local law;

1. The source individual's blood shall be tested as soon as feasible and after consent is obtained in order to determine HBV and HIV infectivity. If consent is not obtained, the employer shall establish that legally required consent cannot be obtained. When the source individual's consent is not required by law, the source individual's blood, if available, shall be tested and the results documented.
2. When the source individual is already known to be infected with HBV or HIV, testing for the source individual's known HBV or HIV status need not be repeated.
3. Results of the source individual’s testing shall be made available to the exposed employee, and the employee shall be informed of applicable laws and regulations concerning disclosure of the identity and infectious status of the source individual.

(C) The employer shall provide for collection and testing of the employee’s blood for HBV, HCV and HIV serological status;

1. The exposed employee's blood shall be collected as soon as feasible and tested after consent is obtained.
2. If the employee consents to baseline blood collection, but does not give consent at that time for HIV serologic testing, the sample shall be preserved for at least 90 days. If, within 90 days of the exposure incident, the employee elects to have the baseline sample tested, such testing shall be done as soon as feasible.
3. Additional collection and testing shall be made available as recommended by the U.S. Public Health Service

(D) The employer shall provide for post-exposure prophylaxis, when medically indicated, as recommended by the U.S. Public Health Service;

(E) The employer shall provide for counseling and evaluation of reported illnesses.

(4) Information Provided to the Healthcare Professional.

(A) The employer shall ensure that the healthcare professional responsible for the employee’s hepatitis B vaccination is provided a copy of this regulation.

(B) The employer shall ensure that the healthcare professional evaluating an employee after an exposure incident is provided the following information:

1. A copy of this regulation;
2. A description of the exposed employee’s duties as they relate to the exposure incident;
3. Documentation of the route(s) of exposure and circumstances under which exposure occurred, as required by subsection (f)(3)(A);
4. Results of the source individual’s blood testing, if available; and
5. All medical records relevant to the appropriate treatment of the employee, including vaccination status, which are the employer’s responsibility to maintain, as required by subsection (h)(1)(B)2.

(5) Healthcare Professional's Written Opinion.

The employer shall obtain and provide the employee with a copy of the evaluating healthcare professional's written opinion within 15 days of the completion of the evaluation.

(A) The healthcare professional's written opinion for hepatitis B vaccination shall be limited to whether hepatitis B vaccination is indicated for the employee, and if the employee has received such vaccination.

(B) The healthcare professional's written opinion for post-exposure evaluation and follow-up shall be limited to the following information:

1. That the employee has been informed of the results of the evaluation; and
2. That the employee has been told about any medical conditions resulting from exposure to blood or OPIM which require further evaluation or treatment.

(C) All other findings or diagnoses shall remain confidential and shall not be included in the written report.

(6) Medical Recordkeeping.

Medical records required by this standard shall be maintained in accordance with subsection (h)(1) of this section.

(g) Communication of Hazards to Employees.

(1) Labels and Signs.

(A) Labels.

1. Warning labels shall be affixed to containers of regulated waste; refrigerators and freezers containing blood or other potentially infectious material; and other containers used to store, transport, or ship blood or other potentially infectious materials, except as provided in subsection (g)(1)(A)5, 6, and 7. Note: Other labeling provisions such as HSC Sections 25080–25082 may be applicable.

2. Labels required by this section shall include either the following legend as required by Section 3341:

BIOHAZARD

Or, in the case of regulated waste the legend:

BIOHAZARDOUS WASTE or SHARPS WASTE

as described in *Health and Safety Code* Sections 118275 through 118320.

3. These labels shall be fluorescent orange or orange-red or predominantly so with lettering and symbols in a contrasting color.
4. Labels required by subsection (g)(1)(A) shall either be an integral part of the container or shall be affixed as close as feasible to the container by string, wire, adhesive, or other method that prevents their loss or unintentional removal.
5. Red bags or red containers may be substituted for labels except for sharp containers or regulated waste red bags. Bags used to contain regulated waste shall be color-coded red and shall be labeled in accordance with subsection (g)(1)(A)2. Labels on red bags or red containers do not need to be color-coded in accordance with subsection (g)(1)(A)3.
6. Containers of blood, blood components, or blood products that are labeled as to their contents and have been released for transfusion or other clinical use are exempted from the labeling requirements of subsection (g).
7. Individual containers of blood or OPIM that are placed in a labeled container during storage, transport, shipment or disposal are exempted from the labeling requirement.
8. Labels required for contaminated equipment shall be in accordance with this subsection and shall also state which portions of the equipment remain contaminated.

9. Regulated waste that has been decontaminated need not be labeled or color-coded . . .

(2) Information and Training.

(A) Employers shall ensure that all employees with occupational exposure participate in a training program which must be provided at no cost to the employee and during working hours.

(B) Training shall be provided as follows:

1. At the time of initial assignment to tasks where occupational exposure may take place;

2. At least annually thereafter.

(C) For employees who have received training on bloodborne pathogens in the year preceding the effective date of the standard, only training with respect to the provisions of the standard which were not included need be provided.

(D) Annual training for all employees shall be provided within one year of their previous training.

(E) Employers shall provide additional training when changes, such as introduction of new engineering, administrative or work practice controls, modification of tasks or procedures or institution of new tasks or procedures affect the employee's occupational exposure. The additional training may be limited to addressing the new exposures created.

(F) Material appropriate in content and vocabulary to educational level, literacy, and language of employees shall be used.

(G) The training program shall contain at a minimum the following elements:

1. Copy and Explanation of Standard. An accessible copy of the regulatory text of this standard and an explanation of its contents;

2. Epidemiology and Symptoms. A general explanation of the epidemiology and symptoms of bloodborne diseases;

3. Modes of Transmission. An explanation of the modes of transmission of bloodborne pathogens;

4. Employer's Exposure Control Plan. An explanation of the exposure control plan and the means by which the employee can obtain a copy of the written plan;
5. Risk Identification. An explanation of the appropriate methods for recognizing tasks and other activities that may involve exposure to blood and other potentially infectious materials;
6. Methods of Compliance. An explanation of the use and limitations of methods that will prevent or reduce exposure including appropriate engineering controls, work practices, and personal protective equipment;
7. Decontamination and Disposal. Information on the types, proper use, location, removal, handling decontamination and disposal of personal protective equipment;
8. Personal Protective Equipment. An explanation of the basis for selection of personal protective equipment;
9. Hepatitis B Vaccination. Information on the hepatitis B vaccine, including information on its efficacy, safety, method of administration, the benefits of being vaccinated, and that the vaccine and vaccination will be offered free of charge;
10. Emergency. Information on appropriate actions to take and persons to contact in an emergency involving blood or other potentially infectious materials;
11. Exposure Incident. An explanation of the procedure to follow if an exposure incident occurs, including the method of reporting the incident and the medical follow-up that will be made available;
12. Post-Exposure Evaluation and Follow-up. Information on the post-exposure evaluation and follow-up that the employer is required to provide for the employee following an exposure incident;
13. Signs and Labels. An explanation of the signs and labels and/or color coding required by subsection (g)(1); and
14. Interactive Questions and Answers. An opportunity for interactive questions and answers with the person conducting the training session . . .

(H) The person conducting the training shall be knowledgeable in the subject matter covered by the elements contained in the training program as it relates to the workplace that the training will address.

(h) Recordkeeping.

(1) Medical Records.

(A) The employer shall establish and maintain an accurate record for each employee with occupational exposure, in accordance with Section 3204.

(B) This record shall include:

1. The name and social security number of the employee;
2. A copy of the employee’s hepatitis B vaccination status, including the dates of all the hepatitis B vaccinations and any medical records relative to the employee’s ability to receive vaccination as required by subsection (f)(2);
3. A copy of all results of examinations, medical testing, and follow-up procedures as required by subsection (f)(3);
4. The employer’s copy of the healthcare professional’s written opinion as required by subsection (f)(5); and
5. A copy of the information provided to the healthcare professional as required by subsections (f)(4)(B)2, 3, and 4.

(C) Confidentiality. The employer shall ensure that employee medical records required by subsection (h)(1) are:

1. Kept confidential; and
2. Not disclosed or reported without the employee’s express written consent to any person within or outside the workplace except as required by this section or as may be required by law.

(D) The employer shall maintain the records required by subsection (h)(1) for at least the duration of employment plus 30 years in accordance with Section 3204.

(2) Training Records.

(A) Training records shall include the following information:

1. The dates of the training sessions;

2. The contents or a summary of the training sessions;

3. The names and qualifications of persons conducting the training; and

4. The names and job titles of all persons attending the training sessions.

(B) Training records shall be maintained for 3 years from the date on which the training occurred . . .

(4) Availability.

(A) The employer shall ensure that all records required to be maintained by this section shall be made available upon request to the Chief and NIOSH for examination and copying.

(B) Employee training records required by this subsection shall be provided upon request for examination and copying to employees to employee representatives, to the Chief, and to NIOSH.

(C) Employee medical records required by this subsection shall be provided upon request for examination and copying to the subject employee, to anyone having written consent of the subject employee, to the Chief, and to NIOSH in accordance with Section 3204.

(4) Transfer of Records.

(A) The employer shall comply with the requirements involving transfer of records set forth in Section 3204.

(B) If the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer shall notify NIOSH at least three months prior to their disposal and transmit them to the NIOSH, if required by the NIOSH to do so, within that three month period.

(i) Appendix.

Appendix A to this section is incorporated as a part of this section and the provision is mandatory.

Appendix A: Hepatitis B Vaccine Declination (MANDATORY)

The employer shall assure that employees who decline to accept hepatitis B vaccination offered by the employer sign the following statement as required by subsection (f)(2)(D):

I understand that due to my occupational exposure to blood or other potentially infectious materials I may be at risk of acquiring hepatitis B virus (HBV) infection. I have been given the opportunity to be vaccinated with hepatitis B vaccine, at no charge to myself. However, I decline hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with hepatitis B vaccine, I can receive the vaccination series at no charge to me.

Hazard Communication; Standardized Safety Data Sheets
8 *CCR* 5194.

(b) Scope and Application

(1) This section requires . . . all employers to provide information to their employees about the hazardous substances to which they may be exposed, by means of a hazard communication program, labels and other forms of warning, Standardized Safety Data Sheets, and information and training . . .

(2) This section applies to any hazardous substance which is known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a reasonably foreseeable emergency resulting from workplace operations.

(3) This section applies to laboratories that primarily provide quality control analyses for manufacturing processes or that produce hazardous substances for commercial purposes, and to all other laboratories **except those under the direct supervision and regular observation of an individual who has knowledge of the physical hazards, health hazards, and emergency procedures associated with the use of the particular hazardous substances involved, and who conveys this knowledge to employees in terms of safe work practices** [emphasis added]. Such excepted laboratories must also ensure that labels of incoming containers of hazardous substances are not removed or defaced . . . and must maintain any Standardized Safety Data Sheets that are received with incoming shipments of hazardous substances and ensure that they are readily available to laboratory employees . . .

(d) Hazard Determination.

(1) Manufacturers and importers shall evaluate substances produced in their workplaces or imported by them to determine if they are hazardous. **Employers are not required to evaluate substances unless they choose not to rely on the evaluation performed by the manufacturer or importer for the substance to satisfy this requirement** *. . .* [emphasis added].

(e) Written Hazard Communication Program.

(1) Employers shall develop, implement, and maintain at the workplace a written hazard communication program for their employees which at least describes how the criteria specified in sections 5194(f), (g), and (h) for labels and other forms of warning, Standardized Safety Data Sheets, and employee information and training will be met, and which also includes the following:

(A) A list of the hazardous substances known to be present using an identity that is referenced on the appropriate Standardized Safety Data Sheet (the list may be compiled for the workplace as a whole or for individual work areas);

(B) The methods the employer will use to inform employees of the hazards of nonroutine tasks (for example, the cleaning of reactor vessels) and the hazards associated with substances contained in unlabeled pipes in their work areas.

(2) . . . the written hazard communication program shall include the methods employers will use to inform any employers sharing the same work area of the hazardous substances to which their employees may be exposed while performing their work, and any suggestions for appropriate protective measures . . .

(3) The employer shall make the written hazard communication program available, upon request, to employees, their designated representatives, the Chief, and NIOSH, in accordance with the requirements of Section 3204(e).

(f) Labels and Other Forms of Warning.

(1) The manufacturer, importer, or distributor shall ensure that each container of hazardous substances leaving the workplace is labeled, tagged, or marked with the following information:

(A) Identity of the hazardous substance(s);

(B) Appropriate hazard warnings; and

(C) Name and address of the manufacturer, importer, or other responsible party . . .

(2) Manufacturers, importers, or distributors shall ensure that each container of hazardous substances leaving the workplace is labeled, tagged, or marked in accordance with this section in a manner which does not conflict with the requirements of the Hazardous Materials Transportation Act (18 *U.S.C.* 1801 et seq.) and regulations issued under that Act by the Department of Transportation.

(3) If the hazardous substance is regulated by these orders in a substance-specific health standard, the manufacturer, importer, distributor, or employer shall ensure that the labels or other forms of warning used are in accordance with the requirements of that standard.

(4) Except as provided in sections 5194(f)(5) and (f)(6) the employer shall ensure that each container of hazardous substances in the workplace is labeled, tagged, or marked with the following information:

(A) Identity of the hazardous substance(s) contained therein; and

(B) Appropriate hazard warnings.

(5) The employer may use signs, placards, process sheets, batch tickets, operating procedures, or other such written materials in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the information required by Section 5194(f)(4) to be on a label. The written materials shall be readily accessible to the employees in their work area throughout each work shift . . .

(6) The employer is not required to label portable containers into which hazardous substances are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer . . .

(7) The employer shall not remove or intentionally deface existing labels on incoming containers of hazardous substances, unless the container is immediately marked with the required information.

(8) The employer shall ensure that labels or other forms of warning are legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. Employers having employees who speak other languages

may add the information in their language to the material presented, as long as the information is presented in English as well.

(9) The manufacturer, importer, distributor, or employer need not affix new labels to comply with this section if existing labels already convey the required information.

(g) Standardized Safety Data Sheets.

(1) . . . Employers shall have a Standardized Safety Data Sheet for each hazardous substance which they use.

Note to (g)(1): Employers should also refer to Section 3204 concerning information to be retained after a particular substance is no longer in use.

(2) . . . Standardized Safety Data Sheet shall be in English (although the employer may maintain copies in other languages as well) and includes at least the following . . . information from the Guide to the California Hazard Communication Regulations (://www.dir.ca.gov/dosh/dosh_publications/hazcom.) :

(A) The identity used on the label, and, except as provided for in Section 5194(i) on trade secrets:

1. If the hazardous substance is a single substance, its chemical and common name(s) and CAS number(s);

2. If the hazardous substance is a mixture which has been tested as a whole to determine its hazards, the chemical, common name(s), and CAS number(s) of the ingredients which contribute to these known hazards, and the common name(s) of the mixture itself; or,

3. If the hazardous substance is a mixture which has not been tested as a whole:

   a. The chemical and common name(s), and CAS number(s) of all ingredients which have been determined to be health hazards, and which comprise 1% or greater of the composition, except that substances identified as carcinogens under subsection 5194(d)(4) shall be listed if the concentrations are 0.1% or greater;

   b. The chemical and common name(s), and CAS number(s) of all ingredients which comprise less than 1% (0.1% for carcinogens) of the mixture, if there is evidence that the ingredient(s) could be released from the mixture in concentrations which would exceed an established OSHA permissible exposure limit or ACGIH Threshold Limit Value, or could present a health hazard to employees; and,

c. The chemical, common name(s) and CAS number(s) of all ingredients which have been determined to present a physical hazard when present in the mixture;

(B) Physical and chemical properties of the hazardous substance (such as vapor pressure, flashpoint);

(C) The physical hazards of the hazardous substance, including the potential for fire, explosion, and reactivity;

(D) The health hazards of the hazardous substance, including signs and symptoms of exposure, and any medical conditions which are generally recognized as being aggravated by exposure to the substance;

(E) The potential route(s) of entry;

(F) The OSHA permissible exposure limit, ACGIH Threshold Limit Value, and any other exposure limit used or recommended by the manufacturer, importer, or employer preparing the Standardized Safety Data Sheet, where available;

(G) Whether the hazardous substance is listed in the National Toxicology Program (NTP) Annual Report on Carcinogens latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs, (latest editions), or by OSHA;

(H) Any generally applicable precautions for safe handling and use which are known to the manufacturer, importer, or employer preparing the Standardized Safety Data Sheet, including the appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for cleanup of spills and leaks;

(I) Any generally applicable control measures which are known to the manufacturer, importer, or employer preparing the Standardized Safety Data Sheet, such as appropriate engineering controls, work practices, or personal protective equipment;

(J) Emergency and first-aid procedures;

(K) The date of preparation of the Standardized Safety Data Sheet or the last change to it;

(L) The name, address and telephone number of the manufacturer, importer, employer, or other responsible party preparing or distributing the Standardized Safety Data Sheet, who can provide additional information on the hazardous substance and appropriate emergency procedures, if necessary; and,

(M) A description in lay terms, if not otherwise provided, on either a separate sheet or with the body of the information specified in this section, of the specific potential health risks posed by the hazardous substance intended to alert any person reading the information . . .

(8) The employer shall maintain copies of the required Standardized Safety Data Sheets for each hazardous substance in the workplace, and shall ensure that they are readily accessible during each work shift to employees when they are in their work area(s) . . .

(10) Standardized Safety Data Sheets may be kept in any form, including operating procedures, and may be designed to cover groups of hazardous substances in a work area where it may be more appropriate to address the hazards of a process rather than individual hazardous substances . . .

(11) Standardized Safety Data Sheets shall also be made readily available, upon request, to designated representatives, and to the Chief, in accordance with the requirements of Section 3204(e). NIOSH and the employee's physician shall also be given access to Standardized Safety Data Sheets in the same manner.

(12) If the Standardized Safety Data Sheet, or any item of information required by Section 5194(g)(2), is not provided by the manufacturer or importer, the employer shall:

(A) Within 7 working days of noting this missing information, either from a request or in attempting to comply with section 5194(1), make written inquiry to the manufacturer or importer of a hazardous substance responsible for the Standardized Safety Data Sheet, asking that the complete Standardized Safety Data Sheet be sent to the employer. If the employer has made written inquiry in the preceding 12 months as to whether the substance or product is subject to the requirements of the Act or the employer has made written inquiry within the last 6 months requesting new, revised or later information on the Standardized Safety Data Sheet for the hazardous substance, the employer need not make additional written inquiry.

(B) Notify the requester in writing of the date that the inquiry was made, to whom it was made, and the response, if any, received. Providing the requestor with a copy of the inquiry sent to the manufacturer, producer or seller and a copy of the response will satisfy this requirement.

(C) Notify the requestor of the availability of the Standardized Safety Data Sheet within 15 days of the receipt of the Standardized Safety Data Sheet from the manufacturer, producer or seller or provide a copy of the Standardized Safety Data Sheet to the requestor within 15 days of the receipt of the Standardized Safety Data Sheet from the manufacturer, producer or seller.

(D) Send the Director [of Industrial Relations] a copy of the written inquiry if a response has not been received within 25 working days.

(13) The preparer of a Standardized Safety Data Sheet shall provide the Director with a copy of the Standardized Safety Data Sheet. Where a trade secret claim is made, the preparer shall submit the information specified in Section 5194(i)(15).

(h) Employee Information and Training.

(1) Employers shall provide employees with information and training on hazardous substances in their work area at the time of their initial assignment, and whenever a new hazard is introduced into their work area. Information and training may relate to general classes of hazardous substances to the extent appropriate and related to reasonably foreseeable exposures of the job.

(2) Information and training shall consist of at least the following topics:

(A) Employees shall be informed of the requirements of this section.

(B) Employees shall be informed of any operations in their work area where hazardous substances are present.

(C) Employees shall be informed of the location and availability of the written hazard communication program . . .

(D) Employees shall be trained in the methods and observations that may be used to detect the presence or release of a hazardous substance in the work area (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous substances when being released, etc.).

(E) Employees shall be trained in the physical and health hazards of the substances in the work area, and the measures they can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous substances, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(F) Employees shall be trained in the details of the hazard communication program developed by the employer, including an explanation of the labeling system and the Standardized Safety Data Sheet, and how employees can obtain and use the appropriate hazard information.

(G) Employers shall inform employees of the right:

1. To personally receive information regarding hazardous substances to which they may be exposed, according to the provisions of this section;
2. For their physician or collective bargaining agent to receive information regarding hazardous substances to which the employee may be exposed according to provisions of this section;
3. Against discharge or other discrimination due to the employee's exercise of the rights afforded pursuant to the provisions of the Hazardous Substances Information and Training Act.

(3) Whenever the employer receives a new or revised Standardized Safety Data Sheet, such information shall be provided to employees on a timely basis not to exceed 30 days after receipt, if the new information indicates significantly increased risks to, or measures necessary to protect, employee health as compared to those stated on a Standardized Safety Data Sheet previously provided.

(i) Trade Secrets.

[**Note:** The text is not included here. This section provides for the withholding of the specific chemical identity of trade secrets on Standardized Safety Data Sheets as long as information concerning the properties and effects of the hazardous substance is disclosed. If a physician or nurse determines that a medical emergency exists and the chemical identity of the substance is necessary for treatment, the chemical identity must be disclosed immediately. A confidentiality agreement may be a provision of the disclosure. *Ed.*]

[Appendices A through D to Section 5194 are not reprinted here. The titles of those appendices are as follows:

Appendix A: Health Hazard Definitions (Mandatory)

Appendix B: Hazard Determination (Mandatory) [outlines the principles and procedures of hazard assessment]

Appendix C: Information Sources (Advisory) [gives a list of data sources that may be consulted to evaluate the hazards of substances]

Appendix D: Definition of "Trade Secret" (Mandatory)]

CCR, **Title 22**

Identification Numbers for the Generator [of Hazardous Waste]
22 *CCR* 66262.12.

(a) Except as specified in (d), a generator shall not treat, store, dispose of, transport or offer for transportation, hazardous waste without having received an Identification Number.

(b) A generator who has not received an Identification Number may obtain one by applying to the Administrator or to the Department using EPA form 8700-12 (Revised 12/99). Following receipt of the request, the generator will be assigned an identification number.

(c) A generator shall not offer the hazardous waste to transporters or to transfer, treatment, storage or disposal facilities that have not received an Identification Number.

(d) Generators who generate no more than 100 kilograms of waste per month that is hazardous solely due to the presence of silver in the waste pursuant to *HSC* Section 25143.13 are not required to obtain an Identification Number.

Note: Authority cited: Sections 208, 25150 and 25159, *Health and Safety Code.* Reference: Sections 25143.13, 25159, 25159.5 and 25160.2, *Health and Safety Code;* and 40 *Code of Federal Regulations* sections 261.5 and 262.12.

General Requirements.
22 *CCR* 66262.20.

(a) For shipments initiated before September 5, 2006, a generator, except those generators identified in subsection (a)(1), who transports, or offers for transportation, hazardous waste for off-site transfer, treatment, storage, or disposal shall prepare a Manifest, DTSC Form 8022A (4/97), and if necessary, the EPA continuation Form 8700-22A, according to the instructions included in the appendix to Chapter 12 of this division before the waste is transported off-site. Before September 5, 2006, all manifest requests should be submitted to the following agency:

Legislative Bill Room

State Capitol Room B-32

Sacramento, CA 95814

For further information with regard to manifest ordering and associated fees, contact (916) 445-5357.

For shipments initiated on and after September 5, 2006, a generator, except those generators identified in subsection (a)(1), who transports, or offers for transport a hazardous waste for off-site transfer, treatment, storage, or disposal, or a treatment, storage, and disposal facility who offers for transport a rejected hazardous waste load, shall prepare a Uniform Hazardous Waste Manifest (OMB Control number 2050-0039) on EPA Form 8700-22, and, if necessary, a Continuation Sheet on EPA Form 8700-22A, according to the instructions included in the appendix to Chapter 12 of this division before the waste is transported off-site.

Compliance with the revisions to the Manifest form and procedures announced in the regulations published by EPA on March 4, 2005 as modified by regulations adopted on June 16, 2005 and these regulations adopted by the department on August 24, 2006, shall not be required until on and after September 5, 2006.

(2) A generator who qualifies as a contributing school, as defined in section 67450.41(a)(3) of Chapter 45, is not subject to the provisions of this article for transportation of hazardous wastes to a K-12 schools hazardous waste collection,

consolidation, and accumulation facility (SHWCCAF) in accordance with article 5 of Chapter 45 as long as the generator also maintains compliance with the provisions of article 5 of Chapter 45 (commencing with section 67450.40) that are applicable to contributing schools.

(b) A generator shall designate on the manifest one facility which is permitted to handle the waste described on the manifest.

(c) A generator may also designate on the manifest one alternate facility which is permitted to handle the waste in the event an emergency prevents delivery of the waste to the primary designated facility.

(d) If the transporter is unable to deliver the hazardous waste to the designated facility or the alternate facility, the generator shall either designate another facility or instruct the transporter to return the waste.

Note: Authority cited: Sections 208, 25150, 25150.6, 25159 and 25161, *Health and Safety Code*. Reference: Sections 25150.6, 25159, 25159.5, 25160 and 25200, *Health and Safety Code*; 40 Code of Federal Regulations Sections 262.20 and 262.60.

Acquisition and Submission of Manifests.
22 *CCR* 66262.21.

(a) If the state to which the shipment is manifested (consignment state) supplies the manifest and requires its use, then the generator shall use that manifest. This subsection is repealed on September 5, 2006.

(b) If the consignment state does not supply the manifest, the generator shall use the California Uniform Hazardous Waste manifest, EPA 8700-22/DTSC 8022A (4/97). This subsection is repealed on September 5, 2006.

(c) For shipments initiated on and after September 5, 2006, a generator shall use the Uniform Hazardous Waste Manifest, EPA Form 8700-22, and, if necessary, a Continuation Sheet, EPA Form 8700-22A, printed by a registrant in accordance with 40 Code of Federal Regulations section 262.21. No previous manifest form versions may be used for shipments initiated on and after September 5, 2006. A registrant may not print, or have printed, the manifest for use or distribution unless it has received approval from the U.S. EPA Director of the Office of Solid Waste pursuant to 40 Code of Federal Regulations section 262.21 (c) and (e).

(d) Each copy of the manifest and continuation sheet shall indicate how the copy shall be distributed, as follows:

Page 1 (top copy): "Designated facility to destination State (if required)".

Page 2: "Designated facility to generator State (if required)".

Page 3: "Designated facility to generator".

Page 4: "Designated facility's copy".

Page 5: "Transporter's copy".

Page 6 (bottom copy): "Generator's initial copy".

(e) (1) A generator may use manifests printed by any source so long as the source of the printed form has received approval from U.S. EPA to print the manifest under 40 Code of Federal Regulations section 262.21 (c) and (e). A registered source may be a:

(A) State agency;

(B) Commercial printer;

(C) Hazardous waste generator, transporter or TSDF; or

(D) Hazardous waste broker or other preparer who prepares or arranges shipments of hazardous waste for transportation.

(2) A generator shall determine whether the generator state or the consignment state for a shipment regulates any additional wastes (beyond those regulated federally) as hazardous wastes under these states' authorized programs.

(3) Generators also shall determine whether the consignment state or generator state requires the generator to submit any copies of the manifest to these states. In cases where the generator shall supply copies to either the generator's state or the consignment state, the generator is responsible for supplying legible photocopies of the manifest to these states.

(f) Manifests shall be submitted to the department by any generator when the waste is generated in California or is transported to a designated facility located in California. The generator manifest copy shall be submitted to the department for every shipment on a manifest when California is either the generator state or the destination or consignment state. The generator manifest copy shall be mailed to:

DTSC Generator Manifests
P.O. Box 400
Sacramento, CA 95812-0400

Note: Authority cited: Sections 25150, 25159 and 25161, Health and Safety Code. Reference: Sections 25159, 25159.5 and 25160, Health and Safety Code; 40 Code of Federal Regulations Section 262.21.

Use of the Manifest.
22 *CCR* 66262.23.

(a) The generator of any hazardous or extremely hazardous waste to be transported off-site or into California shall:

(1) complete the generator and waste section and sign the manifest certification according to the instructions in the appendix to this chapter; and

(2) obtain the handwritten signature of the initial transporter and date of acceptance on the manifest; and

(3) retain one copy, in accordance with section 66262.40(a); and

(4) within 30 days of each shipment of hazardous waste submit to the Department a legible copy of each manifest used; and

(5) on or after September 5, 2006, for hazardous waste that is not regulated as a hazardous waste by the U.S. EPA (non-RCRA waste), describe these wastes in Item 9b of the manifest or Item 27b of the continuation sheet as follows:

(A) describe non-RCRA hazardous wastes which do not have a U.S. DOT description indicating a generic name of the waste and the phrase "Non-RCRA Hazardous Waste, Solid" or "Non-RCRA Hazardous Waste, Liquid" for solid or liquid wastes, respectively. When possible, the generic name shall be obtained from Chapter 11, Appendix X, subsection (b) of this division. If not listed in Chapter 11, Appendix X, subsection (b) of this division, the commonly recognized industrial name of the waste shall be used.

(B) describe non-RCRA hazardous wastes which have a U.S. DOT description by the U.S. DOT description, and

(6) The EPA hazardous waste number, if applicable, can be found in Chapter 11, articles 3 and 4 and the California Hazardous Waste Code Number can be found in Chapter 11, Appendix XII.

(b) The generator shall give the transporter the remaining copies of the manifest.

(c) For shipments of hazardous waste within the United States solely by water (bulk shipments only), the generator shall send three copies of the manifest dated and signed in accordance with this section to the owner or operator of the designated facility or the last water (bulk shipment) transporter to handle the waste in the United States if exported by water. Copies of the manifest are not required for each transporter.

(d) For rail shipments of hazardous waste within the United States which originate at the site of generation, the generator shall send at least three copies of the manifest dated and signed in accordance with this section to:

(1) the next non-rail transporter, if any; or

(2) the designated facility if transported solely by rail; or

(3) the last rail transporter to handle the waste in the United States if exported by rail.

(e) For shipments of hazardous waste to a designated facility in an authorized State which has not yet obtained authorization to regulate that particular waste as hazardous, the generator shall assure that the designated facility agrees to sign and return the manifest to the generator, and that any out-of-state transporter signs and forwards the manifest to the designated facility.

Note: Authority cited: Sections 25150, 25159, 25161 and 58012, Health and Safety Code. Reference: Sections 25159, 25159.5 and 25160, Health and Safety Code; 40 Code of Federal Regulations Section 262.23.

Marking

22 *CCR* 66262.32.

(a) Before transporting or offering hazardous waste for transportation off-site, a generator shall mark each package of hazardous waste in accordance with the applicable

Department of Transportation regulations on hazardous materials under Title 49 Code of Federal Regulations Part 172;

(b) (1) Before September 5, 2006, and before transporting hazardous waste or offering hazardous waste for transportation off-site, a generator shall mark each container of 110 gallons or less used in such transportation with the following words and information displayed in accordance with the requirements of Title 49 Code of Federal Regulations section 172.304:

HAZARDOUS WASTE-State and Federal Law Prohibit Improper Disposal. If found, contact the nearest police or public safety authority, the U.S. Environmental Protection Agency or the California Department of Toxic Substances Control.
Generator's Name and Address__________________________.
Manifest Document Number_____________________________.

(3) On and after September 5, 2006, before transporting hazardous waste or offering hazardous waste for transportation off-site, a generator shall mark each container of 119 gallons or less used in such transportation with the following words and information displayed in accordance with the requirements of 49 Code of Federal Regulations section 172.304:

HAZARDOUS WASTE-State and Federal Law Prohibit Improper Disposal. If found, contact the nearest police or public safety authority, the U.S. Environmental Protection Agency or the California Department of Toxic Substances Control.

Generator's Name and Address _________________________.

Generator's EPA Identification Number ___________________.

Manifest Tracking Number _____________________________.

Note: Authority cited: Sections 25150, 25159, 25161 and 58012, Health and Safety Code. Reference: Sections 25159, 25159.5 and 25160, Health and Safety Code; 40 Code of Federal Regulations Section 262.32; 49 Code of Federal Regulations Section 172.304; and 49 Code of Federal Regulations Part 172.

Recordkeeping

22 *CCR* 66262.40.

(a) A generator shall keep a copy of each manifest signed in accordance with section 66262.23(a) for three years or until the generator receives a signed copy from the designated facility which received the waste. This signed copy shall be retained as a record for at least three years from the date the waste was accepted by the initial transporter.

(b) A generator shall keep a copy of each Biennial Report and Exception Report for a period of at least three years from the due date of the report.

(c) A generator shall keep records of any test results, waste analyses, or other determinations made in accordance with section 66262.11 for at least three years from the date that the waste was last sent to on-site or off-site treatment, storage, or disposal.

(d) The periods or retention referred to in this section are extended automatically during the course of any unresolved enforcement action regarding the regulated activity or as requested by the USEPA Administrator or the Department.

Note: Authority cited: Sections 208, 25150, 25159 and 25161, Health and Safety Code. Reference: Sections 25159, 25159.5 and 25160, Health and Safety Code; 40 Code of Federal Regulations Section 262.40.

Ordering Information
(for manifests)

Note: Manifests are not necessary when a noncommercial waste producer transports small quantities of waste (*HSC* Section 25163[c]).

The U.S. Environmental Protection Agency (EPA) revised the Uniform Hazardous Waste Manifest and requires the use of only the new version nationally after September 5, 2006. States may not modify the form or the instructions. Old versions of the California manifest may not be used after September 5, 2006. The new manifest form is no longer color coded, nor does the new form include a copy for generators to submit to their state, although California requires the generator to submit a copy.

California does not sell the new manifest forms; they are available only from EPA-approved private printers or online at ://www.epa.gov/osw/hazard/transportation (accessed November 17, 2014). Links to more information about the manifest are available at ://www.dtsc.ca.gov/IDManifest (accessed November 17, 2014).

Health and Safety Code

Humane Care of Animals

***HSC* 1650.**

The public health and welfare depend on the humane use of animals for scientific advancement in the diagnosis and treatment of human and animal diseases, for education, for research in the advancement of veterinary, dental, medical and biologic sciences, for research in animal and human nutrition, and improvement and standardization of laboratory procedures of biologic products, pharmaceuticals and drugs.

***HSC* 1651.**

The State Department of Health Services shall administer the provisions of this chapter.

Every provision of this chapter shall be liberally construed to protect the interests of all persons and animals affected.

As used in this chapter, “person” includes: laboratory, firm, association, corporation, copartnership, and educational institution.

As used in this chapter, “board” or “department” means the State Department of Health Services.

***HSC* 1660.**

The department shall make and promulgate, and may thereafter modify, amend or rescind, reasonable rules and regulations to carry out the purposes of this chapter, including the control of the humane use of animals for the diagnosis and treatment of human and animal diseases, for research in the advancement of veterinary, dental, medical and biologic sciences, for research in animal and human nutrition, and for the testing and diagnosis, improvement and standardization of laboratory specimens, biologic products, pharmaceuticals and drugs. Such rules and regulations shall include requirements for satisfactory shelter, food, sanitation, record keeping, and for the humane treatment of animals by persons authorized by the board to raise, keep or to use animals under the provision of this chapter. The department shall not make or promulgate any rule compelling the delivery of animals for the purpose of research, demonstration, diagnosis, or experimentation.

***HSC* 1662.**

The department is hereby authorized to inspect any premises or property on or in which animals are kept for experimental or diagnostic purposes, for the purpose of investigation of compliance with the rules and regulations adopted hereunder. Such inspection or other method of control shall be enforced only by employees of the department and such power and authority may not be delegated to any other persons or agency.

Retrograde Material
***HSC* 25121.5.**

"**Retrograde material**" means any hazardous material which is not to be used, sold, or distributed for use in an originally intended or prescribed manner or for an originally intended or prescribed purpose and which meets any one or more of the following criteria:

(1) Has undergone chemical, biochemical, physical, or other changes due to the passage of time or the environmental conditions under which it was stored.

(2) Has exceeded a specified or recommended shelf life.

(3) Is banned by law, regulation, ordinance, or decree.

(4) Cannot be used for reasons of economics, health or safety, or environmental hazard.

Repeal of Requirement for Obtaining an Extremely Hazardous Waste Disposal Permit
***HSC* 25153.**

The offsite storage, treatment, transportation, and disposal of extremely hazardous waste is subject to the same requirements specified in this chapter that are applicable to hazardous waste and the department shall not require any special or additional permits for the offsite handling of extremely hazardous waste.

***HSC* 25205.7(o).**

Any person producing or transporting extremely hazardous waste shall pay a fee of two hundred dollars ($200) per calendar year, in addition to any other fee imposed by this section. The fee shall be collected annually.

Transportation of Hazardous Waste

***HSC* 25163.**

(c) Persons transporting hazardous wastes to a permitted hazardous waste facility for transfer, treatment, recycling, or disposal, which wastes do not exceed a total volume of five gallons or do not exceed a total weight of 50 pounds, are exempt from the requirements . . . concerning possession of a manifest while transporting hazardous waste, upon meeting all of the following conditions:

(1) The hazardous wastes are transported in closed containers and packed in a manner that prevents containers from tipping, spilling, or breaking during the transporting.

(2) Different hazardous waste materials are not mixed within a container during the transporting.

(3) If the hazardous waste is extremely hazardous waste or acutely hazardous waste, the extremely hazardous waste or acutely hazardous waste was not generated in the course of any business and is not more than 2.2 pounds.

(4) The person transporting the hazardous waste is the producer of that hazardous waste, and the person produces not more than 100 kilograms of hazardous waste in any month.

(5) The person transporting the hazardous waste does not accumulate more than a total of 1,000 kilograms of hazardous waste onsite at any one time . . .

(e) Any person authorized to collect and transport solid waste, as defined in Section 40191 of the Public Resources Code, who unknowingly transports hazardous waste to a solid waste facility, as defined in Section 40194 of the Public Resources Code, incidental to the collection of solid waste is not subject to subdivision (a).

***HSC* 25163.1.**

The Department shall not adopt any regulations requiring a person hauling hazardous wastes who is not in the business of hauling hazardous wastes or who is not hauling these wastes as part of, or incidental to, any business to obtain the registration specified if that person meets the conditions specified in subsection (c) of Section 25163.

Hazardous Materials Release Response Plans and Inventory

[The following is a summary of the relevant sections of Chapter 6.95. *Ed.*]

***HSC* 25500.**

In order to protect public health and safety and the environment, it is necessary to establish business and area plans relating to the handling and release of hazardous materials . . . Basic information on the location, type, quantity, and the health risks of hazardous materials handled, used, stored, or disposed of . . . is necessary to prevent or mitigate the damage to the health and safety of persons and the environment from the release or threatened release of hazardous materials into the workplace and environment.

***HSC* 25502.**

Every county is required, through a designated administering agency, to implement the establishment of business and area plans as to the handling of hazardous materials and assure availability and access of information to emergency rescue personnel and other appropriate entities. A city may assume that responsibility within its boundaries, coordinating its activities with the county in which it is located.

***HSC* 25503.3**

[Businesses handling hazardous materials shall annually complete a hazardous materials reporting form and submit it to the administering agency. Ed.]

***HSC* 25503.5**

[Any business which handles a quantity of hazardous material which at any time during the year is equal to or greater than a total weight of 500 lbs or a total volume of 55 gallons, or 200 cubic feet at standard temperature and pressure for compressed gas, shall establish and implement a business plan for emergency response to a release or threatened release of a hazardous material. Ed.]

***HSC* 25504.**

[Business plans shall include a chemical inventory as required by Section 25509, emergency response plans in the event of a reportable release or threatened release of hazardous material, and training for all new employees and annual training regarding release or threatened release of hazardous materials.]

***HSC* 25505.**

[Each handler shall submit its business plan to the administering agency.]

***HSC* 25507.**

[Handlers shall immediately report any release or threatened release to the administering agency and provide fire, health, safety, and/or rescue personnel access to the facilities.]

***HSC* 25509.**

(a) The annual inventory form shall include, but shall not be limited to, information on all of the following which are handled in quantities equal to or greater than the quantities specified in Section 25503.5:

(1) A listing of the chemical name and common names of every hazardous substance or chemical product handled by the business.

(2) The category of waste, including the general chemical and mineral composition of the waste listed by probable maximum and minimum concentrations, of every hazardous waste handled by the business.

(3) A listing of the chemical name and common names of every other hazardous material or mixture containing a hazardous material handled by the business which is not otherwise listed, pursuant to paragraph (1) or (2).

(4) The maximum amount of each hazardous material or mixture containing a hazardous material disclosed in paragraphs (1), (2), and (3) which is handled at any one time by the business over the course of the year.

(5) Sufficient information on how and where the hazardous materials disclosed in paragraphs (1), (2), and (3) are handled by the business to allow fire, safety, health, and other appropriate personnel to prepare adequate emergency responses to potential releases of the hazardous materials.

(6) The name and phone number of the person representing the business and able to assist emergency personnel in the event of an emergency involving the business during nonbusiness hours.

Appendix B

Sample Safety Regulations for Science Students

While working in the science laboratory, students will have important responsibilities that do not apply to other classrooms. Students will be working with materials and apparatus that, if handled carelessly or improperly, have the potential to cause injury or discomfort.

A science laboratory can be a safe place in which to work if the student is foresighted, alert, and cautious. The following practices will be followed:

1. Report any accident to the teacher immediately, no matter how minor, including any burns, scratches, cuts, or contact with corrosive liquid (on skin or clothing).
2. Prepare for each laboratory activity by reading all instructions before coming to class. Follow all directions implicitly and intelligently. Make note of any modification in procedure given by the teacher.
3. Any science project or individually planned experiment must be approved by the teacher.
4. Use only those materials and equipment authorized by the teacher.
5. Inform the teacher immediately of any equipment that does not work properly.
6. Clean up any nonhazardous spill on the floor or work space immediately.
7. Wear appropriate eye protection, as directed by the teacher, whenever working in the laboratory or in field experiments such as rocket launches. Safety goggles must be worn during hazardous activities involving caustic/corrosive chemicals, heating of liquids, and other activities that may injure the eyes.
8. Splashes and fumes from hazardous chemicals present a special danger to people who wear contact lenses. Therefore, it is preferable for students to wear regular glasses (inside splash-proof goggles, when appropriate) rather than contact lenses during all class activities or purchase personal splash-proof goggles and wear them whenever exposure to chemicals or chemical fumes is possible.

9. Students with open skin wounds on hands must wear gloves or be excused from the laboratory activity.
10. Never carry hot equipment or dangerous chemicals through a group of students.
11. Check labels and equipment instructions carefully. Be sure correct items are used in the proper manner.
12. Be aware of any hazardous chemicals being used. Know the location of the SDS and be familiar with what the sheets indicate for the hazardous chemicals being used.
13. Never taste anything or touch chemicals with the hands, unless specifically instructed to do so.
14. Test for odor of chemicals only by waving a hand above the container and sniffing cautiously from a distance.
15. Eating or drinking in the laboratory or from laboratory equipment is not permitted.
16. Use a mechanical pipette filler (never the mouth) when measuring or transferring small quantities of liquid with a pipette.
17. When heating material in a test tube, do not look into the tube or point it in the direction of any person during the process.
18. Never pour reagents back into bottles, exchange stoppers of bottles, or lay stoppers on the table.
19. When diluting acids, always pour **acids into water**, never the reverse. Combine the liquids slowly while stirring to distribute heat buildup throughout the mixture.
20. Keep hands away from face, eyes, and clothes while using solutions, specimens, equipment, or materials in the laboratory. Wash hands as necessary and wash thoroughly at the conclusion of the laboratory period.
21. To treat a burn from an acid or alkali, wash the affected area immediately with plenty of running water. If the eye is involved, irrigate it at the eyewash station without interruption for 15 minutes. Report the incident to the teacher immediately.
22. Know the location of the emergency shower, eyewash and facewash station, fire blanket, fire extinguisher, fire alarm box, and exits.
23. Know the proper fire- and earthquake-drill procedures.

24. Roll long sleeves above the wrist. Long, hanging necklaces, bulky jewelry, and excessive or bulky clothing should not be worn in the laboratory.
25. Confine long hair during a laboratory activity.
26. Do not wear sandals in the laboratory; always wear closed-toe shoes.
27. Keep work areas clean. Floors and aisles should be kept clear of equipment and materials.
28. Light gas burners only as instructed by the teacher. Be sure no volatile materials (such as alcohol or acetone) are being used nearby.
29. Use a burner with extreme caution. Keep head and clothing away from the flame and turn it off when not in use.
30. Use a fire blanket (stop, drop, and roll) to extinguish any flame on a person.
31. Dispose of laboratory waste as instructed by the teacher. Use separate, designated containers (not the wastebasket) for the following:
    - Matches, litmus paper, wooden splints, toothpicks, and so on
    - Broken and waste glass
    - Rags, paper towels, or other absorbent materials used in the cleanup of flammable solids or liquids
    - Hazardous/toxic liquids and solids
32. Place books, purses, and other personal items in the designated storage area. Take only laboratory manuals and notebooks into the working area.
33. Students are not permitted in laboratory storage rooms or teachers' workrooms without the approval of the teacher.
34. To cut small-diameter glass tubing, use a file or tubing cutter to make a deep scratch. Wrap the tubing in a paper towel before breaking the glass by pushing the glass with the thumbs in an outward direction. Fire-polish all ends.
35. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same appearance. Determine whether an object is hot by bringing the back of the hand close to the object.
36. Match hole sizes and tubing when inserting glass tubing into a stopper. If necessary, expand the hole first by using an appropriately sized cork borer. Lubricate the stopper

hole and glass tubing with water or glycerin to ease insertion, using towels to protect the hand. Carefully twist (never push) glass tubing into stopper holes.

37. Remove all broken glass from the work area or floor as soon as possible. Never handle broken glass with bare hands; use a counter brush and dustpan.
38. Report broken glassware, including thermometers, to the teacher immediately.
39. Operate electrical equipment only in a dry area and with dry hands.
40. When removing an electrical plug from its socket, pull the plug, not the electrical cord.
41. Treat all animals in the science laboratory humanely—that is, with respect and consideration for their care.
42. Always approach laboratory experiences in a serious and courteous manner.
43. Always clean the laboratory area before leaving.
44. Students (and teacher) should wash hands with soap and water before leaving the laboratory area.

Note: Persistent or willful violation of the regulations will result in the loss of laboratory privileges and possible dismissal from the class.

Student Science Safety Agreement

School: ____

Teacher: ____

Date: ____

Student's name: ____

The student has received specific instruction regarding the use, function, and location of the following:

Aprons, gloves	☐
Chemical-spill kit	☐
Eye-protective devices (goggles, face shield, safety shield)	☐
Eyewash fountain, drench spray, and drench shower	☐
Fire extinguisher	☐
Fire blanket	☐
First-aid kit	☐
Heat sources (burners, hot plate, microwave) and techniques in their use	☐
Standardized Safety Data Sheets (SDS)	☐
Waste-disposal containers for glass, chemicals, matches, paper, wood	☐

The student will abide by the "Safety Regulations for Science Students" to prevent accidents and injury to herself or himself and others and will:

- follow all additional instructions given by the teacher;
- conduct herself or himself in a responsible manner at all times in the laboratory.

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) that may affect the student's safety in the laboratory or on field trips. Attach to this sheet a list of emergency medications and procedures to be used in case the student is exposed.

____

____

Check this box if the student wears contact lenses: ☐

Student's Statement

I have in my possession and have read the "Safety Regulations for Science Students" and agree to abide by them at all times while in the laboratory. I have received specific safety instruction as indicated above.

Signature of student:____

Date:____

Parent's or Guardian's Statement

I have read this agreement and the "Safety Regulations for Science Students" and give my consent for the student who has signed the preceding statement to engage in laboratory activities using a variety of science equipment and materials, including those described. I pledge my cooperation in urging that she or he observe the safety regulations prescribed.

Signature of parent or guardian:____

Date:____

Return the completed and signed form to____

by ______________________________.

(date)

Student Science Safety Agreement

Lower Elementary School

School: ____

Teacher: ____

Date: ____

Student's name: ____

The student has received specific instruction regarding the use, function, and location of the following:

- Aprons, gloves ☐
- Chemical-spill kit ☐
- Eye-protective devices (goggles, face shield, safety shield) ☐
- Eyewash fountain, drench spray, and drench shower ☐
- Fire extinguisher ☐
- Fire blanket ☐
- First-aid kit ☐
- Waste-disposal containers for glass, chemicals, matches, paper, and wood ☐

Learn the rules listed below and follow them at all times during science activities.

1. Listen carefully and follow ALL directions given by the teacher.
2. Practice good behavior at all times during science activities.
3. Ask questions if unsure of what to do.
4. Never touch, taste, or smell any material unless directed by the teacher.
5. Long hair is to be tied back. Take off any jewelry and adjust loose clothing in order to maintain safe working conditions.
6. Use proper safety eyewear and protective aprons or smocks when necessary.
7. Clear all work areas of extra books, papers, notebooks, and the like before beginning science activities. Always leave the work area clean and dispose of trash as directed by the teacher.
8. Always wash hands thoroughly after each science activity.
9. Tell the teacher about any accident, no matter what happens.
10. Do not carry out science activities at home without adult supervision.

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) that may affect the student's safety in the laboratory or on field trips. Attach to this sheet a list of emergency medications and procedures to be used in case the student is exposed.

____

____

Check this box if the student wears contact lenses: ☐

Teacher's Statement

I have explained this Science Safety Agreement to the class in detail. Please review this agreement with your child.

Signature of teacher: ____

Date: ____

Parent's or Guardian's Statement

I have read this agreement and the "Safety Regulations for Science Students" and give my consent for my child to engage in laboratory activities using a variety of science equipment and materials, including those described. I pledge my cooperation in urging that she or he observe the safety regulations prescribed.

Signature of parent or guardian:____

Date:____

Return the completed and signed form to____

by ______________________________.

(date)

Student Science Safety Agreement

Upper Elementary School

School: ____

Teacher: ____

Date: ____

Student's name: ____

The student has received specific instruction regarding the use, function, and location of the following:

Aprons, gloves	☐
Chemical-spill kit	☐
Eye-protective devices (goggles, face shield, safety shield)	☐
Eyewash fountain, drench spray, and drench shower	☐
Fire extinguisher	☐
Fire blanket	☐
First-aid kit	☐
Heat sources (burners, hot plate, microwave) and techniques in their use	☐
Standardized Safety Data Sheets (SDS)	☐
Waste-disposal containers for glass, chemicals, matches, paper, and wood	☐

Learn the rules listed below and follow them at all times during science activities.

1. Listen carefully and follow ALL directions given by the teacher.
2. Practice good behavior at all times during science activities.
3. Ask questions if unsure of what to do.
4. Never touch, taste, or smell any material unless directed by the teacher.
5. Long hair is to be tied back. Take off any jewelry and adjust loose clothing in order to maintain safe working conditions.
6. Use proper safety eyewear and protective aprons or smocks when necessary.
7. Clear all work areas of extra books, papers, notebooks, and the like before beginning science activities. Always leave the work area clean and dispose of trash as directed by the teacher.

8. Always wash hands thoroughly after each and every science activity.
9. Tell the teacher about any accident, no matter what happens.
10. Do not carry out science activities at home without adult supervision.

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) that may affect the student's safety in the laboratory or on field trips. Attach to this sheet a list of emergency medications and procedures to be used in case the student is exposed.

____

____

Check this box if the student wears contact lenses: ☐

Student's Statement

I, ____________________________________, understand and agree to follow the safety rules and conduct guidelines described above. I agree to follow any other guidelines or instructions provided by my teacher.

Signature of student:____

Date:____

Parent's or Guardian's Statement

I have read this agreement and the "Safety Regulations for Science Students" and give my consent for the student who has signed the preceding statement to engage in laboratory activities using a variety of science equipment and materials, including those described. I pledge my cooperation in urging that she or he observe the safety regulations prescribed.

Signature of parent or guardian:____

Date:____

Return the completed and signed form to____

by ______________________________.

(date)

Student Safety Agreement

Biological Science Laboratory Regulations

School: ____

Teacher: ____

Date: ____

Student’s name: ____

The student has received specific instruction regarding the use, function, and location of the following:

Aprons, gloves	☐
Chemical-spill kit	☐
Eye-protective devices (goggles, face shield, safety shield)	☐
Eyewash fountain, drench spray, and drench shower	☐
Fire extinguisher	☐
Fire blanket	☐
First-aid kit	☐
Heat sources (burners, hot plate, microwave) and techniques in their use	☐
Standardized Safety Data Sheets (SDS)	☐
Waste-disposal containers for glass, chemicals, matches, paper, and wood	☐

The student will abide by the “Biological Science Laboratory Regulations” to prevent accidents and injury to herself or himself and others and will:

- follow all additional instructions given by the teacher;
- conduct herself or himself in a responsible manner at all times in the laboratory.

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) that may affect the student’s safety in the laboratory or on field trips. Attach to this sheet a list of emergency medications and procedures to be used in case the student is exposed.

____

____

Check this box if the student wears contact lenses: ☐

Student's Statement

I have in my possession and have read the "Biological Science Laboratory Regulations" and agree to abide by them at all times while in the laboratory. I have received specific safety instruction as indicated above.

Signature of student:____

Date:____

Parent's or Guardian's Statement

I have read the "Biological Science Laboratory Regulations" and give my consent for the student who has signed the preceding statement to engage in laboratory activities using a variety of science equipment and materials, including those described. I pledge my cooperation in urging that she or he observe the safety regulations prescribed.

Signature of parent or guardian:____

Date:____

Return the completed and signed form to____

by ________________________________.

(date)

Student Safety Agreement

Physical Science Laboratory Regulations

School: ____

Teacher: ____

Date: ____

Student's name: ____

The student has received specific instruction regarding the use, function, and location of the following:

Aprons, gloves	☐
Chemical-spill kit	☐
Eye-protective devices (goggles, face shield, safety shield)	☐
Eyewash fountain, drench spray, and drench shower	☐
Fire extinguisher	☐
Fire blanket	☐
First-aid kit	☐
Heat sources (burners, hot plate, microwave) and techniques in their use	☐
Standardized Safety Data Sheets (SDS)	☐
Waste-disposal containers for glass, chemicals, matches, paper, and wood	☐

The student will abide by the "Physical Science Laboratory Regulations" to prevent accidents and injury to herself or himself and others and will:

- follow all additional instructions given by the teacher;
- conduct herself or himself in a responsible manner at all times in the laboratory.

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) that may affect the student's safety in the laboratory or on field trips. Attach to this sheet a list of emergency medications and procedures to be used in case the student is exposed.

____

____

Check this box if the student wears contact lenses: ☐

Student's Statement

I have in my possession and have read the "Physical Science Laboratory Regulations" and agree to abide by them at all times while in the laboratory. I have received specific safety instruction as indicated above.

Signature of student:____

Date:____

Parent's or Guardian's Statement

I have read the "Physical Science Laboratory Regulations" and give my consent for the student who has signed the preceding statement to engage in laboratory activities using a variety of science equipment and materials, including those described. I pledge my cooperation in urging that she or he observe the safety regulations prescribed.

Signature of parent or guardian:____

Date:____

Return the completed and signed form to____

by ____________________________.

(date)

Appendix C

Science Laboratory Safety Checklist

The safety program in the school and school district should be dedicated to preventing and minimizing injury to personnel and protecting and preserving the facilities and the environment.

The following checklist identifies some of the important considerations for schools, school districts, and interested individuals to address in planning and implementing a science laboratory safety program. This is not an exhaustive list; schools, school districts, and interested individuals are encouraged to review the pertinent statues and regulations and consult with appropriate safety personnel and/or legal counsel as needed, to ensure compliance with the applicable laws.

1. The school or the school district must have a written plan for, or exemption from, each of the following. If the plan is for the school district, it should be written to include the schools involved.

   - Chemical hygiene plan (CHP), *CCR,* Title 8, Section 5191. Required of all employers in workplaces where there is laboratory use of hazardous chemicals; the plan must include safe operating procedures, use of protective equipment, employee information and training, provisions for medical consultations and examinations, and designation of a chemical hygiene officer. ☐
   - Bloodborne pathogens exposure control plan, *CCR,* Title 8, Section 5193. Required of all *employers* with employees reasonably anticipated to have exposure to blood or other potentially infectious materials in the performance of their duties. ☐
   - Hazard communication; Standardized Safety Data Sheets (SDS), *CCR,* Title 8, Section 5194. May be included in chemical hygiene plan noted above (see also Chapter 7, Section E). Required of all employers in workplaces where hazardous chemicals are used unless all exposed employees are under the direct supervision and regular observation of an individual with knowledge of physical and health hazards and emergency procedures and who conveys this knowledge to employees in terms of safe work practices. Labels and SDS received must be maintained and available to employees. ☐

2. The school or school district has implemented a plan for the safe storage, use, and disposal of hazardous chemicals (*EC* Section 49411). ☐
3. The implementation of the overall safety plan makes provisions at all levels for instruction and training, responsible supervision, and adequate and well-maintained facilities and equipment. ☐
4. Safety equipment includes each of the following, as appropriate:
   - Fire extinguisher for class A, B, and C fires ☐
   - Dry sand or other provision for class D fires ☐
   - Fire blanket ☐
   - Splash-proof goggles and sterilizer ☐
   - Eyewash, or eyewash and facewash fountain; drench hose ☐
   - Deluge shower ☐
   - Chemical-spill kit ☐
   - Fume hood ☐
   - First-aid kit ☐
5. Teachers are prepared to safely handle, use, and store science supplies and equipment as well as safety equipment. Documentation of staff training should be maintained at both school and school district sites. ☐
6. A safety assessment is regularly made of the science classrooms/laboratories and auxiliary rooms (e.g., by using the “Sample Safety Checklist for Science Instruction, Preparation, and Storage Areas” in Appendix F). ☐
7. Each science teacher consciously includes safety as a component in planning and conducting each lesson, demonstration, and activity. ☐
8. Classrooms are inspected daily for irregularities or dangerous conditions, including, but not limited to, faulty equipment, improper ventilation, and missing or nonfunctional safety supplies. ☐
9. Potential dangers (safety hazards, defective equipment, or unsafe conditions) that cannot be readily corrected within the department are reported immediately to the site administrator for necessary action. ☐

10. Each class is provided with proper initial instruction in safety procedures, specific to the subject, which are reviewed regularly. The review includes the following:
    - Use of safety equipment, devices, and materials ☐
    - Proper laboratory preparation, attire, and attitude ☐
    - Proper use of material and equipment ☐
    - Disposal and cleanup procedures ☐
11. Documentation is maintained on the types of instruction given and the dates on which safety-related topics were demonstrated, conducted, or tested. ☐
12. Student safety consent/agreement forms, which attest to initial safety instruction and a knowledge of laboratory regulations and potential dangers, are signed by the student and his or her parent or guardian and retained by the teacher. ☐
13. The school and school district fire and earthquake drills and emergency procedures include special provisions related to science equipment, facilities, and materials. Procedures are included for contacting community resources (fire department, ambulance, paramedics, hospital, or doctor). Contact the California Emergency Management Agency (Cal EMA) for information on disaster preparedness. ☐
14. A report is made of any injury, illness, or incident, including appropriate procedures for remediation. ☐
15. Safety guidelines adopted by the school and school district are reviewed and updated on a regular basis. ☐

By following the suggestions noted above, instructors, schools, school districts, and students can improve their ability to conduct laboratory activities safely and effectively. Failure to implement the procedures increases the relative degree of liability of school districts and individuals.

Appendix D

List of Incompatible Chemicals[1]

The following list is only a guide; it is not a complete list of all incompatible chemicals. For specific incompatibilities, please consult the Standardized Safety Data Sheets (SDS) for each chemical in use. For an extensive listing and discussion of reactivity risks of chemicals alone or in combination, as well as toxicity hazards for unexpected reactions, refer to *Bretherick's Handbook of Reactive Chemical Hazards* (Volumes 1–2), 7th Edition, 2007, published by Elsevier, Inc.

Chemical	**Incompatible with**
Acetic acid	Oxidizing agents (e.g., chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates)
Acetone	Nitric acid and sulfuric acid; other oxidizing agents
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium)	Water, carbon tetrachloride, other chlorinated hydrocarbon compounds, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury (e.g., in manometers), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Reducing agents
Azides	Acids
Bromine	See *chlorine*
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, other oxidizing agents

1. Adapted from UC Davis, Environmental Health and Safety, Safety Net #4, 2007. Available at http://safetyservices.ucdavis.edu/snfn/safetynets/snml/sn42/sn4 (accessed November 17, 2014).

Chemical	Incompatible with
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Chromium trioxide (chromic acid)	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids
Copper	Acetylene, hydrogen peroxide
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons (e.g., butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide, other oxidizing agents
Hydrocyanic acid (anhydrous)	Alkali
Hydrofluoric acid	Potassium permanganate, sulfuric acid
Hydrogen sulfide	Metal oxides, powdered copper, oxidizing gases
Hypochlorites	Acids, activated carbon, ammonia
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Powdered metals and nonmetals, metal sulfides, flammable/combustible liquids
Nitric acid	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids and gases, copper, brass, heavy metals, alkalis
Nitrites	Ammonium salts, amides, phosphides, reducing agents
Nitroparaffins	Acids, bases, amines, halides
Oxalic acid	Silver, chlorites, urea
Oxygen	Oils, grease, hydrogen, and other reducing agents, including flammable liquids, solids or gases
Perchlorates	See *chlorates*
Perchloric acid	Reducing agents such as acetic anhydride, bismuth and its alloys, alcohols, paper, wood, grease, oils

Chemical	Incompatible with
Phosphorous (white)	Air, oxygen, alkalis, halogens, halogen oxides, oxidizing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, other reducing agents, sulfuric acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium peroxide	Ethyl and methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Permanganates, water, aqueous solutions, reducing agents, chlorates, perchlorates, nitric acid
Water	Acids (Remember to add acid to water, not vice versa.)

Sample Chemical Inventory

School: Room: Date:

Inventory prepared by:

Date Acquired	*Chemical Name*	*Concentration/ Purity*	*Type of Container*	*Quantity*	*Hazard Class*	*Storage Location*	*Storage Compatibility*	*Shelf Life*	*SDS Available*	*Notes*
8-2004	Acetic Acid	1.0	Glass	1 liter						
2-2004	Acetone	99.5%	Metal can	400 ml						

Appendix E

Sample Science Laboratory Safety Test

The following are suggested questions from which teachers might prepare tests for specific courses. The list of questions is not intended to be comprehensive; each teacher is expected to supplement the sample items.

1. If you see something in the classroom or laboratory that is dangerous, tell the teacher
   a. When you have time
   b. Immediately
   c. After class
   d. After school

2. Rags or paper towels with flammable liquids or solids on or in them must be put in
   a. A cardboard box
   b. A metal or crockery container with a lid
   c. A wastebasket
   d. A trash can

3. Any spill on the floor can cause an accident. Always clean it up
   a. Immediately
   b. During cleanup time
   c. When you have time
   d. At the end of the period

4. Alcohol, acetone, and other volatile materials that can burn easily should never be used near
   a. Another person
   b. An open flame
   c. A laboratory counter
   d. A work table

5. When you work with laboratory chemicals and Bunsen burners, long hair must be
   a. Cut off
   b. Held with both hands
   c. Kept out of the way by wearing a band, hat, or hairnet
   d. Combed nicely

6. When you work with laboratory chemicals, equipment, or burners, you must wear
   a. Loose clothes
   b. Goggles
   c. Contact lenses
   d. Loose jewelry

7. If you are hurt (cut, burned, and so on), tell the
   a. Nurse at once
   b. Teacher at once
   c. Class at once
   d. Doctor after school

8. Whenever you are in the classroom or laboratory, you should wear
   a. Sandals
   b. Closed shoes
   c. Open-toe shoes
   d. No shoes

9. If you think there is something wrong with a piece of equipment you are using, stop, turn it off, and tell
   a. The class leader
   b. The teacher
   c. Another student
   d. The custodian

10. If you break a piece of glassware or other equipment, tell the teacher
   a. The next period
   b. At cleanup time
   c. Immediately
   d. Never

11. All floors, aisles, and passageways should be kept clear of
   a. Teacher and students
   b. Laboratory equipment and chemicals
   c. Laboratory equipment only
   d. Chemicals only

12. If you see a fire in an apparatus assembly or a burning liquid, such as alcohol, it is best to put it out with
   a. The fire blanket
   b. Water from the sink
   c. Your coat
   d. The ABC fire extinguisher

13. To put out a fire in a person's clothing, use
   a. The fire blanket
   b. A handy chemical
   c. The wind from running
   d. The fire extinguisher

14. The correct way to move about the classroom or laboratory is to
   a. Run
   b. Walk
   c. Hurry
   d. Skip

15. Helping to clean up the classroom or laboratory is the job of
    a. New students
    b. Old students
    c. Each student
    d. The teacher

16. When you use laboratory equipment or chemicals, you should give the procedure all of your
    a. Interest
    b. Attention
    c. Effort
    d. All of these (a, b, and c)

17. Chemicals, small parts, glassware, and stirring rods are not to be
    a. Used in the laboratory
    b. Put in your mouth
    c. Put on the bench
    d. Taken from boxes

18. To prevent accidents during laboratory activities with chemicals and equipment, you should
    a. Use shortcuts
    b. Follow your teacher's directions
    c. Hurry ahead of teachers
    d. Ask someone else to do the work

19. Playing (rather than working) in the laboratory or bothering another person is
    a. Always against the rules
    b. All right
    c. Not dangerous
    d. All right if you are working

20. To be able to put out a fire quickly and safely, you should know
    a. How to use extinguishers
    b. Where the extinguishers are located
    c. Which extinguisher is used for each class of fire
    d. All of the above

21. If flammable liquids such as alcohol are spilled, you should first
    a. Let them dry up
    b. Use a fire extinguisher
    c. Tell the teacher
    d. Pour water on them

22. Before you touch an electrical switch, plug, or outlet
    a. Your hands must be dry
    b. Ask the custodian
    c. Your hands must be clean
    d. Ask the nurse

23. Eyeglasses do not provide as much protection as
    a. A face shield
    b. Safety glasses
    c. Splash-proof goggles
    d. Any of these (a, b, or c)

24. Laboratory aprons, when provided, are for
    a. The protection of you and your clothes
    b. Wiping your hands
    c. Others to hang up
    d. When you are wearing your best clothes

25. Cabinet drawers and doors that are left open cause a hazard and should be
    a. Walked around
    b. Closed by you
    c. Left alone
    d. Closed by the teacher only

26. If there is a fire in the laboratory, notify the teacher at once and prepare to
    a. Evacuate the building or laboratory
    b. Remove flammable materials
    c. Open the windows
    d. Rapidly clean the laboratory

27. All chemicals should be stored in
    a. Tin cans
    b. Dark brown bottles
    c. Clear glass bottles
    d. Properly labeled containers

28. When preparing dilute solutions of an acid, carefully pour
    a. The acid into water
    b. The acid into the container
    c. Water into the acid
    d. Both liquids at once

29. If acid gets on your skin or clothes, wash at once with
    a. Sulfuric acid
    b. Soap
    c. Water
    d. Oil

30. Small quantities of spilled acids can be made safe with
    a. Gasoline
    b. Alcohol
    c. Water
    d. Sodium bicarbonate solution

31. Small amounts of spilled bases can be neutralized and made safe with
    a. Gasoline
    b. Alcohol
    c. Water
    d. Dilute acetic acid solution (vinegar)

32. You must wear approved eye protection while working in the laboratory
    a. To improve your vision
    b. Sometimes
    c. To avoid myopia
    d. Whenever the laboratory instructions tell you to

33. Disturbing other students while they are working in the laboratory is
    a. Helpful
    b. Impolite
    c. Dangerous
    d. The quickest way to do a job

34. You should prepare for each laboratory activity by reading all instructions
    a. After school
    b. While you are working
    c. Before you start to work
    d. Next week

35. When measuring small amounts of liquids with a pipette, draw the liquid into the tube by using
    a. Your mouth
    b. Your thumb
    c. A mechanical pipette filler
    d. The palm of your hand

36. When heating substances in a test tube, be sure the open end of the tube points toward
    a. Yourself
    b. No one
    c. Your partner
    d. A classmate

37. After heating glass tubing to bend it, the soonest you may safely handle the tubing is
    a. Within 30 seconds
    b. After you are sure it is cool
    c. After school
    d. The next day

38. To insert glass tubing into a rubber stopper, you should (after fire-polishing and cooling)—
    a. Lubricate with water or glycerin
    b. Use a towel for protection
    c. Twist carefully
    d. All of these (a, b, and c)

39. To remove an electrical plug from its socket, you should
    a. Pull the plug itself
    b. Pull on the cord
    c. Pull on the appliance
    d. None of these (a, b, or c)

40. On the back of your answer sheet, draw a diagram of your science laboratory or classroom and label the locations of the following items:

    Fire blanket

    Fire extinguisher

    Exits

    Safety-goggles storage (or dispensing area)

    Eyewash station

    Safety shower

    Closest fire alarm

    Waste-disposal containers (label the type of waste for which each container is suitable)

Student Answer Sheet for Science Laboratory Safety Test

Name:____

Period:_________________ Test No.:_______________ Score:________________

Directions: Read each statement on the safety test. Under each question there are four possible answers. Choose the one correct answer and fill in the box that represents the answer.

Example: Read question 1. The correct answer is “b.” Note that the “b” box beside number 1 (see example below) is darkened. Continue marking all the answers in this manner.

	a	b	c	d
1.	☐	■	☐	☐
2.	☐	☐	☐	☐
3	☐	☐	☐	☐
4.	☐	☐	☐	☐
5.	☐	☐	☐	☐
6.	☐	☐	☐	☐
7.	☐	☐	☐	☐
8.	☐	☐	☐	☐
9.	☐	☐	☐	☐
10.	☐	☐	☐	☐
11.	☐	☐	☐	☐
12.	☐	☐	☐	☐
13.	☐	☐	☐	☐
14.	☐	☐	☐	☐
15.	☐	☐	☐	☐
16.	☐	☐	☐	☐
17.	☐	☐	☐	☐
18.	☐	☐	☐	☐
19.	☐	☐	☐	☐
20.	☐	☐	☐	☐

21.	☐	☐	☐	☐
22.	☐	☐	☐	☐
23.	☐	☐	☐	☐
24.	☐	☐	☐	☐
25.	☐	☐	☐	☐
26.	☐	☐	☐	☐
27.	☐	☐	☐	☐
28.	☐	☐	☐	☐
29.	☐	☐	☐	☐
30.	☐	☐	☐	☐
31.	☐	☐	☐	☐
32.	☐	☐	☐	☐
33.	☐	☐	☐	☐
34.	☐	☐	☐	☐
35.	☐	☐	☐	☐
36.	☐	☐	☐	☐
37.	☐	☐	☐	☐
38.	☐	☐	☐	☐
39.	☐	☐	☐	☐
40.	**Place answer on back of sheet.**			

Answer Key

Items 1–39

Science Laboratory Safety Test

	a	b	c	d
1.	□	■	□	□
2.	□	■	□	□
3	■	□	□	□
4.	□	■	□	□
5.	□	□	■	□
6.	□	■	□	□
7.	□	■	□	□
8.	□	■	□	□
9.	□	■	□	□
10.	□	□	■	□
11.	□	■	□	□
12.	□	□	□	■
13.	■	□	□	□
14.	□	■	□	□
15.	□	□	■	□
16.	□	□	□	■
17.	□	■	□	□
18.	□	■	□	□
19.	■	□	□	□
20.	□	□	□	■
21.	□	□	■	□
22.	■	□	□	□
23.	□	□	□	■
	a	b	c	d
24.	■	□	□	□
25.	□	■	□	□
26.	■	□	□	□
27.	□	□	□	■
28.	■	□	□	□
29.	□	□	■	□
30.	□	□	□	■
31.	□	□	□	■
32.	□	□	□	■
33.	□	□	■	□
34.	□	□	■	□
35.	□	□	■	□
36.	□	■	□	□
37.	□	■	□	□
38.	□	□	□	■
39.	■	□	□	□

40. **(Diagram of lab with location of required items: fire blanket, fire extinguisher, exits, safety-goggles storage [or dispensing area], eyewash station, safety shower, closest fire alarm, waste-disposal containers [label type of waste for which each container is suitable])**

Appendix F

Sample Safety Checklist for Science Instruction, Preparation, and Storage Areas

School: ____

Date: ____

Teacher(s): ____

Room or area: ____

Science teachers should check their instructional areas periodically to determine whether unsafe conditions exist. Teachers who have concerns about safety conditions related to facilities, equipment, supplies, curriculum, classroom occupant load, and so on should notify their department chairpersons and school-site administrators immediately in writing for assistance in alleviating the conditions.

The following checklist may be used to determine whether a safe environment exists and to indicate possible areas of concern and danger.

1. Good general housekeeping prevails, and aisles are clear of materials and apparatus. ☐

2. Signs of the locations of first-aid and safety equipment are visible throughout the room (e.g., fire extinguishers, fire blanket, eyewash station). ☐

3. Adequate storage space is provided for chemicals, materials, and apparatus. ☐

4. The classroom/laboratory has no blind spots—that is, areas in which students cannot be supervised by the teacher from anywhere in the room. ☐

5. There is adequate classroom/laboratory space for the various learning activities planned. ☐

6. The following equipment or conditions are adequate:

   - Counter and work space for all students to do laboratory activities at one time ☐
   - Three-prong Electrical outlets ☐
   - Gas outlets ☐

- Sinks and water faucets ☐
- Space between laboratory stations ☐
- Ventilation for the laboratory activities planned (or a manually controlled purge system for the rapid exchange of room air) ☐

7. There are ground fault circuit interrupters (GFCIs) on electrical outlets near sinks. ☐

8. Cabinets and open shelves are equipped with lips or restraining wires to prevent chemical spillage or breakage of glassware during an explosion or earthquake. ☐

9. The room has at least two exits. ☐

10. The light level is adequate (about 75 to 100 foot-candles at work surfaces). ☐

11. Separate designated waste containers are provided for:
    - Broken glass ☐
    - Spent matches, wood splints, toothpicks, and so on ☐
    - Flammable waste chemicals ☐
    - Nonflammable waste chemicals ☐

12. Quantities of hazardous chemicals kept on hand are limited to the amounts needed for one school year. ☐

13. Proper labels and signs are kept in place on all chemicals and on the storage area. ☐

14. A chemical-spill kit is available for emergency use. ☐

15. Chemical containers are inspected periodically for leakage or deterioration (such as sediments and discoloration), and approved disposal procedures are followed as necessary. ☐

16. Any cylinder gas is stored according to the required safety code (for example, chained or strapped in a cart or to the wall). ☐

17. Splash-proof indirectly ventilated safety goggles, face shields, aprons, safety shields, and so on are available to protect the teacher and students when hazardous conditions exist. ☐

18. Goggles and face-shield sterilization facilities are available. ☐

19. Eyewash fountains, hand-held drench hoses, and safety showers (as necessary) are easily accessible and are flushed weekly to remove scale and rust. ☐

20. Fume hoods are clean, are uncluttered, and have a streamer easily visible throughout the room when in operation; the hoods are tested periodically to ensure adequate air flow. ☐

21. All equipment is properly maintained. ☐

22. All electrical equipment is three-wire grounded (except for double-insulated tools and equipment). ☐

23. Electrical outlets and extension cords are kept in safe, working condition. ☐

24. Electrical equipment, such as the refrigerator and aquarium aerator, is connected directly to a wall outlet and is not serviced through an extension cord. ☐

25. Gas outlets and burners are maintained in safe working condition. ☐

26. A fire extinguisher capable of extinguishing class A, B, and C fires is kept in working condition at all times and in a conspicuous and accessible place. ☐

27. Dry sand or other appropriate means is available to extinguish class D fires. ☐

28. An approved fire blanket (preferably fire-retardant-treated 100 percent wool) is kept in a conspicuous and accessible place. ☐

29. Flammable liquids are stored in the classroom in fireproof containers (not glass) and in quantities sufficient for only one day’s supply. ☐

30. Approved fire-retardant storage cabinets (with a bottom pan to contain spills temporarily), separate from the classroom, are used for storing larger quantities of flammable, corrosive, and other dangerous chemicals. ☐

31. The larger storage containers of acids and bases are stored on the lower cabinet shelves. ☐

32. Flammable liquids are not kept in refrigerators, unless the refrigerators are certified as explosion-proof. ☐

33. Food is not kept in refrigerators that are used for storing science materials. ☐

34. Ether on hand was purchased less than one year ago. ☐

35. Ethers are periodically disposed of before they exceed their one-year shelf life. (See “Use and Disposal of Ethers” in Chapter 7.) ☐

36. Sodium is stored underneath kerosene or oil. ☐

37. Incompatible chemicals are not stored adjacent to one another. (See Appendix D for a list of incompatible chemicals found in high school laboratories.) ☐

38. All chemical containers are dated on receipt, and a current inventory is maintained. ☐

39. The Standardized Safety Data Sheet for any chemical being handled or used in school is readily available. ☐

40. The locations of the master electrical and gas shut-off controls are labeled and readily accessible. ☐

41. Plumbing fixtures are in correct operating condition. Faucets are equipped with air gaps to prevent backflow. ☐

42. Animals are cared for in an appropriate, safe, and humane environment. ☐

43. Hazardous chemical waste is properly stored, handled, and disposed of. ☐

44. Fire-drill and earthquake-drill procedures are posted and familiar to all teachers and students. ☐

45. The school district's emergency procedures are prominently posted. ☐

46. An adequate first-aid kit, including the Red Cross *Standard First Aid and Personal Safety Manual* or appropriate alternate information, is provided. (See Chapter 2, "First Aid.") ☐

47. The teacher is familiar with first-aid and safety measures related to science instruction as presented in this publication. ☐

48. The *Science Safety Handbook for California Public Schools* is readily accessible. ☐

Write a summary of the survey and note actions taken to remedy inadequate conditions.

Signature(s) ______________________________ Date_______________

______________________________ Date_______________

______________________________ Date_______________

Appendix G

End-of-Year Safety and Energy-Savings Procedures

1. Inventory all chemicals. Remove all substances that are outdated, deteriorated, potentially dangerous, and unlikely to be used. Pack them in separate boxes by compatibility category and clearly mark the boxes “Chemicals for disposal.” Attach a list of contents to each box. Call the appropriate school district office or waste disposal agency to pick up the materials; identify the *exact location* of the items to be picked up.

2. Dispose of diethyl ether older than one year and ethers in containers that are partially used; follow the procedure outlined in Chapter 7, Section I. (Any ether may form peroxides, as described earlier in the handbook.) Only unopened, recently received containers of ethers that were dated on receipt and can be verified as less than one year old by the time of their use in fall laboratory activities may be retained and should be locked in the school district’s standard flammable-liquids cabinet during the summer break. Refer to the safety checklist in Appendix F, items 15, 34, and 35.

   Recommendation: Order only those supplies of ether necessary for the current school year.

3. Be certain all gas cylinders in high school laboratories are capped and properly secured for the summer.

4. Clean out, defrost, and leave unplugged all refrigerators during the summer break. Prop the doors open to allow air circulation and prevent growth of mildew. This recommendation is a safety measure and saves electrical energy.

5. Arrange for shutoff of any water heaters in the science department.

6. Unplug all electrical items, such as isolated wall clocks, timers, personal table clocks/radios, hotplates, aquarium pumps, computers, terminals, microscope lights, oscilloscopes, and any other electrically powered science instructional item.

7. Arrange for adequate temperature control and ventilation of sensitive equipment and chemicals to ensure safe storage.

Appendix H

The California Poison Control System

The California Poison Control System (CPCS) provides immediate, free, and expert treatment advice and referral concerning exposure to poisonous or toxic substances. The system can be accessed anytime—24 hours a day, seven days a week, 365 days a year—by dialing **1-800-222-1222** from anywhere in California. Even if a poisoning is merely suspected, it is better to call the CPCS and be sure.

The CPCS is managed by the University of California San Francisco, School of Pharmacy, Department of Clinical Pharmacy, and consists of four answering sites: Children's Hospital Central California (Fresno/Madera Division), UC Davis Medical Center (Sacramento Division), UC San Diego Medical Center (San Diego Division), and San Francisco General Hospital (San Francisco Division).

Contact information for the central office and the four answering sites is given below.

Central Office
School of Pharmacy—Department of Clinical Pharmacy
University of California San Francisco
Box 1262
San Francisco, California 94143-1262
Telephone: 415-502-8600 (administrative office only)
Fax: 415-502-8620

Fresno/Madera Division
at Valley Children's Hospital
9300 Valley Children's Place, MB15
Madera, California 93638-8762
Telephone: 559-622-2300 (administrative office only)
Fax: 559-622-2322

Sacramento Division
at UC Davis Medical Center
2315 Stockton Boulevard
Sacramento, California 95817-2201
Telephone: 916-227-1400 (administrative office only)
Fax: 916-227-1414

San Diego Division
at UC San Diego Medical Center
200 West Arbor Drive
San Diego, California 92103-8925
Telephone: 858-715-6300 (administrative office only)
Fax: 858-715-6323

San Francisco Division
at San Francisco General Hospital
University of California San Francisco
Box 1369
San Francisco, California 94143-1369
Telephone: 415-502-6000 (administrative office only)
Fax: 415-502-6010

Appendix I

Reimbursement for Removal and Disposal of Chemicals

On July 28, 1988, the Commission on State Mandates (Commission) adopted a Statement of Decision finding that Statutes 1984, Chapter 1107 and the Department of Education Guidelines developed pursuant thereto, imposed a new program or higher level of service for school districts and county offices of education within the meaning of article XIII B, Section 6 of the California Constitution and *Government Code* Section 17514. The Commission determined the following activities to be reimbursable:

- Implementing and maintaining a program for the regular removal and disposal of all chemicals whose shelf life has elapsed in accordance with the guidelines issued by the State Department of Education, and
- Certifying to the Superintendent of Public Instruction whether the district is in compliance with the guidelines.

Statutes 1994, Chapter 840 amended *EC* Section 49411, subdivision (b), and deleted the language that required each school district, on or before January 1, 1986, to certify compliance with the guidelines to the superintendent. On October 4 2006, the Commission amended the parameters and guidelines to conform to Statutes 1994, Chapter 840.

All costs incurred after June 30, 1988, associated with the removal of chemicals that meet the definition of “retrograde materials,” as defined in *HSC* Section 25121.5, **are non-reimbursable.**

While this is still the case, California currently owes hundreds of thousands of dollars in unpaid mandates.

Chemicals that should be removed from School Science Laboratories

The following list identifies three groups of chemicals:

1. Those chemicals included on lists of hazardous chemicals that were recommended for removal and disposal in the 1999 edition of this handbook and that, at this time, are considered "retrograde materials" are identified with an asterisk (*). (See definition of retrograde materials in Appendix B of *HSC* Section 25125.5.) The costs for disposal of these "retrograde materials" are **not** considered reimbursable.
2. Chemicals that have been added to the previous lists of hazardous chemicals recommended for immediate or prompt removal and disposal (see Tables 7.1, 7.2, and 7.3) are identified with two asterisks (**).
3. Chemicals that are subject to regular removal and disposal, on approaching their estimated shelf life, because they pose a significant threat to the health and safety of teachers, staff, and students but have not yet reached a "retrograde" condition **have no asterisk**. The costs for disposal of these materials *are* reimbursable.

A		
Acetic acid (glacial)	2-Acetylaminofluorine*	Acetone
Acrylamide**	Aluminum (powder)	Aluminum chloride
Aluminum sulfate	4-Aminodiphenyl*	Ammonium carbonate
Ammonium chloride	Ammonium hydroxide	Ammonium nitrate
Ammonium persulfate	Aniline*	Antimony**
Arsenic compound (any)*	Arsenic powder*	Arsenic trioxide*
Asbestos*		
B		
Barium (soluble compounds)	Barium chloride	Barium hydroxide
Barium nitrate	Bismuth and alloys (powder)	Benzene*
Benzidine (and salts)*	Benzoyl peroxide*	Beryllium**
Beryllium compounds**	Boric acid	Bromine**
Butyl alcohols		

C		
Cadmium powder*	Cadmium salts*	Calcium carbide**
Calcium chloride	Calcium hydroxide	Calcium hypochlorite
Calcium metal	Calcium nitrate	Calcium oxide
Camphor	Carbon disulfide*	Carbon tetrachloride*
Chloroform*	Chromium (VI) oxide*	All hexavalent chromium compounds**
Cobalt**	Cobalt chloride	Cobalt II oxide**
Cobalt nitrate	Cobalt sulfate	Cupric chloride
Cupric nirate	Cupric oxide	Cupric sulfate
Cyclohexane		
D		
p-Dichlorobenzene**	3,3-Dichlorobenzidene (and salts)*	Diisopropyl ether (if stored more than 1 year)*
Dimethyl amine*	4-Dimethylaminoazobenzene*	
Dinitrophenols	2, 4-Dinitrophenol	
E		
Ethidium bromide**	Ethyl acetate	Ethyl alcohol
Ethyl ether/Diethyl ether (if stored more than 1 year)*	Ethylene dichloride*	Ethylene oxide*
Ethyleneimine*		
F		
Ferric chloride	Ferric nitrate	Ferrous sulfate
Formaldehyde**	Formic acid	
H		
Hexane	Hydrazine (anhydrous)*	Hydrochloric acid
Hydrofluoric acid*	Hydrogen peroxide (35%)**	

I		
Iodine	Isobutyl alcohol	Isopropyl alcohol
K		
Kerosene		
L		
Lead (powder)**	Lead acetate**	Lead arsenate*
Lead carbonate**	Lead chloride**	Lead nitrate**
Lead oxide**	Lead peroxide (dioxide)**	Lead sulfate**
Lead sulfide**	Lithium nitrate	
M		
Magnesium chloride	Magnesium metal (powder/ribbon)	Magnesium nitrate
Magnesium oxide	Manganese dioxide	Manganous sulfate
Mercurous/mercuric nitrate**	Mercury compounds**	Mercury metal**
Methanol	Methyl cellulose	Methyl ethyl ketone
Methylchloromethyl ether*	4-4-Methylene bis (2-chloroanaline)*	Methylene chloride*
N		
Alpha-naphthylamine*	Beta-naphthylamine*	Nickel compounds**
Nickel powder*	Nicotine**	4-Nitrobiphenyl*
Nitric acid	Nitrogen triiodide*	
O		
Oxalic Acid		

P		
Pentane	Perchloric acid*	Phenol (carbolic acid)**
Phosphorous (red)**	Phosphorous (yellow/white)*	Picric acid*
Potassium bromide	Potassium chlorate**	Potassium hydroxide
Potassium iodide	Potassium metal*	Potassium nitrate
Potassium permanganate	Beta-propiolactone*	
R		
Resorcinol		
S		
Sodium arsenate*	Sodium arsenite*	Sodium azide*
Sodium chlorate	Sodium chromate	Sodium hypochlorite
Sodium metal	Sodium nitrate	Sodium peroxide
Sodium thiosulfate	Styrene	Sulfur
Sulfuric acid		
T		
Toluene**	Turpentine	
V		
Vinyl chloride*		
X		
Xylene		
Z		
Zinc, metal powder	Zinc nitrate	

Appendix J

Safety Precautions for Rocket Launchings on School Sites

Always wear appropriate eye protection during rocket launchings.

Solid Propellant Engine Rockets

State fire laws now allow model rockets to be launched on school sites provided that the conditions outlined in this appendix are observed.

Activities involving the firing of rockets must be well planned. It is recommended that launchings be limited to no more than 10 rockets if an audience will be present. Only authorized classes and clubs may engage in this kind of activity.

Guidelines for the firing of model rockets on school sites are as follows:

1. **Purpose.** These regulations have been prepared for the purpose of establishing reasonable safety standards for the testing and flying of model rockets. Model rockets are classified as nonprofessional rockets that are propelled by approved, commercially manufactured solid propellant engines.
2. **Special permit.** At least four weeks before the date selected for the firing of model rockets, the school shall submit a firing request to the responsible district office. A special permit shall be obtained from the fire department for a given period. (Usually, the fire department's policy is to issue such a permit to cover a brief time.) The permit is issued in the name of the school administrator. The instructor shall comply with all safety standards and conduct the launching in a manner that is also acceptable to the school administrator.
3. **Size of rockets.** Rockets with a class A or smaller engine are strongly recommended. Configuration of the rockets is not limited except for weight (four ounces [112 gm] with engine) and length (not less than ten inches [25 cm] or greater than 15 inches [38 cm]). The rocket shall contain no metal parts.

4. **Launch site standards.** The following stipulations apply:
    a. The launch site shall consist of a firing area and a recovery area. The firing area shall be considered that area contained within a radius of 25 feet (8 m) from the location of the launching platform. The recovery area shall include the firing area and shall be determined to be the minimum area necessary for retrieval of the launched rocket.
    b. The minimum size of the launch site shall extend to a radius of at least 100 feet (30 m) from the firing position.
    c. The launch site shall not be located in a grain field, in an area of dry grass or bush, or in a forested area.
    d. The launch site shall not contain or be located near any high-voltage line, major highway, or any other obstacle deemed hazardous by the fire department.
    e. The launch site shall not include any buildings or other structures, unless approved by an official from the fire department.
    f. The firing area shall not be closer than 25 feet (8 m) from the boundary of the launch site.
5. **Launching facilities.** Model rockets shall be launched only from platforms that meet the following conditions:
    a. A launch guide (tube, wire, or other suitable device) shall be used to restrict the horizontal motion of the rocket until sufficient flight velocity is achieved to maintain stability during flight. Ignition of the model rocket engine shall be by remote electrical means and shall be under the control only of the person launching the rocket. The launch shall be properly supervised by the instructor in charge.
    b. The launching angle shall not be less than 75 degrees from the horizontal plane.
    c. The surface wind at the launch site shall not exceed 18 miles per hour (30 km per hour), and vertical visibility from the firing area shall be at least 715 yards (650 m).
    d. The recovery device material (parachute or other) ejected from the rocket during the flight sequence shall be of flame-resistant material.

e. The model rocket shall be launched only during daylight hours (except when specifically approved otherwise by the fire department).

f. All personnel conducting or observing the firing shall maintain a clear distance of not less than 25 feet (8 m) from the launch platform during the countdown and firing. The firing site shall be clearly blocked off by rope or some other temporary measure.

g. Only one source of power shall be used for each launch site. No vehicles shall be within the firing area.

h. The person launching the rocket shall make all electrical connections at both the firing platform and the source of power.

i. All spectators shall be positioned upwind of the firing areas and at a distance of at least 25 feet (8 m) from the firing site.

6. **Supervision.** The instructor in charge of the firing site shall supervise the arming of the rocket with the rocket engine, the firing of the rocket, and the disposal of all unfired or defective rocket engines. A second adult shall be responsible for the safety of spectators and all other persons who may be present.

7. **Misfires.** After any misfire, the rocket shall be allowed to remain in the launch position for at least one full minute before the rocket is approached. All disarming shall be performed under the supervision of the instructor in charge. The person checking the misfire shall wear a face shield.

Water Rockets

Safety is very important with any rocket. Water rockets in particular are not toys. A pressurized water rocket can store huge amounts of energy and fly hundreds of miles per hour. They can suddenly burst, or injure bystanders by landing hundreds of feet away. Students should never be allowed to launch water rockets without constant adult supervision. Local laws and regulations may apply. It is the responsibility of all participants to be familiar with and follow all appropriate regulations related to rocketry. Use ordinary tap water. Do not use substances that are harmful to the environment.

1. **Construction Materials**

   a. Only lightweight, nonmetallic external parts for the nose, body, payload container, and fins should be used so that the rocket does not conduct electricity.

b. Never use “glass” or other breakable containers at any time. Use only carbonated beverage bottles or pressure chambers that are designed to handle the envisioned flight pressures.

2. Payload Materials

a. The payload container has to be constructed from strong, nonmetallic materials.

b. The payload section is to be attached above all pressurized parts of the rocket and must not contain any exposed metal parts.

c. The payload section must be separate from any pressurized portions of the rocket.

d. Payloads should never include any flammable, explosive, biohazardous materials or live animals.

3. Recovery System

a) All launched parts of a rocket that travel over 6 meters (20 feet) in altitude must have a recovery system that limits their descent rate at time of touchdown at ground level to a maximum velocity of 10 meters/second (33 feet/second). This includes all pieces that separate or are shed in flight. Fast-falling rockets, debris, and rocket parts can be very dangerous. Recovery system malfunctions will disallow any record flights.

b) The recovery system cannot contain black powder, fireworks, or pyrotechnic “squibs.”

4. Pressure Vessel

a) The pressure vessel shall be made of thin, ductile plastic capable of withstanding the intended launch pressure.

b) The pressure vessel may not be constructed using any portion of an existing high-pressure enclosure.

c) The pressure vessel and all external parts of the rocket may not be fabricated from metal. In addition to being heavy and dangerous if falling because of failed deployment, metal can also cause major problems if landing on power lines.

d) Metallic components should never be in contact with the outside of the pressure vessel, as they could become dangerous projectiles should the rocket explode.

e) Pressure testing of all rocket pressure vessels should be performed by filling the vessel completely with water before pressurizing the system. It is also recommended that a protection barrier be deployed to minimize projectiles being ejected from the testing area if a burst of the vessel occurs.

f) The rocket must be pressurized with atmospheric air. No exotic gases, cryogenics, or combustibles are allowed.

5. Launcher

a) Rockets should be launched from a stable launch device that is pointed to within 30 degrees of the vertical to ensure that the rocket flies nearly straight up.

b) The rocket must be launched remotely. Operators/spectators are to stand back a minimum of 15 meters (50 feet) while a rocket is pressurized and remotely launched. A high-pressure rocket can rupture and explode violently and may cause severe injury.

c) Safe distance: Everyone should be kept at a safe distance from any pressurized rocket. Fifty feet (15 meters) between flight-crew members and a pressurized rocket is considered a safe distance. Add a minimum of 10 feet (three meters) or more for spectators. Spectators should always stay behind flight-crew members.

6. Pressure Source

a) All valves, hoses, pipes, and fittings from the pressure source to the launch pad shall be rated for the planned launch pressure.

b) The rocket must be pressurized using atmospheric air only.

7. Flight Safety

a) Rockets should be launched only outdoors, in a clear, open area without obstacles such as trees or power lines.

b) An audible countdown should be used before each launch.

c) Rockets should be launched in safe weather conditions, with wind speeds no greater than 15 miles per hour.

d) Do not attempt to recover any rocket from power lines, tall trees, rooftops, or other dangerous places.

e) Do not launch rockets over or near roadways or into the path of a vehicle.

Appendix K

Science Classroom First-Aid and Safety Materials

A science classroom should be stocked with the supplies and equipment:

Adhesive bandages

Antiseptic

Antiseptic applicators

Aprons

Bucket of sand or commercial absorbent—to smother alkali fires, form a dam around spills, reduce slippery conditions, and so on

Cotton

Earthenware crock—for disposal of solid chemicals, if needed. Have on hand several crocks, each labeled to prevent mixing of incompatible chemicals.

Fume hoods, where appropriate

Mercury-cleanup chemicals (e.g., zinc dust, mercury "sponges"[*])

Neutralizing agents

- Acetic acid (30% [5 M] solution)—for neutralizing spilled bases
- Sodium bicarbonate (saturated solution)—for neutralizing spilled acids

Rubber and nitrile gloves

Safety equipment:

- Eyewash/shower unit
- Face shields
- Fire blanket
- Fire extinguisher(s), multipurpose (2A-10B, C)
- Safety shield

Splash-proof indirectly ventilated goggles—for every student, instructor, and visitor

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[*] See Chapter 7, Section K, "Handling and Cleanup of Mercury."

Note: This list is purposely conservative because the school health office (or school nurse) should have more extensive supplies.

Sample Accident Report

School: ______________________________

Staff member completing report: ________________________Room: _________________

Date and time of incident: ____

Location of the incident: ____

Person(s) involved in the incident:

Staff	Student
__________________________________	__________________________________
__________________________________	__________________________________
__________________________________	__________________________________
__________________________________	__________________________________

Description of the incident:

____

____

____

Immediate action in responding to the emergency:

____

____

____

Action taken (or required) to prevent such incidents in the future:

____

____

____

Witnesses to the incident: _______________________________

____

____

_______________________________ ____

Date/time of report Signature

Appendix L

Sample Field Trip Permission Slip

School: ____

Teacher: ____ Date: ___________

Student’s name: ____

Subject: ____

A field trip has been scheduled for the class, which includes the student named above, on _______________(date). Transportation is by (bus, vehicle) ___________________ , which will leave the school at _________ (a.m./p.m.) and return at approximately __________ (a.m./p.m.).

The field activities will take place at (location)________________________________.

The purposes of the trip are as follows:

Each student will be expected to:

Dress requirements/options are as follows:

Possible hazards and necessary precautions are as follows:

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) or other concerns you may have that might affect the student's safety on the field trip:

Parent's or Guardian's Statement

I have read the description of the proposed field activity noted above and give my consent for this student to engage in the field trip.

I pledge my cooperation in making her/him aware of the precautions, as necessary, and in urging that she/he observe the precautions and any other instructions during the trip.

Signature of parent or guardian:_________________________________ Date:____________

Telephone number:____

Return the completed and signed form to ___________________________ by ____________.

Appendix M

Outbreaks of Coccidioidomycosis Associated with Field Work

Recommendations for Prevention from the
California Department of Public Health

There has been increasing public health concern about outbreaks of coccidioidomycosis (valley fever) among archaeology students in California. The purpose of this statement is to place the problem in its proper perspective and to list precautions which we feel should be taken to help prevent future outbreaks.

On November 24, 1970, the Bureau of Communicable Disease Control, State Department of Public Health, wrote anthropology departments of California colleges that susceptible students and faculty were at risk of acquiring coccidioidomycosis on archaeologic expeditions and suggested that this risk be made known to all who might participate in field work in areas in which the disease is endemic.

Additional outbreaks of coccidioidomycosis have occurred in California among archaeology students since then. Illness rates have exceeded 50 percent in several student groups, and serious disseminated diseases (which required protracted hospitalization and treatment) occurred in a few instances. Outbreaks have continued to occur year after year at sites known to be contaminated with the fungal agent causing coccidioidomycosis.

Coccidioidomycosis can be contracted by minimal exposure to dusty soil in contaminated areas. Almost all of the millions of people who are lifetime residents in these areas eventually develop infection from and a lifetime immunity to the soil fungus. However, when groups of persons from noncontaminated areas enter contaminated areas to engage in field activities which include excavation, particularly archaeological digging, a high infection and illness rate can result from a relatively brief exposure.

Therefore, we recommend the following to all school programs engaged in *any* field work involving exposure to dusty soil in areas in which coccidioidomycosis is endemic:

1. No educational institution should require students or faculty to participate in field work in areas in which coccidioidomycosis is endemic. Alternative course work should be considered to satisfy course requirements.
2. Information on coccidioidomycosis should be made available to all prospective students and faculty. Recommended references should include at least the following publications:
    a. Loofbourow, J. C., and D. Pappagianis. *Coccidioidomycosis—An Occupational Hazard for Archaeologists.* Society for California Archaeology, Special Report No. 2, December, 1971.
    b. *Coccidioidomycosis (or Valley Fever).* Sacramento: California State Department of Public Health, 1969.

Appendix N

Certified Unified Program Agency (CUPA) Directory—Web Site

A Certified Unified Program Agency (CUPA) is a government agency that is responsible for implementing the Unified Program at the local level. The Unified Program consolidates, coordinates, and provides consistency for the administrative requirements, permits, inspections, and enforcement activities of six environmental and emergency response programs.

A local CUPA may be found by conducting a search of county or local government at the following Web site: ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014)

The information available through this Web site is updated continuously.

Appendix O

Managing Empty Containers

The *CCR,* Title 22, Section 66261.7, addresses the issue of contaminated containers. Any container, or inner liner removed from a container, that previously held hazardous materials or hazardous waste must be managed as a hazardous waste. However, the following containers are exempt from regulation as a hazardous waste pursuant to Chapter 6.5 of Division 20 of the *HSC* (commencing with Section 25100): (1) empty containers managed in accordance with these regulations and (2) specific containers that meet special provisions. Additional information is available through the local Certified Unified Program Agency (CUPA) and the Department of Toxic Substances Control Fact Sheet, “Managing Empty Containers,” dated February 2009. The fact sheet is available at http://www.dtsc.ca.gov/HazardousWaste/upload/Managing-Empty-Containers.pdf (accessed November 17, 2014). The local CUPA can be found through the Unified Program Regulator Directory maintained by the California Environmental Protection Agency at ://cersapps.calepa.ca.gov/public/directory/ (accessed November 17, 2014).

Empty Containers

A container is a portable device in which material can be stored, handled, treated, transported, recycled, or disposed (*CCR*, Title 22, Section 66260.10). The definition of an **empty container** is dependent upon the contained material (*CCR,* Title 22, Section 66261.7(b) and (d)):

- Container with pourable materials: All material removed by any practicable means (draining, pouring, pumping, or aspirating) until there is no longer a continuous stream of material coming from the opening when the container is held in any orientation.
- Container with nonpourable materials: All material removed that can be feasibly removed by physical methods (scraping, chipping, but not rinsing).
- Container with acute or extremely hazardous waste: All material removed by triple-rinsing the container using a solvent capable of removing the material or a proven equivalent cleaning method. These activities may require a formal permit from the Department of Toxic Substances Control or the local CUPA.

To be exempt from regulation as hazardous waste, a container must meet the definition of an empty container and must be managed by one of the following methods (*CCR,* Title 22, Section 66261.7[e]):

- Reclaim the scrap value of the container on site.
- Send the container to a person who reclaims the scrap value of the container.
- Recondition or remanufacture the container on site.
- Ship the container to a person who reconditions or remanufactures the container.

Alternatively, an empty container with a capacity of 5 gallons or less may be disposed of at an appropriate solid waste disposal facility. The following requirements also apply for empty containers with a capacity of more than 5 gallons:

- Mark container with the date emptied and manage within one year of that date (*CCR,* Title 22, Section 66261.7[f]).
- Maintain the name, street address, mailing address, and telephone number of the owner or operator of the facility where the empty container has been shipped for three years (*CCR,* Title 22, Section 66261.7[g]).

Special Provisions for Specific Containers

The following specific containers are exempt from regulation as hazardous waste if the associated special provisions are met:

- Uncontaminated container in which the inner liner has prevented contact of the hazardous material with the inner surface of the container (*CCR,* Title 22, Section 66261.7[h]).
- Compressed gas cylinder in which pressure in the container approaches atmospheric pressure (*CCR,* Title 22, Section 66261.7[l]).
- Aerosol container emptied of contents and propellant to the maximum extent practical under normal use (i.e., the spray mechanism was not defective and allowed discharge of contents). Additionally, the aerosol container must not be a federal hazardous waste as defined in the Resource Conservation and Recovery Act and must not contain an acute or extremely hazardous waste. An aerosol container is defined as a pressurized, sealed

container that contains a product and liquefied or compressed gases dispensed by a pressure-sensitive valve (*CCR,* Title 22, Section 66261.7[m]).

- Containers made from absorptive materials (wood, cardboard, cloth, or paper) if the container was not in contact with and has not absorbed hazardous waste or material (*CCR,* Title 22, Section 66261.7[n]).

Appendix P

Sample Biological Science Laboratory Regulations

______________________ School District

The following regulations have been compiled for the safety of students performing laboratory work in biological science classes. Strict observance of the regulations is mandatory. All students in the school district are to follow these regulations, rather than any conflicting instructions in textbooks or laboratory manuals.

Students and parents are to read the regulations, sign the form, and return the form to the instructor. This procedure must be completed before a student can begin any laboratory activity. The student should keep a copy of the regulations in his or her notebook for future reference.

General

1. An instructor must be present during the performance of all laboratory work.
2. Prepare for each laboratory activity by reading all instructions before coming to class. Follow all directions implicitly and intelligently. Make a note of any modification in procedure given by the teacher.
3. Always approach laboratory experiences in a serious and courteous manner.
4. Use only those materials and equipment authorized by the instructor. Any science project or individually planned experiment must be approved by the teacher.
5. Know the proper fire- and earthquake-drill procedures.
6. Roll long sleeves above the wrist. Long, hanging necklaces; bulky jewelry; and excessive or bulky clothing should not be worn in the laboratory.
7. Confine long hair during a laboratory activity.
8. Wear closed-toe shoes in the laboratory. Sandals are not permitted.
9. Wear appropriate eye protection, as directed by the instructor, whenever working in the laboratory. Safety goggles must be worn during hazardous activities involving

caustic/corrosive chemicals, heating of liquids, and other activities that may injure the eyes.

10. Splashes and fumes from hazardous chemicals present a special danger to wearers of contact lenses. Therefore, it is preferable for students to wear regular glasses (inside splash-proof goggles, when appropriate) during all class activities or purchase personal splash-proof goggles and wear them whenever exposure to chemicals or chemical fumes is possible.
11. Place books, purses, and other personal items in the designated storage area. Take only laboratory manuals and notebooks into the working area.
12. Report any accident to the teacher immediately, no matter how minor. This includes any burns, scratches, cuts, or contact with corrosive liquid (on skin or clothing).
13. Students with open skin wounds on hands must wear gloves or be excused from the laboratory activity.
14. Eating or drinking in the laboratory or from laboratory equipment is not permitted.
15. Students are not permitted in laboratory storage rooms or teachers' workrooms without the approval of the teacher.

Handling Equipment

16. Inform the teacher immediately of any equipment that is not working properly.
17. Report broken glassware, including thermometers, to the instructor immediately.
18. Operate electrical equipment only in a dry area and with dry hands.
19. When removing an electrical plug from its socket, pull the plug, not the electrical cord.
20. When heating material in a test tube, do not look into the mouth of the tube or point it in the direction of any person during the process.
21. When heating volatile or flammable materials, use a water bath; that is, heat the materials in or over heated water, using a hot plate to heat the water. Extinguish all open flames.
22. Know the location and operation of the emergency shower, eyewash and facewash fountain, fire blanket, fire extinguisher, fire-alarm box, and exits.
23. Light gas burners only as instructed by the teacher. Be sure no volatile materials (such as alcohol or acetone) are being used nearby.
24. Use a burner with extreme caution. Keep head and clothing away from the flame and turn it off when not in use.
25. Use a fire blanket to extinguish any flame on a person (see "stop, drop, and roll" procedure in Chapter 2, Section C).

26. Use the fume hood whenever noxious, corrosive, or toxic fumes are produced or released.
27. Exercise caution in using scissors, scalpels, dissecting needles, and other sharp-edged instruments. Pass them with handles extended when handing them to other persons.
28. Wash all sharp-edged and pointed instruments separately from other equipment.
29. Match hole size and tubing when inserting glass tubing into a stopper. If necessary, expand the hole first by using an appropriately sized cork borer. Lubricate the stopper hole and glass tubing with water or glycerin to ease insertion, using towels to protect the hand. Carefully twist (never push) glass tubing into stopper holes.

Handling Chemicals

30. Check labels and equipment instructions carefully. Be sure correct items are used in the proper manner.
31. Be aware if the chemicals being used are hazardous. Know where the Standardized Safety Data Sheets (SDS) are and what they indicate for each of the hazardous chemicals being used.
32. Never pour reagents back into bottles, exchange stoppers of bottles, or lay stoppers on the table.
33. Use great care when working with ether or other volatile liquids. Windows and doors should be opened for greatest possible ventilation. Be sure that caps or lids of containers used for chemicals are securely closed.
34. Keep hands away from face, eyes, and clothes while using solutions, specimens, equipment, or materials in the laboratory.
35. To treat a burn from an acid or alkali, wash the affected area immediately with plenty of running water. If the eye is involved, irrigate it at the eyewash station without interruption for 15 minutes. Report the incident to the instructor immediately.
36. Never carry hot equipment or dangerous chemicals through a group of students.
37. Use a mechanical pipette filler (never the mouth) when measuring or transferring small quantities of liquid with a pipette.
38. Never taste anything or touch chemicals with the hands unless specifically instructed to do so.

Plants and Animals

39. Rinse dissection specimens occasionally or whenever fumes or chemicals are released in the dissection process.

40. Never handle animals in the laboratory unless directed to do so by the teacher.
41. Never insert fingers or objects through the wire mesh of animal cages to pet or tease the animals.
42. Notify the teacher at once if bitten by an animal.
43. Never bring animals or poisonous plants to school.

Bacteria and Fungi

44. Never open petri dishes containing bacterial or fungal growth unless directed to do so by the teacher.
45. Dispose of all discarded bacterial and fungal cultures by sterilization as directed by the teacher.

Cleanup and Disposal

46. Be sure all glassware is clean before use. Clean glassware thoroughly after use. Residue may cause errors in new experiments or cause a violent reaction or explosion.
47. Keep work areas clean. Floors and aisles should be kept clear of equipment and materials.
48. Clean up any spill on the floor or work space immediately.
49. Dispose of laboratory waste as instructed by the teacher. Use separate, designated containers (not the wastebasket) for the following:
    - Matches, litmus paper, wooden splints, toothpicks, and so on
    - Broken and waste glass
    - Rags, paper towels, or other absorbent materials used in the cleanup of flammable solids or liquids
    - Hazardous/toxic liquids and solids
50. Remove all broken glass from the work area or floor as soon as possible. Never handle broken glass with bare hands; use a counter brush and dustpan.
51. Always clean the laboratory area before leaving.
52. Students and teacher should wash hands with soap and water before leaving the laboratory area.

Note: Persistent or willful violation of these regulations will result in the loss of laboratory privileges and possible dismissal from the class.

Appendix Q

Carcinogen “Report of Use” Form

CCR, Title 8

General Industry Safety Orders

5203. Carcinogen Report of Use Requirements.

(a) Scope. All employers who use a regulated carcinogen shall report that use in writing to the Chief as required by this section . . .

The form on the following page (along with the accompanying questionnaire) should be completed by any school that uses or has in storage any carcinogen included in the list shown on the form. A copy of the completed form should also be posted in a conspicuous place in the area in which the carcinogen(s) is used.

STATE OF CALIFORNIA

DEPARTMENT OF INDUSTRIAL RELATIONS
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
OCCUPATIONAL CARCINOGEN CONTROL UNIT
1515 Clay Street, Suite 1901
Oakland, CA 94612

ADDRESS REPLY TO:
DOSH - OCCU
P.O. Box 420603
San Francisco, CA 94142

Report of Use Number: __________

Report of Use
of Regulated Carcinogens

Title 8, *CCR* Section requires reporting the use of regulated carcinogens to the Division of Occupational Safety and Health. The list below indicates those carcinogens currently regulated and references the appropriate Title 8 section numbers (in bold) for each regulated carcinogen. Completion of the information below meets these requirements for report of use.

Any change in location, use, additions, or deletions of carcinogens used in the workplace must be reported within 15 calendar days.

A copy of each written report required by the section is required to be posted in the locations where the carcinogens are present in the workplace or in another appropriate location where the posting is conspicuous to employees.

____ 2-Acetylaminofluorene, **5209**
____ 4-Aminodiphenyl
____ Benzidine (and its salts)
____ 3,3'-Dichlorobenzidine (and its salts)
____ 4-Dimethylaminoazobenzene
____ 2, 4-Dinitrophenol and Dinitrophenols **51285, 329715**
____ alpha-Naphthylamine
____ beta-Naphthylamine
____ 4-Nitrobiphenyl
____ N-Nitrosodimethylamine
____ beta-Propiolactone
_____bis-Chloromethyl ether
____ Methyl chloromethyl ether
____ Ethyleneimine
____ Methylenedianiline (MDA), **1535, 5200**
____ 1,3 Butadiene, **5201**

____ Methylene chloride, **5202**
____ Chromium, **5206, 1532.2, 8359**
____ Cadmium, **1532, 5207**
____ Asbestos, **1529, 5208, 8358**
____ Non-asbestiform tremolite, anthophyllite, actinolite, **5208.1**
____ Vinyl chloride, **5210**
____ Coke Oven Emissions, **5211**
____ 1,2-Dibromo-3-Chloropropane (DBCP), **5212**
____ Acrylonitrile, **5213**
____ Inorganic arsenic, **5214**
____ 4,4'-Methylenebis(2-Chloroaniline) (MBOCA), **5215**
____ Formaldehyde, **5217**
____ Benzene, **5218**
____ Ethylene dibromide (EDB), **5219**
____ Ethylene oxide (Et0), **5220**

____( )______________

Employer/Company and Division name Telephone number

____

Street address City County Zip code

____

(If there has been a change, write the previous name, address, date, & report number if known)

____

Original signature and title of responsible representative Date (please print name)

Provide the information in items 1 through 6 below for each carcinogen checked on page one.

If multiple carcinogens are checked on page one, make extra copies of this page and indicate here the name of the carcinogen the information is for: ___________________________

1. A brief description of each process or operation that may result in employee exposure to the carcinogen.

2. The location in the workplace where the carcinogen is present or used.

3. The number of employees engaged in each process or operation.

4. The name and address of any collective bargaining representative(s), or other representatives of the employees.

5. A brief description of the quantities of carcinogen present or used.

6. Nature of Business: Indicate the Standard Industrial Classification (SIC) or North American Industry Classification System (NAICS) code (see ://www.census.gov/eos/www/ 11/17/14), or if the SIC and NAICS code are unknown, list the type of industry and principal product(s).

When completed, this form should be mailed the Division of Occupational Safety and Health at:

DOSH–OCCU
PO Box 420603
San Francisco, CA 94142

or faxed to:
Fax number: 510-286-7040

(If a temporary work-site location needs to be reported, see Section (e), and/or to report an emergency, see Section (f) for additional reporting requirements.)

Appendix R

Department of Transportation Hazard Classes

The U.S. Department of Transportation (DOT) has compiled a list of materials that are designated as hazardous for the purpose of transporting those materials in commerce. The list, labeled "Hazardous Materials Table" in the *Code of Federal Regulations,* Title 49, Transportation, specifies for each listed material a **hazard class** (or division within the class), which affects the required packaging, mailing, and labeling of the material. The hazard class specification is important to anyone who will ship those materials either for initial use or for disposal.

The hazard groups include explosives, combustible liquids, compressed gases, corrosives, flammable gases, flammable liquids, flammable solids, and poisons. The most up-to-date version of the Hazardous Materials Table is available on the U.S. DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) Web site at ://www.phmsa.dot.gov/hazmat/ (accessed December 29, 2014). Excerpts from the *Code of Federal Regulations,* Title 49 (49 *CFR*), Chapter 1 defining those groups are as follows:

49 *CFR* 173.50. Class 1—Definitions

(a) **Explosive** . . . An **explosive** means any substance or article, including a device, which is designed to function by explosion (i.e., an extremely rapid release of gas and heat) or which, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion . . .

(b) Explosives in Class 1 are divided into six divisions as follows:

(1) Division 1.1 consists of explosives that have a mass explosion hazard. A mass explosion is one which affects almost the entire load instantaneously.

(2) Division 1.2 consists of explosives that have a projection hazard but not a mass explosion hazard.

(3) Division 1.3 consists of explosives that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.

(4) Division 1.4 consists of explosives that present a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

(5) Division 1.5 consists of very insensitive explosives. This division is comprised of substances which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport.

(6) Division 1.6 consists of extremely insensitive articles which do not have a mass explosive hazard. This division is comprised of articles which contain only extremely insensitive detonating substances and which demonstrate a negligible probability of accidental initiation or propagation . . .

49 *CFR* 173.115. Class 2, Divisions 2.1, 2.2, and 2.3—Definitions

(a) Division 2.1 **(Flammable Gas)** . . . means any material which is a gas at 20°C (68°F) or less and 101.3 kPa (14.7 psia) of pressure (a material which has a boiling point of 20°C (68°F) or less at 101.3 kPa [14.7 psia]) which:

(1) Is ignitable at 101.3 kPa (14.7 psia) when in a mixture of 13 percent by volume with air; or

(2) Has a flammable range at 101.3 kPa (14.7 psia) with air of at least 12 percent regardless of the lower limit . . .

(b) Division 2.2 (Nonflammable, Nonpoisonous Compressed Gas—including compressed gas, liquefied gas, pressurized cryogenic gas, and compressed gas in solution . . .) A non-flammable, nonpoisonous compressed gas . . . means any material (or mixture) which—

(1) Exerts in the packaging an absolute pressure of 200 kPa (25.9 psig/43.8 psia) at 20°C (68°F), is a liquefied gas or is a cryogenic liquid, and

(2) Does not meet the definition of Division 2.1 or 2.3.

(c) Division 2.3 **(Gas poisonous by inhalation)** . . . means a material which is a gas at 20°C [68°F] or less and a pressure of 101.3 kPa (14.7 psia) . . . and which—

(1) Is known to be so toxic to humans as to pose a hazard to health during transportation, or

(2) In the absence of adequate data on human toxicity, is presumed to be toxic to humans . . .

49 *CFR* 173.120. Class 3—Definitions

(a) **Flammable liquid** . . . means a liquid having a flash point of not more than 60.5°C (141°F), or any material in a liquid phase with a flash point at or above 37.8°C (100°F).

(b) (1) . . . a **combustible liquid** means any liquid that does not meet the definition of any other hazard class specified in this subchapter and has a flash point above 60.5°C (141°F) but below 93°C (200°F) . . .

(2) A flammable liquid with a flash point at or above 38°C (100°F) that does not meet the definition of any other hazard class . . .

(c) **Flash point.** (1) Flash point means the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid . . .

49 *CFR* 173.124. Class 4, Divisions 4.1, 4.2, and 4.3—Definitions

(a) Division 4.1 **(Flammable Solid)** . . . means any of the following three types of materials:

(1) Desensitized explosives that—

(i) When dry are explosives of Class I other than those of compatibility group A which are wetted with sufficient water, alcohol, or plasticizer to suppress explosive properties; and

(ii) Are specifically authorized by name either in the section 172.101 table or have been assigned a shipping name and hazard class by the Associate Administrator for Hazardous Materials Safety under the provisions of—

(A) An exemption issued under subchapter A of this chapter; or

(B) An approval issued under section 173.56(i) of this part.

(2) (i) Self-reactive materials are materials that are thermally unstable and that can undergo a strongly exothermic decomposition even without participation of oxygen (air) . . .

(3) Readily combustible solids are materials that—

(i) Are solids which may cause a fire through friction, such as matches;

(ii) Show a burning rate faster than 2.2mm (0.087 inches) per second when tested in accordance UN Manual of Tests and Criteria; or

(iii) Are metal powders that can be ignited and react over the whole length of a sample in 10 minutes or less, when tested in accordance with UN Manual of Tests and Criteria.

(b) Division 4.2 **(Spontaneously combustible material)** . . . means--

(1) A pyrophoric material. A pyrophoric material is a liquid or solid that, even in small quantities and without an external ignition source, can ignite within five (5) minutes after coming in contact with air when tested according to UN Manual of Tests and Criteria.

(2) A self-heating material. A self-heating material is a material that, when in contact with air and without an energy supply, is liable to self-heat.

(c) Division 4.3 **(Dangerous when wet material)** . . . means a material that, by contact with water, is liable to become spontaneously flammable or to give off flammable or toxic gas at a rate greater than 1 liter per kilogram of the material per hour . . .

49 *CFR* 173.127. Class 5, Division 5.1—Definition and assignment of packing groups

. . . **oxidizer** (Division 5.1) means a material that may, generally by yielding oxygen, cause or enhance the combustion of other materials . . .

49 *CFR* 173.128. Class 5, Division 5.2—Definitions and types

. . . organic peroxide (Division 5.2) means any organic compound containing oxygen (O) in the bivalent -O-O- structure and which may be considered a derivative of hydrogen peroxide, where one or more of the hydrogen atoms have been replaced by organic radicals . . .

49 *CFR* 173.132. Class 6, Division 6.1—Definitions

. . . **poisonous material** . . . means a material, other than a gas, which is known to be so toxic to humans as to afford a hazard to health during transportation, or which, in the absence of adequate data on human toxicity:

(1) Is presumed to be toxic to humans because it falls within any one of the following categories when tested on laboratory animals (whenever possible, animal test data that has been reported in the chemical literature should be used):

   (i) Oral Toxicity. A liquid with an LD50 for acute oral toxicity of not more than 500 mg/kg or a solid with an LD50 for acute oral toxicity of not more than 200 mg/kg.

   (ii) Dermal Toxicity. A material with an LD50 for acute dermal toxicity of not more than 1000 mg/kg.

   (iii) Inhalation Toxicity. (A) A dust or mist with an LC50 for acute toxicity on inhalation of not more than 10 mg/L; or (B) a material with a saturated vapor concentration in air at 20°C (68°F) greater than or equal to one-fifth of the LC50 for acute toxicity on inhalation of vapors of not more than 5000 ml/m3; or

(2) Is an irritating material, with properties similar to tear gas, which causes extreme irritation, especially in confined spaces . . .

49 *CFR* 173.134. Class 6, Division 6.2—Definitions and exceptions

Division 6.2 (*infectious substance*) means a material known or reasonably expected to contain a pathogen. A pathogen is a microorganism (including bacteria, viruses, parasites, fungi) or other agent, such as a proteinaceous infectious particle (prion) that can cause disease in humans or animals . . .

49 *CFR* 173.401–173.476. Class 7 **Radioactive**

49 *CFR* 173.136. Class 8

. . . **corrosive material** (Class 8) means a liquid or solid that causes full thickness destruction of human skin at the site of contact within a specified period of time. A liquid that has a severe corrosion rate on steel or aluminum . . . is also a corrosive material.

49 *CFR* 173.140. Class 9

. . . **miscellaneous hazardous material** (Class 9) means a material which presents a hazard during transportation but which does not meet the definition of any other hazard class . . .

49 *CFR* 173.144. Other Regulated Materials (ORM)--Definitions

. . . "ORM-D material" means a material, such as a consumer commodity, which, although otherwise subject to the regulations of this subchapter, presents a limited hazard during transportation due to its form, quantity, and packaging . . .

Appendix S

Sample Physical Science Laboratory Regulations

_________________ **School District**

The following regulations have been compiled for the safety of students performing experiments and related work in physical science classes. Strict observance of the regulations is mandatory. All students in the school district are to follow these regulations, rather than any conflicting instructions in textbooks or laboratory manuals.

Students and parents are to read the regulations, sign the form, and return the form to the instructor. This procedure must be completed before a student can begin any laboratory activity. The student should keep a copy of the regulations in his or her notebook for future reference.

General

1. A teacher must be present during the performance of all laboratory work.
2. Prepare for each laboratory activity by reading all instructions before coming to class. Follow all directions implicitly and intelligently. Make a note of any modification in procedure given by the instructor.
3. Always approach laboratory experiences in a serious and courteous manner.
4. Use only those materials and equipment authorized by the teacher. Any science project or individually planned experiment must be approved by the teacher.
5. Know the proper fire- and earthquake-drill procedures.
6. Roll long sleeves above the wrist. Long, hanging necklaces; bulky jewelry; and excessive or bulky clothing should not be worn in the laboratory.
7. Confine long hair during a laboratory activity.
8. Wear closed-toe shoes in the laboratory. Sandals are not permitted.

9. Wear appropriate eye protection, as directed by the teacher, whenever working in the laboratory. Safety goggles must be worn during hazardous activities involving caustic/corrosive chemicals, heating of liquids, and other activities that may injure the eyes.
10. Splashes and fumes from hazardous chemicals present a special danger to wearers of contact lenses. Therefore, it is preferable for students to wear regular glasses (inside splash-proof goggles, when appropriate) during all class activities or purchase personal splash-proof goggles and wear them whenever exposure to chemicals or chemical fumes is possible.
11. Place books, purses, and other personal items in the designated storage area. Take only laboratory manuals and notebooks into the working area.
12. Report any accident to the teacher immediately, no matter how minor. This includes any burns, scratches, cuts, or contact with corrosive liquid (on skin or clothing).
13. Students with open skin wounds on hands must wear gloves or be excused from the laboratory activity.
14. Eating or drinking in the laboratory or from laboratory equipment is not permitted.
15. Students are not permitted in laboratory storage rooms or teachers’ workrooms without the approval of the teacher.

Handling Equipment

1. Inform the teacher immediately of any equipment that is not working properly.
2. Report broken glassware, including thermometers, to the teacher immediately.
3. Operate electrical equipment only in a dry area and with dry hands.
4. When removing an electrical plug from its socket, pull the plug, not the electrical cord.
5. When heating material in a test tube, do not look into the mouth of the tube or point it in the direction of any person during the process.
6. When working with lasers or apparatus that produce X-rays, microwaves, or ultraviolet rays, make certain that proper shielding and other precautions are used.

7. Know the location and operation of the emergency shower, eyewash and facewash fountain, fire blanket, fire extinguisher, fire-alarm box, and exits.
8. Light gas burners only as instructed by the teacher. Be sure no volatile materials (such as alcohol or acetone) are being used nearby.
9. Use a burner with extreme caution. Keep head and clothing away from the flame and turn it off when not in use.
10. A face shield should be worn when handling glassware in a vacuum situation.
11. Use a fire blanket to extinguish any flame on a person (see “stop, drop, and roll” procedure in Chapter 2, Section C).
12. Use the fume hood whenever noxious, corrosive, or toxic fumes are produced or released.
13. To cut small-diameter glass tubing, use a file or tubing cutter to make a deep scratch. Wrap the tubing in a paper towel before breaking the glass with both thumbs pushing outward. Fire-polish all ends.
14. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass look the same. Determine whether an object is hot by bringing the back of a hand close to the object.
15. Match hole size and tubing when inserting glass tubing into a stopper. If necessary, expand the hole first by using an appropriately sized cork borer. Lubricate the stopper hole and glass tubing with water or glycerin to ease insertion, using towels to protect the hand. Carefully twist (never push) glass tubing into stopper holes.

Handling Chemicals

1. Check labels and equipment instructions carefully. Be sure correct items are used in the proper manner.
2. Be aware if the chemicals being used are hazardous. Know where the Standardized Safety Data Sheets (SDS) are and what they indicate for each of the hazardous chemicals being used.
3. Never pour reagents back into bottles, exchange stoppers of bottles, or lay stoppers on the table.

4. When diluting acids, always pour acids into water, never the reverse. Combine the liquids slowly while stirring to distribute heat buildup throughout the mixture.
5. Keep hands away from face, eyes, and clothes while using solutions, specimens, equipment, or materials in the laboratory.
6. To treat a burn from an acid or alkali, wash the affected area immediately with plenty of running water. If the eye is involved, irrigate it at the eyewash station without interruption for 15 minutes. Report the incident to the instructor immediately.
7. Never carry hot equipment or dangerous chemicals through a group of students.
8. Use a mechanical pipette filler (never the mouth) when measuring or transferring small quantities of liquid with a pipette.
9. Never taste anything or touch chemicals with the hands unless specifically instructed to do so.
10. Test for odor of chemicals only by waving a hand above the container and sniffing cautiously from a distance.

Cleanup and Disposal

1. Be sure all glassware is clean before use. Clean glassware thoroughly after use. Residue may cause errors in new experiments or cause a violent reaction or explosion.
2. Keep work areas clean. Floors and aisles should be kept clear of equipment and materials.
3. Clean up any spill on the floor or work space immediately.
4. Dispose of laboratory waste as instructed by the teacher. Use separate, designated containers (not the wastebasket) for the following:

- Matches, litmus paper, wooden splints, toothpicks, and so on
- Broken and waste glass
- Rags, paper towels, or other absorbent materials used in the cleanup of flammable solids or liquids
- Hazardous/toxic liquids and solids

5. Remove all broken glass from the work area or floor as soon as possible. Never handle broken glass with bare hands; use a counter brush and dustpan.
6. Always clean the laboratory area before leaving.
7. Students and teacher should wash hands with soap and water before leaving the laboratory area.

Note: Persistent or willful violation of these regulations will result in the loss of laboratory privileges and possible dismissal from the class.

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